MINISTRY OF HEALTH
NATIONAL INSTITUTE FOR MEDICAL RESEARCH

TANZANIA JOURNAL OF HEALTH RESEARCH

Volume 26, Number 3,
2025

TANZANIA JOURNAL OF HEALTH RESEARCH

About the Journal

Sponsoring Organizations

The *Tanzanian Journal of Health Research* is published by the Tanzania Health Research Users Trust Fund

Publication Scheduling

Published quarterly in January, April, July and October

General

The Tanzania Journal of Health Research (TJHR) is a no-fee, open-access, peer-reviewed journal published online at https://www.ajol.info/index.php/thrb. It is published four times per year (January, April, July and October) by the Health Research Users Trust Fund under the National Institute for Medical Research (NIMR) in Tanzania.

TJHR publishes articles from various disciplines that include basic and biomedical sciences; behavioural sciences; epidemiology; clinical sciences; health economics and health policy; operations research and implementation sciences; and social sciences and humanities. It aims to advance health sciences by publishing high-quality research and review articles that communicate new ideas and developments in biomedical and health research.

TJHR accepts articles written in English; spelling should be based on British English. Manuscripts should be prepared in accordance with the fifth edition of the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" established by the Vancouver Group (International Committee of Medical Journal Editors, ICMJE). For additional details not covered in the ICMJE Recommendations, EAHRJ refers to the American Medical Association (AMA) Manual of Style (10th edition), published by the American Medical Association and Oxford University Press. The complete document, updated October 2001, is available at http://www.icmje.org/index.html. The manuscripts should be addressed exclusively to the TJHR. Their simultaneous presentation to other journals whether in regards to the text, tables or figures, whether in their totality or in part, is prohibited.

TJHR does not set explicit limits on the length of papers submitted but encourages authors to be concise in order to reach our audience effectively. In some cases, providing more detail in appendices may be appropriate. Formatting approaches such as subheadings, lists, tables, figures, and highlighting key concepts are highly encouraged.

Summaries and single-sentence tag lines or headlines— abstracted sentences containing keywords that convey the essential messages—are also standard. The authors must sign and submit a declaration in accordance with the copyright agreement. Original scientific articles should follow the conventional structure: Introduction, Materials and Methods, Results and Discussion.
Manuscripts must be submitted online using the following URL: http://www.ajol.info/index.php/thrb/login
For further information please contact us via tjhr@nimr.or.tz.

Journal Identifiers

eISSN: 1821-9241
print ISSN: 1821-6404

TANZANIA JOURNAL OF HEALTH RESEARCH

The *Tanzania Journal of Health Research* (TJHR) accepts articles written in English; spelling should be based on British English. Manuscripts should be prepared by the fifth edition of the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" established by the Vancouver Group (International Committee of Medical Journal Editors, ICMJE). For additional details not covered in the ICMJE Recommendations, EAHRJ refers to the American Medical Association (AMA) Manual of Style (10th edition), published by the American Medical Association and Oxford University Press.

TJHR does not set explicit limits on the length of papers submitted but encourages authors to be concise to reach our audience effectively. In some cases, providing more detail in appendices may be appropriate. Formatting approaches such as subheadings, lists, tables, figures, and highlighting key concepts are highly encouraged. Summaries and single-sentence tag lines or headlines— abstracted sentences containing keywords that convey the essential messages—are also standard. The authors must sign and submit a declaration of the copyright agreement. Original scientific articles should follow the conventional structure: Introduction, Materials and Methods, Results and Discussion.

CATEGORIES OF ARTICLES

1. **Original research articles:** Research articles that make a substantial, original contribution to research, practice or policy in any biomedical, socio-behavioural, structural or health research areas. Research articles are contributions that have the purpose of publication of original unpublished research which may be reproduced and generalised. They should be between 3000 and 6000 words, excluding tables, figures and references. The original research article should follow the conventional structure: Introduction, Materials and Methods, Results and Discussion.
2. **Short communications:** Short communications are intended to provide preliminary research results or unpublished hypotheses of public health relevance. Short communications may contain an abstract and can be organized either along the lines of a regular manuscript or without subdivisions. The accompanying abstract should not exceed 200 words. Authors may also consider combining the results and discussion sections. They should be up to 2500 words and include a table or figure, preferably not more than five references.
3. **Letters to the Editor**: These include letters which seek to discuss recent articles published in *TJHR* or report on original research or significant findings. They should not exceed 600 words and 5 references.
4. **Reviews:** *TJHR* welcomes review papers relating to biomedical and health research themes. The review should emphasize the implication of reviewed literature for future practical application and policy implications. A review paper should not exceed 6000 words.
5. **Clinical studies:** *TJHR* supports the registration of trials as an important initiative to improve the reporting of clinical studies. Trial registers that currently meet all of the International Committee of Medical Journal Editors and World Health Organization requirements can be found at http://www.icmje.org/faq.pdf
6. **Case reports:** TJHR accepts highly informative cases illustrated with a single table or up to two images [figure may have x 2 illustrations labelled (a) and (b)]. Articles submitted as case reports should be no more than 1500 words and a maximum of six references

Preparing a manuscript: Manuscripts for publication in ***the Tanzania Journal of Health Research*** should be prepared by the fifth edition of the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" established by the Vancouver Group (International Committee of Medical Journal Editors, ICMJE). The complete document, updated October 2001, is available at http://www.icmje.org/index.html. The manuscripts should be addressed exclusively to the TJHR. Their simultaneous presentation to other journals whether in regards to the text, tables or figures, whether in their totality or part, is prohibited. The authors must sign and submit a declaration of the copyright agreement. Original scientific articles should follow the conventional structure: Introduction, Materials and Methods, Results and Discussion as described in detail below:

1. **Title**: It should be short; omit phrases such as "Investigation on…' "Preliminary report of …'; numbered series articles followed by a subtitle are not allowed. Taxonomic affiliation and authority should be given in the abstract, or the keywords, but not in the Title. Full addresses should appear under the names of the author(s); in addition, the title page should contain the name and address of the person to whom the proofs should be sent. If the author's address has changed, his full present address should also appear on the title page. A short list of terms suitable for indexing should be included.
2. **Abstract**: A summary of your research paper.
3. **Introduction**: It should be short, defining the problem studied, stating its importance and highlighting the present gaps in knowledge. The introduction serves multiple purposes. It presents the background to your study, introduces your topic and aims, and gives an overview of the paper, should also cite what is already known about the study. The number of citations should be limited.
4. **Materials and methods**: All information must be given so that it is quite clear how the experiments were done: any interested colleague should be able to verify the experiments from this information. However, details about already commonly used methods and materials must be omitted. Information about the origin of the source materials is necessary.
5. **Results**: This section should be limited to the description of the findings achieved with no inclusion of interpretation. The results are usually presented in tables and figures, and the text must provide a clear explanation of this information. Tables and figures should be limited to a total of 5 and it is recommended that they include only essential data. Tables and figures should only be used for substantial amounts of data, otherwise, the information should be inserted in the text. Avoid repeating data from tables and figures in the text as much as possible. Numerals are always used with abbreviated units (e.g. 3 $mm^{2,}$ not three mm^2). In all other cases, whole numbers above 10, fractions and decimals should be expressed as numerals, and whole numbers between 1 and 10 are to be spelt out in full. All units are to conform to the standards of the International System (S.I).
6. **Discussion**: It should include the limitation of the study, a comparison with the available literature, the interpretation of the authors, concluding. The findings should be discussed about what is already known, and indications of the course for further research may be provided. Scientific as well as policy implications of the major findings may be mentioned. Within space limitations, the author has some freedom to express his own opinion, even if editors or referees differ from him.
7. **References**:
    1. For citations in the text: use name and year system; e.g. (Magesa, 1998); for two authors, use the ampersand (&); e.g. (Ijumba & Kitua, 2004); for more than two authors, use *et al.,* g. (Lusingu *et al.,* 2004). If referring to personal communication use initials e.g. (B.K. Mayala, per comm.). For unpublished results, use unpubl., e.g. (M. Urassa, unpubl). The latter two categories, however, cannot be put on the reference list.
    2. For citations in the reference section: list each reference alphabetically on the first author's last name; if a single author has more than one contribution, list each chronologically; in cases of more than one author, list each reference alphabetically on 2nd, the 3rd, etc. author's names. Publications in preparation or submitted can only appear in the reference list if they have been accepted for publication, mentioning the year of publication and volume of the journal with the reference note 'in press' added. Journal titles should be given in full.
    3. Include a list of all references cited at the end of the article, in the order in which they were mentioned in the text. References should be numbered consecutively in the order in which they are first mentioned in the text. Identify references in text, tables, and legends by Arabic numerals in superscript.

Submission of the Manuscript:

1. Please submit your paper through our online submission using the following URL: https://www.ajol.info/index.php/thrb/login. After creating an account, the online system will ask you to enter information about your paper, such as the title, abstract, and author names. Then you will be instructed to upload your title page, paper, and any accompanying figures, tables, photos, and supplementary materials.
2. Please upload the main paper with references as either a Microsoft Word document (DOC, DOCX) or in rich text format (RTF). It is the responsibility of the authors to ensure the good quality of tables, figures, tables and any other images in the published article.
3. The resolution of photos should be approximately 300 dpi (dots per inch), and line or halftone figures

and illustrations should be approximately 600 dpi. If you submit photographs with identifiable people you must also submit a form to grant permission to TJHR to use those images before final publication.

Conflict of Interest: All authors must complete the ICMJE Form for Disclosure of Potential Conflicts of Interest. You do not need to submit the forms to the Journal. Instead, the corresponding author should keep the forms on file if a question arises about competing interests related to your submission. The online submission system will ask you, however, to declare any competing interests for all authors, based on the ICMJE Uniform Disclosure Form. If there are no competing interests, please indicate, "None declared."

Submission fee: TJHR does not charge any fees to authors to submit or publish articles in our journal.

Contact: For further information, please contact the editors at tjhr@nimr.or.tz

EDITORIAL TEAM

EDITOR-IN-CHIEF

Dr William N. Kisinza,
The National Institute for Medical Research, Amani Research Centre,
P. O. Box 81 MUHEZA, Tanzania
Tel. (General line): +255 272977611, Tel. (Direct line): +255 27 2977612
Fax # : +255 272977610, E-mail: william.kisinza@nimr.or.tz, wnkisinza@gmail.com

MANAGING EDITOR

Mr Prince Pius Mutalemwa,
National Institute for Medical Research, 3 Barack Obama Drive, P.O. Box 9653, 11101 Dar-es-Salaam. Tel (Off): +255 22 2121400
Fax (Off): +255 22 2121360, Email: prince.mutalemwa@nimr.or.tz

DEPUTY MANAGING EDITOR

Dr Ruby D Mcharo
National Institute for Medical Research, 3 Barack Obama Drive, P.O. Box 9653, 11101 Dar-es-Salaam. Tel (Off): +255 22 2121400
Fax (Off): +255 22 2121360, Email: rmcharo@nimr-mmrc.org

JOURNAL ADMINISTRATION

Dr William N. Kisinza, Editor-In-Chief
Mr Prince Pius Mutalemwa, Managing Editor
Dr Ruby Mcharo, Deputy Managing Editor
Prof Said Aboud, Editorial Board Chair
Dr Mary Mayige, Editorial Director

JOURNAL MANAGEMENT

Dr William N. Kisinza, Editor-In-Chief
Mr Prince Pius Mutalemwa, Managing Editor
Dr Ruby Mcharo, Deputy Managing Editor
Dr Mbazi Senkoro, Associate Editor
Dr Alphaxard Manjurano, Associate Editor
Dr Sokoine Kivuyo, Associate Editor
Prof Said Aboud, Editorial Board Chair
Dr Mary Mayige, Editorial Director

EDITORIAL BOARD

Prof. Said S Aboud, National Institute for Medical Research, Dar es Salaam
Prof. Daudi Simba, Muhimbili University of Health and Allied Sciences, Dar es Salaam
Dr Werner Maokola, Ministry of Health, Dodoma
Prof Blandina Mmbaga, Kilimanjaro Clinical Research Institute, Moshi
Dr Mary T Mayige, National Institute for Medical Research, Dar es Salaam
Dr Gerry Mshana, National Institute for Medical Research, Mwanza
Dr Joseph Otieno, Muhimbili University of Health and Allied Sciences, Dar es Salaam
Prof Stella Mpagama, Kobong'oto Infectious Disease Hospital, Moshi
Prof Robinson Mdegela, Sokoine University of Agriculture, Mororogo
Dr Suzan Rumisha. National Institute for Medical Research, Dar es Salaam
Dr Marceline Finda, Ifakara Health Institute, Bagamoyo
Andrew Y. Kitua, Morogoro, Tanzania
James K. Tumwine, Kampala, Uganda
Mark Rowland, London, United Kingdom
Peter de Vries, Amsterdam, The Netherlands
Eligius F. Lyamuya, Dar es Salaam, Tanzania
Adamson S. Muula, Blantyre, Malawi
Ude F. Ezepue, Lagos, Nigeria
Edwin Michael, Notre Darme, USA
Paul E. Simonsen, Copenhagen, Denmark
Janusz Paweska, South Africa
Wolfgang R. Mukabana, Nairobi, Kenya

Journal Identifiers

eISSN: 1821-9241
print ISSN: 1821-6404

Contact

National Institute for Medical Research, 3 Barack Obama Drive,
P.O. Box 9653, 11101 Dar es Salaam TANZANIA

Principal Contact

Mr Prince Pius Mutalemwa
National Institute for Medical Research
+255 22 2121400
tjhr@nimr.or.tz

Support Contact

Dr Ruby D Mcharo
+255-22-2121400
rmcharo@nimr-mmrc.org

Journal Identifiers

eISSN: 1821-9241
print ISSN: 1821-6404

1. **STEPS Survey of non-communicable diseases, mental health, oral health and injuries in Tanzania: methodology and study population** *Gibson B. Kagaruki, Frank E Hassan, Kaushik L Ramaiya, Neema Kileo, Alphoncina Nanai, Omary S Ubuguyu, Sylvia Meku, Zuhura Saleh Amour, Kombo Mdachi Kombo, Stephano G Cosmas, Albert Kapala, Happy Nchimbi, Valeria P Millinga, Savin Stefan, Goodluck T. Mtei, Mary T. Mayige* https://dx.doi.org/10.4314/thrb.v26i3.1 ,,,,,1879
2. **Mosquito larvae abundance and adult productivity in an area of intensive malaria control in northeast Tanzania** *Eliningaya J. Kweka, Frank Magogo, Filemoni Tenu, Ming-Chieh Lee, William N. Kisinza, Leonard E.G. Mboera* https://dx.doi.org/10.4314/thrb.v26i3.2.....1894
3. **A Rare Case of Iron Deficiency Anemia Manifesting with Xylophagia** *Adamu Kilungu, Beatrice Thadei, Maguzu Nganga* https://dx.doi.org/10.4314/thrb.v26i3.3.....1911
4. **Influence of occupational cement exposure on inflammatory markers, hepatorenal function indices and oxidative stress markers among male cement handlers in Ilorin-Metropolis** *Adunmo Godwin Olawoyin, Adeniyi Temidayo Daniel, Oyeniyi Gbadebo Maroof, Abisoye Godwin Temitope, Adunmo Eyitayo Olutoyin, Owoiya Toheeb, Osho Mercy Adeola* https://dx.doi.org/10.4314/thrb.v26i3.4.....1915
5. **Molecular characterisation of urogenital schistosomiasis in Shinyanga and Misungwi districts, North-Western Tanzania** Yasinta D. Sylivester, Maria Zinga, Coleman Kishamawe, Charles Mangya, Bonnie L. Webster, Humphrey D. Mazigo, Safari M. Kinung'hi https://dx.doi.org/10.4314/thrb.v26i3.5.....1925
6. **Ebola Virus Disease Outbreak Prevention and Control Preparedness: A Qualitative Experience from High-Risk Regions in Tanzania** *Hussein Mohamed, Emmy Metta, Tumaini Nyamhanga, Priscilla Kusena, Deodatus Kakoko, Nathanael Sirili, Awet Araya, Allan Rwechungura, Gasto Frumence* https://dx.doi.org/10.4314/thrb.v26i3.6.....1940
7. **Factors Influencing Modern Contraceptive Use among Women of Reproductive Age in Rural Areas of Tanzania** *Anicet Rwezaula, Edmund Zakayo, Nsajigwa Mwalupani* https://dx.doi.org/10.4314/thrb.v26i3.7.....1950
8. **Comparative study on genital yeasts diversity isolated from rural and urban women with vaginitis attending antenatal and gynecology clinics in Southern Highland regions of Tanzania** *Lucy A. Namkinga, Joseph D. Swilla, Clement N. Mweya, Rebecca Mokeha, Delfina D Mkenda, Omary Salehe* https://dx.doi.org/10.4314/thrb.v26i3.8.....1960
9. **Ethnobotany and Antimicrobial Activity of the Selected Medicinal Plants Used for the Management of Microbial Infections in Pemba Island, Tanzania** *Hassan Mohamed Faqih, Ramadhani S.O. Nondo, Joseph N. Otieno, Michael Qwarse, Samson Hilonga, Khamis Rashid Kheir, Mayassa Salum Ally, Boniphace Charles Mwita, Francis Machumi, Mariana John Shayo* https://dx.doi.org/10.4314/thrb.v26i3.9.....1969
10. **Examining sociodemographic factors affecting male involvement in family planning services: a study of married men in Musanze district** *Emmanuel Ndahiro Manirafasha, Clemence Nishimwe* https://dx.doi.org/10.4314/thrb.v26i3.10.....1998
11. **Effectiveness of knowledge sources in acquiring mental health knowledge among adults in Tanzania** *Fransiska Josephat Mruma, Emmanuel Mkhai, Mohammed Kassim* https://dx.doi.org/10.4314/thrb.v26i3.11.....2010
12. **Exploring the drivers of unprescribed antibiotics dispensing in community drug outlets in Dodoma Region, Central Tanzania: a cross-sectional study** *Richard James Mabilika, Emmanuel George Mang'ombe* https://dx.doi.org/10.4314/thrb.v26i3.12.....2026
13. **Orofacial cleft patterns and risk factors among patients at Mbeya Zonal Referral Hospital, Tanzania: A retrospective descriptive study** *Hery Mwakayoka, Anange Lwilla, Willyhelmina*

Olomi, Flaviana Nyatu, Ekaristo Mwang'ande, Clement N Mweya, Omary Khamis https://dx.doi.org/10.4314/thrb.v26i3.13.....2037

14. **Navigating Barriers: Challenges and Strategies for Adopting Artificial Intelligence in Qualitative Research in Low-Income African Contexts** *Kahabi Ganka Isangula* https://dx.doi.org/10.4314/thrb.v26i3.14.....2048
15. **Prevalence of hypertension and associated factors in Dar es Salaam semi-urban, Tanzania: A community-based cross-sectional study** *Lilian Leonard Fweja, Akwilina Wendelin Mwanri, Cornelio N. Nyaruhucha* https://dx.doi.org/10.4314/thrb.v26i3.15.....2060
16. **Factors for Prime Vendor System Performance in Complementing Health Commodities in Public Health Facilities: A Case Study of Tanzania Mainland** *Mathew Mganga, Stephen Kibusi, Romuald Mbwasi* https://dx.doi.org/10.4314/thrb.v26i3.16.....2073
17. **Cumulative effect of consanguinity on prenatal mortalities among offspring in Northern Morocco** *Mohamed Hajjaji, Mohamed El Bakkali AbdErrazzak Khadmaoui* https://dx.doi.org/10.4314/thrb.v26i3.17.....2084
18. **Determinants of the desire for more children among women of reproductive age using TDHS data 2022** *Nsajigwa Mwalupani, Christina Geoffrey Mandara, Mwajabu Mashinde* https://dx.doi.org/10.4314/thrb.v26i3.18.....2098
19. **The role of commodification of health care in Reproducing Health Care inequality in the Context of Neoliberalism in Amana Regional Referral Hospital** *Nassoro Rajabu Kitunda* https://dx.doi.org/10.4314/thrb.v26i3.19.....2110
20. **Factors associated with postpartum depression among adolescent mothers in Kigamboni municipality, Dar es Salaam: A cross-sectional study** *Beatrice Mungi Matondo, Peter Joseph Wangwe, Ester Steven Mzilangwe* https://dx.doi.org/10.4314/thrb.v26i3.20.....2021
21. **Factors contributing to errors during radiotherapy in a resource-constrained setting: Experience from Ocean Road Cancer Institute in Tanzania** *Polikalipo Simon Kagina, Furahini Yoram* https://dx.doi.org/10.4314/thrb.v26i3.21.....2033
22. **Community Perceptions on Mass Drug Treatments for Schistosomiasis and Strategies to Increase Treatment Coverage in Mwanza Region, Tanzania** *Ndaro RC, Kinung'hi SM, Musai A, Kishamawe C, Sambaiga R* https://dx.doi.org/10.4314/thrb.v26i3.22.....2041
23. **Oral prosthesis cleaning practice and oral health status of Removable Oral Prosthesis Wearers attended Kilimanjaro Christian Medical Centre, Moshi, Tanzania** Esther Shimba, Florida Muro, Deogratias Rwakatema, Ruchius Philbert https://dx.doi.org/10.4314/thrb.v26i3.23.....2055
24. **Availability and quality of vaccine cold chain equipment at healthcare facilities in Mtwara region, Tanzania: evidence from routine assessment of vaccine cold chain equipment** *Serveus Ruyobya Kamala, Hamad Nyembea, Florence Salvatory Kalabamu, Amos Justinian Ngonzi, Fatuma Manzi, Bonaventura Nestory, Florian Tinuga* https://dx.doi.org/10.4314/thrb.v26i3.24.....2066
25. **Voluntary Choice of Lifestyle Modification in Secondary Prevention of NCDs** *Soumik Gangopadhyay, Soma Sur, Saugat Ghosh, Somnath Chatterjee* https://dx.doi.org/10.4314/thrb.v26i3.25.....2080
26. **Knowledge, Attitudes, Perceptions and Health-Seeking Practices Towards Rabies and Dog-Bite Injuries among Residents in Ibadan, South-Western Nigeria** *Blessing Seun Agbajelola, Victor Ibukun Agbajelola, Mojisola Morenike Oluwasanu* https://dx.doi.org/10.4314/thrb.v26i3.26.....2094

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.1

STEPS Survey of non-communicable diseases, mental health, oral health and injuries in Tanzania: methodology and study population

Gibson B. Kagaruki[1*],Frank E Hassan[1], Kaushik L Ramaiya[2], Neema Kileo[3], Alphoncina Nanai[3], Omary S Ubuguyu[4], Sylvia Meku[6], Zuhura Saleh Amour[5], Kombo Mdachi Kombo[7], Stephano G Cosmas[6], Albert Kapala[6], Happy Nchimbi[2], Valeria P Millinga[4], Savin Stefan[8], Goodluck T. Mtei[4], Mary T. Mayige[1]
**These authors have equal contributions.

[1]National Institute for Medical Research (NIMR), Dar es Salaam, Tanzania, [2]The Tanzania NCD Alliance (TANCDA), Dar es Salaam, Tanzania, [3]World Health Organization (WHO), Dar es Salaam, Tanzania, [4]Ministry of Health (MoH), Dodoma, Tanzania, [5]Ministry of Health (MoH), Unguja, Zanzibar, [6]National Bureau of Statistics (NBS), Dodoma, Tanzania, [7]Office of the Chief Government Statistician (OCGS), Unguja, Zanzibar, [8]World Health Organization (WHO), Geneva, Switzerland

Abstract
Introduction: The burden of non-communicable diseases (NCDs) remains a public health concern in Tanzania, contributing to high morbidity and mortality. STEPS surveys conducted in 2011 and 2012 in Zanzibar and mainland Tanzania indicated a high prevalence of NCDs and related risk factors. This paper describes the methodology of the 2023 STEPS survey on NCD risk factors.
Objectives: The survey was conducted to provide nationally representative data on the NCD risk factors in Tanzania, Mainland, and Zanzibar.
Methods: The survey was a household-based study that employed a three-stage cluster sampling design. The target population consisted of all individuals, both women and men, aged 18 to 69 years, who were usual residents of the selected households. The Tanzania Population and Housing Census 2022 was used as the sampling frame for the 2022/2023 STEPS survey. The overall estimated sample size was 4,320 respondents (Mainland = 3,780 and Zanzibar = 540). Data were collected on the levels of major NCD risk factors, including physical inactivity, unhealthy dietary practices, smoking, harmful alcohol consumption, depression, and overweight/obesity, using the standardized WHO STEPS methodology. Data were collected electronically using Open Data Kit (ODK)-based eSTEPS software. The survey was conducted from September 2022 to September 2023. Ethical approval to conduct the study was obtained from the National Health Research Ethics Committee for Tanzania Mainland, the Zanzibar Health Research Ethics Committee, and the Second Vice President's Office for Zanzibar.
Results: Estimates of NCD prevalence and associated risk factors and determinants will be reported in separate publications.
Conclusion: This survey highlights the prevalence estimates of hypertension, diabetes, mental health issues and depression, road traffic injuries, non-road traffic accidents, and the burden of cardiovascular risks in Tanzania. Risk factor analysis identified and quantified common behaviours and conditions that increase the likelihood of developing non-communicable diseases. Analysing these risk factors will help identify high-risk groups and inform targeted prevention strategies.
Keywords: STEPS Survey, non-communicable diseases, mental health, oral health and injuries, methodology

Introduction: The global trend of non-communicable disease mortality presents a serious obstacle to achieving the WHO Sustainable Development Goal 3, Target 3.4: to reduce premature mortality from NCDs by one-third by 2030(World Health Organization, n.d..). The effects of NCDs have been increasing rapidly worldwide,

* Corresponding author email: gkagaruki@gmail.com

surpassing previous predictions. These effects are also disproportionately felt in low- and middle-income countries (LMICs), particularly in Sub-Saharan Africa. Mortality from NCDs has risen over the past three decades, doubling since 1990 from 18.7 million deaths to approximately 36.6 million deaths in 2020(Habib & Saha, 2010). However, by 2016, mortality from NCDs had already reached 40.1 million worldwide, accounting for 71% of all deaths (Bennett et al., 2018). Like other low- and middle-income countries, Tanzania faces an increasing burden of NCDs. Traditionally, the country has been burdened by a high prevalence of communicable diseases, including diarrhea, tuberculosis, other respiratory tract infections, malaria, neglected tropical diseases, and HIV/AIDS (Aryal et al., 2015). However, with improvements in health and interventions to curb infectious diseases, the population in Tanzania has experienced increased life expectancy, reduced child mortality, and overall improvements in health and health determinants. This development has also led to a surge in NCDs. The clear epidemiological transition in Tanzania has been driven by significant social, economic, and demographic changes, along with urbanization and environmental challenges (Aryal et al., 2015; Moran et al., 2013).

Non-communicable diseases, also known as lifestyle diseases or preventable diseases, affect all populations and have been rising at alarming rates in the country. Four common diseases include diabetes, cancer, chronic respiratory disorders, and cardiovascular diseases. Other categories include mental health disorders, injuries, oral health problems, and blood-related diseases (Aryal et al., 2015; Bennett et al., 2018; Msyamboza et al., 2011). The four major diseases share common risk factors, including high blood pressure, excessive weight and obesity, unhealthy diets, harmful alcohol consumption, insufficient physical activity, and tobacco use. Evidence suggests that addressing these diseases depends heavily on primary prevention and lifestyle modifications (Mayige et al., 2011). Such lifestyles are often ingrained in daily living and the ways of life of the population, varying from country to country and across different regions within a country.

The National Institute for Medical Research (NIMR) of Tanzania has increased its efforts and investment in NCD research as a key strategic area in its Institutional Strategic Plan for 2019-2024, as well as in the National Health Research Agenda and National NCD Research Agenda, which align with the Health Sector Strategic Plan and NCD Strategies(WHO, 2013) (NHRA-2018-2023, Unpublished). Furthermore, the government of Tanzania has been working with development partners to address the burden of NCDs (NIMR, 2013) and has conducted the WHO NCD STEPS survey 2022/2023. This is the first joint STEPS Survey and second survey in both Tanzania Mainland and Zanzibar in the spacing of more than 10 years(WHO, 2013) . The World Health Organization's (WHO) STEP survey is a standardized method for collecting data on NCD risk factors. It uses a tiered approach, with the core questionnaire (STEP 1) gathering information on key behaviours such as tobacco use, alcohol consumption, physical activity, and dietary intake. STEP 2 involves physical measurements of weight, height, and blood pressure. Optionally, STEP 3 can include blood tests to assess cholesterol and blood glucose levels. The STEPS survey also features a modular design that allows for customization, with optional modules focusing on specific topics like mental health or oral health. This makes it a valuable tool for countries at all stages of development to monitor and address the chronic disease burden within their populations based on local needs and available resources.

Due to the chronic nature of NCDs, the costs of care are burdensome for families, communities, and the country(Mathebula et al., 2020; WHO, 2013), Making prevention the most viable solution, preventive efforts require a clear understanding of the risk factors, which, although common, vary across populations, regions, and contexts. The 2022/2023 STEPS survey aimed to determine the national burden of non-communicable diseases and associated risk factors in the country. Specifically, it sought to document the national prevalence and patterns of NCD risk factors at all three levels, using both core and expanded modules to generate data on NCDs and related risk factors.

Objectives

Main objective

To assess the prevalence of major behavioural and biological risk factors for NCDs among adults in Tanzania

Specific Objectives

1. To document the national prevalence and patterns of NCDs risk factors

2. To generate country data on NCDs and related risk factors using WHO recommended approach that can be used for comparison globally
3. To collect data from which to predict likely future demands for NCDs and analysis of trends of NCDs risk factors over time
4. To document the process of data collection and field work experiences.

Methods

Study design and settings

This was a cross-sectional, population-based survey using the WHO STEPS Methodology (WHO, 2017b).

Study Area: The survey was conducted in all regions of Tanzania Mainland and Zanzibar, covering a total of 26 regions in Tanzania Mainland and 5 regions in Zanzibar. In Tanzania Mainland, 129 out of 186 District Councils were selected, while in Zanzibar, the study covered all District Councils. A total of 288 enumeration areas were sampled, with 252 from Tanzania Mainland and 36 from Zanzibar, representing both rural and urban areas. The zones and their respective regions included in this study were as follows: Western (Tabora and Kigoma), Northern (Arusha, Kilimanjaro, and Tanga), Central (Dodoma, Singida, and Manyara), Southern Highlands (Ruvuma, Iringa, and Njombe), Southern (Lindi and Mtwara), Southwest Highlands (Mbeya, Rukwa, Katavi, and Songwe), Lake (Shinyanga, Kagera, Mwanza, Mara, Simiyu, and Geita), and Eastern (Morogoro, Pwani, and Dar es Salaam). Additionally, two zones from Zanzibar were included: Unguja (Kaskazini Unguja, Kusini Unguja, and Mjini Magharibi) and Pemba (Kaskazini Pemba and Kusini Pemba).

Survey population

All adult women and men aged 18 – 69 years residing in Tanzania Mainland and Zanzibar.

Inclusion criteria

All women and men aged 18-69 years living in a selected residential household for at least 6 months. Pregnant women were included but excluded from weight, height, waist, and hip circumferences measurements and spot urine sample collection

Exclusion criteria:

Those living in the selected residence for less than 6 months, household members who is away from home for more than 2 months, those who are mentally incapacitated and those who are sick/ frail and unable to participate in the survey.

Sampling

Sample Size Determination

The overall sample size was determined based on the minimum number of individual interviews required to obtain a national estimate of the proportion of individuals aged 18–69 years with NCD risk factors, with a relative standard error of 5% at the national level. Using a design effect of 1.5 (associated with allocation by strata and an assumed intra-cluster correlation of 0.05 for proportions), and 6 clusters with an 80% response rate, a total sample of 4,320 individuals (one adult per household aged 18–69 years, agreeing to participate) was deemed sufficient to achieve a relative standard error of 5% or less for a proportion estimate of 50% of the population with NCD risk factors (97.2%, 25.9%, and 29.3%) with a 95% confidence interval at the national level, and a relative standard error of 5% at the domain level, across 6 age and sex categories. The age-sex categories are 18–30, 31–45, and 46–69 years for both males and females. The estimated number of households takes into account adjustments for household vacancy and non-response, the number of individuals per household, individual non-response, and refusals.

Sampling Frame and Sample Size

The sampling frame used for STEPS 2022/2023 was the Tanzania Population and Housing Census (TPHC 2022), which was conducted in Tanzania in 2022(Ministry of Finance and Planning, 2022). The sampling frame is a complete list of Enumeration Areas (EAs) covering the entire country, provided by the National Bureau of

Statistics (NBS) of Tanzania. In rural areas, an EA is a natural village, a segment of a large village, or a group of small villages; in urban areas, an EA is a street or a city block (Ministry of Finance and Planning, 2022). Each EA is accompanied by identification information, administrative details, and a measure of size, which is the number of residential households in the EA. Each EA is also classified as either urban or rural. Additionally, each EA includes cartographic material that delineates its geographical location, boundaries, main access points, and landmarks within or outside the EA, which helps in identifying the EAs.

The sample for STEPS 2022/2023 was a stratified sample selected in three stages from the 2022 census frame, as highlighted above. Stratification was achieved by separating urban and rural areas to form distinct sampling strata. In total, four explicit sampling strata were created: Tanzania Mainland Urban (TZM-U), Tanzania Mainland Rural (TZM-R), Zanzibar Urban (ZNZ-U), and Zanzibar Rural (ZNZ-R). EA samples were selected independently in each sampling stratum using a probability proportion to size (PPS) selection procedure. Implicit stratification and proportional allocation were achieved at each lower administrative unit level by sorting the sampling frame within the explicit stratum according to the administrative units at different levels (region, district, ward, EA) before sample selection.

In the first stage: A total of 288 EAs were selected with probability proportional to their size, with independent selection in each sampling stratum and distributed proportionally between rural and urban EAs. With a fixed number of 15 households selected per cluster, the total number of households selected was 4,320.

In the second stage: A fixed number of 15 households were selected from each selected EA using a systematic sampling method. Interviewers were instructed to interview only the pre-selected households, and no replacements were allowed for non-respondent households to prevent bias. Interviewers were also asked to make at least 3-4 revisits to reduce nonresponse bias.

The third sampling stage: This stage involved randomly selecting respondents aged 18-69 years from each selected household. Information on the gender and age of each household member aged 18-69 years was obtained from the household roster. Using the random sampling Kish method algorithm, which was built into the eSTEPS software, one individual aged 18-69 years was selected and interviewed once consent was obtained. The selection was randomized using the eSTEPS tool based on the list of individuals aged 18 to 69 in the household. This random approach aimed to achieve the approximate proportions of females and males in the general population. Benchmark weighting was applied to adjust the gender proportions in the survey results. The proposed sample was expected to provide a representative sample of the main domains of interest, including Urban/Rural and Male/Female at the national level (URT), as well as Urban/Rural and Male/Female for both Mainland and Zanzibar. A full description of the sample design is available in the "STEPS 2022/2023 Sampling Note" as an appendix. This sampling note includes a detailed explanation of how the final weights will be calculated. These weights are applied to the final data files to yield representative survey estimates.

Data collection tools and methods

The STEPS Tanzania questionnaires based on the standard STEPS questionnaires developed by the WHO, adapted to the Tanzania situation, and needs (WHO, 2013).

Details of Data Collection

STEP 1: Interview:

The questionnaire captured the following information: demographic details; behavioural measures on tobacco use, alcohol consumption, and the intake of fruits and vegetables; and an assessment of physical activity. It also included self-reported information on hypertension, diabetes, dyslipidaemia, and a family history of cardiovascular diseases. Additionally, the questionnaire contained measures of socio-economic status, diet, and physical activity, all of which were self-reported. STEPS 2022/2023 also included optional modules on cervical cancer, oral health, injuries, and mental health/depression status. More details are provided below.

Behavioural risks: Information on behavioural risks, such as alcohol consumption, tobacco use, fruit and vegetable consumption, and participation in physical activities, was collected.
Alcohol consumption: Participants were interviewed about their history of alcohol consumption, and those who reported drinking alcohol were asked additional questions. These questions included the age at which they started drinking, the frequency of drinking, and the average amount consumed.

Tobacco use: Participants were interviewed about their history of smoking, using smokeless tobacco, or using electronic cigarettes. Those identified as current smokers or tobacco product users were asked additional questions, including the age at which they started smoking and the age when they began smoking daily. They were also asked about the number of cigarettes they smoke and the frequency of smoking.

Fruits/vegetable consumption: Fruit and vegetable consumption was assessed according to WHO standards. Participants were asked how many days per week they eat fruits and vegetables and to estimate the average number of servings they consume each day.

Physical activities: Physical activity was assessed using questions adopted from the Global Physical Activity Questionnaire (GPAQ). This questionnaire was used to collect information on physical activity participation in three settings: activity during travel, leisure time, and sedentary habits.

Cervical Cancer: Women aged 30-49 years were asked if they had ever undergone a cervical cancer screening test using any of the methods described below: Visual Inspection with Acetic Acid/Vinegar (VIA), Pap smear, or Human Papillomavirus (HPV) test. They were informed that VIA involves inspecting the surface of the uterine cervix after applying acetic acid (or vinegar). For both the Pap smear and HPV test, a doctor or nurse uses a swab to take a sample from inside the vagina and sends it to a laboratory. In some cases, the individual may be given the swab and asked to collect the sample themselves. The laboratory checks for abnormal cell changes if a Pap smear is performed and for the presence of the HPV virus if an HPV test is conducted. The responses were "Yes" or "No."

Injuries: Data were collected to estimate the prevalence of road traffic crashes and non-road traffic accidents, such as falls, burns, poisoning, cuts, near drownings, or animal bites, that required medical attention during the past 12 months. Individuals were categorized into three groups: those who experienced only a road traffic accident, only a non-road accident, or both types of accidents.

STEP 2: Physical measurements
Blood pressure: Blood pressure was measured using an electronic sphygmomanometer, the Bosch & Sohn Medicus UNO BP device. The measurement was taken at rest, with the participant seated for at least 10 minutes and the arm elevated at the level of the heart. All blood pressure readings were repeated three times at 3-minute intervals, and all three readings were recorded in the tablets.

Weighing was done in kilograms (kg) with a digital weighing scale (SECA®) - WS80-N weight scale) on a stable and flat surface in a person with light clothing.

Height was measured in centimetres, using a portable stadiometer (SECA®) or ultrasonic height meters, participants were asked to stand with feet together, heels against the height scale with knees straight, and in light clothing.

Waist circumference: Waist circumference (WC) was measured to the nearest 0.1 cm using a flexible, non-stretch tape. The tape was placed over no more than one layer of clothing, halfway between the lowest rib and

the top of the hip bone, approximately at the level of the umbilicus, without tightening the skin. The respondent was instructed to relax and exhale while the measurement was taken.

Hip Circumference was measured to the nearest 0.1 cm using a flexible non-stretch tape around the widest portion of the buttocks, with the tape parallel to the floor wearing minimal clothing and standing straight.

STEP 3: Laboratory measurements

Blood Glucose, and Cholesterol Measurements

Participants were asked to fast for at least 8 hours. Blood was taken by fingerpick and measured through dry chemistry using CardioChek Professional Analyzer v2.56. All tests were done by a trained technician.

Urine Sodium and Creatinine

Participants were asked to collect their urine before fasting (i.e., before 10 p.m.) and bring it with them to their appointment for blood testing the next morning. They were provided with a container featuring a QR code, a ziplock bag, and instructions for urine collection.

The STEPS survey used the already-established infrastructure for transporting biological samples from all areas across the country to the National Public Health Laboratory. Before transportation, laboratory personnel ensured that the urine sample container was properly labelled and securely sealed. It was then placed in a sealable plastic bag to prevent potential leaks, before being placed in an insulated transport cooler box. The cooler box was sturdy, well-sealed, and labelled with the destination address and handling instructions. The cooler box was taken to the regional postal office for transportation to the National Public Health Laboratory in Dar es Salaam, where urine sodium and creatinine analysis were conducted using standard chemistry methods.

Urine Cotinine: The COT 10 and COT 200 tests were conducted to measure cotinine levels in participants' urine samples. Cotinine, a nicotine metabolite, serves as a reliable biomarker of tobacco exposure, providing valuable information on both active smoking and exposure to second-hand smoke. The COT 10 test detects cotinine at a threshold of 10 ng/ml, effectively identifying recent exposure to tobacco smoke, which is crucial for understanding short-term exposure patterns. In contrast, the COT 200 test, with a higher threshold of 200 ng/ml, is designed to detect more significant or prolonged tobacco use, offering a clearer picture of chronic exposure. Urine samples were collected in the field, and the tests were performed on-site using portable testing kits. The results were promptly recorded on tablets equipped with the survey software, ensuring efficient data capture and integration into the survey database for subsequent analysis. This approach allowed for a timely and accurate assessment of tobacco exposure among the surveyed population. Table 1, summarize the survey models, core and expanded items considered in the reported survey.

Table 1: Core and expanded items per each studied survey model

Survey Module	Core items	Expanded Items
Core Modules		
Demographics	Basic demographic data, age, sex,	educational status, marital status, Socioeconomic variables
Behavioural Risk Factors	Tobacco use Alcohol consumption Fruits and vegetables consumption Physical activity	
Previous Medical History	History of Raised Blood Pressure History of Diabetes Raised Total Cholesterol	

	History of cardiovascular diseases	
Physical Measurements	Weight Height Blood Pressure Waist Circumference	Hip Circumference Heart Rate
Biochemical Measurement	Blood Glucose Total Cholesterol Urinary Sodium Urinary Creatinine	Triglycerides Urinary cotinine
Optional Modules		
Cervical Cancer	History of cervical cancer screening among (eligible)	
Mental Health/ Suicide		
Oral Health		
Violence and injuries		

SURVEY IMPLEMENTATION

Questionnaire adaptation: During the adaptation of the questionnaires, inputs were sought from the Ministries of Health (Tanzania Mainland and Zanzibar), and expert teams in the various health topics covered in the STEPS questionnaires were engaged through a series of workshops.

Survey Advocacy plan: It was important to raise public awareness of the survey and its rationale to improve the response rate and ensure full participation of respondents in the study. Public sensitization meetings and the formal launch of the survey were conducted at the district, regional, and national levels, with key stakeholders such as the Minister of Health, Chief Medical Officers, Directors from the Ministry of Health (MoH), the President's Office – Regional Administration and Local Government (PO-RALG), the National Bureau of Statistics, the Office of the Chief Government Statistician (OCGS), and District and Regional Medical Officers. Representatives from Non-Governmental Organizations and various media outlets were also involved. Local community leaders, including religious leaders, local administrative personnel (e.g., Village Executive Officers, VEO), and respected community elders, were engaged during the community entry process.

Data collection and Study Quality Control Measures

To ensure the quality of the data collected, the following measures were undertaken:

1. Team members were selected based on their experience with field data collection, including many who had participated in the 2011/2012 STEPS surveys.
2. Data collection teams were trained on the data collection tools and survey methods and were involved in piloting the instruments to familiarize themselves with the tools and address any questions before fieldwork.
3. Data collection and measurement protocols, including show cards, were developed and integrated into the tablets, with each data collector receiving a copy in addition to the training.
4. Physical and biochemical measurement instruments were calibrated according to the manufacturer's instructions before use.

5. Blood pressure measurements were repeated three times at 3-minute intervals, as per STEPS standard protocol, to ensure consistency.
6. Data collection was done electronically to minimize errors that could arise from manual data entry, with quality checks in place to limit data entry mistakes.
7. Data collection was monitored daily, and field check tables were produced weekly to assess performance and provide feedback to the research teams. The eSTEPS tool included modules for quality checks, which were routinely monitored by the quality control (QC) team.
8. Daily virtual meetings were held with field supervisors, data collectors, and the national STEPS coordination team (including IT specialists and statisticians) to review collected data and provide feedback to the data collection teams and supervisors.

Data management and analysis

Data management: The flow of household and individual participant data was monitored daily as it was collected, automatically saved on the central server via the eSTEPS platform, and backup files were stored on NIMR servers. Before analysis, meticulous data cleaning procedures were implemented using both Excel and Stata software to identify and address inconsistencies, duplicates, and outliers within the dataset. Data were exported from eSTEPS to Excel for cleaning and to generate information for weighting the data. The cleaned data were then exported into EpiInfo and STATA 17 for analysis. To account for the varying selection probabilities at each stage and adjust for any unequal sampling, weights were assigned at each stage of the sampling process. These weights were further refined based on the most recent population distribution data from the 2022 census, specifically considering age groups (18-30, 31-45, and 46-69 years) and sex (male and female).

Descriptive statistics: Quantitative data analysis began with running descriptive statistics to characterize the dataset. This included univariate analysis of frequency and percentage distributions, as well as measures of central tendency and dispersion. Data were analysed using descriptive statistics, including medians, means, and proportions, along with their corresponding confidence intervals. The data were disaggregated by age and sex categories to provide a more detailed understanding of the findings. Additionally, trend analysis was employed to compare the results from the 2023 survey with those from the 2012 STEPS survey, with a particular focus on the 25–64-year-old age group. Inferential analysis was also conducted using appropriate methods, such as t-tests, correlations, and regression models.

Inferential Analysis: We conducted bivariate analysis to assess differences in the prevalence of target indicators using a Chi-square test for categorical variables and a T-test for continuous variables. Advanced analyses were performed to determine the predictors and determinants of selected indicators, such as the prevalence of hypertension, diabetes, overweight/obesity, mental health and depression, road traffic injuries, non-road traffic injuries, and cardiovascular risks, among others. We applied advanced statistical techniques, including multinomial logistic regression, classical logistic regression, linear regression, and modified Poisson regression.

For binary indicators with a prevalence of less than 10%, we applied the classical logistic regression model, as it is expected to fit well with the outcome and explanatory variables. Modified Poisson logistic regression is recommended for outcomes with a prevalence of ≥10%, as logistic regression tends to overestimate odds ratios when the outcome of interest exceeds this threshold(Lee et al., 2009; Zou, 2004). For linear regression, we reported Beta coefficients, while for modified Poisson and classical logistic regression, we reported prevalence ratios (PR) and odds ratios (OR), respectively. Explanatory variables associated with outcome indicators included zone, location (rural/urban), age, sex, marital status, education, occupation, alcohol consumption, and depression. Additionally, geospatial analysis was performed using the coordinates collected in the survey to map the distribution of outcomes of interest across different zones in Tanzania using Geographic Information Systems (GIS).

Outcome Variables: Outcomes variables were extracted and reported and some of those outcome's variables are listed below and how will be generated:
Harmful alcohol consumption: non-harmful and harmful drinking (<6 harmful or un-harmful drinking ≥6 units of standards drink per week) were used to categorize level of drinking.
Fruits/vegetable consumption: Consumption of fruits and vegetables as per standards were considered if the frequency is greater or equal to 5 days per week.
Physical activities: Physical activities were quantified using the Metabolic Equivalent of Task (MET), which is the ratio of a person's working metabolic rate relative to their resting metabolic rate. By definition, one MET represents the energy expenditure of sitting quietly and corresponds to a caloric consumption of 1 kcal/kg/hour. Compared to sitting quietly, a person's caloric consumption is approximately four times higher during moderate activity and eight times higher during vigorous activity. Therefore, when calculating a person's overall energy expenditure, 4 METs were assigned to time spent in moderate activities, and 8 METs were assigned to time spent in vigorous activities. Low physical activity levels were defined as <600 MET minutes per week, while high levels of physical activity were defined as ≥3000 MET minutes per week (Mashili et al., 2018)
Raised Blood pressure: An individual was classified as having raised blood pressure if BP of SBP≥140 mmHg and or DBP≥90mmHg or was on medication for raised BP (WHO, 2017b)
Abnormal Waist circumference: The values for waist circumference were grouped according to the World Health Organization (WHO) and International Diabetes Federation (IDF) recommendations, where the abnormal waist circumference of males and females is>94 cm and >80 cm, respectively (Diabetes Federation International, 2019).

Body Mass Index: The product of weight (in Kilograms) divided by height squared (m^2) resulting in BMI. Categorization of BMI was based on the following classifications: obesity is ≥30 kg/m2; Overweight if the BMI is > 25 but < 30kg/m2, and normal if the BMI is between 18-24.9kg/m2 and underweight if below 19 kg/m^2 (Kagaruki et al., 2014).

Raised Fasting Blood Glucose: An individual is considered to have raised fasting blood glucose when the result is >7.0mmol/L (WHO, 2017b).

Raised total cholesterol: An individual was classified as having raised total cholesterol if his/her total cholesterol reading was ≥ 5.0 mmol/L or if was currently on medication for elevated cholesterol(WHO, 2012).

Depression: A person was considered to have depression if they experienced five or more symptoms, which significantly impacted their daily life or caused distress. These symptoms included feeling sad or depressed most of the day for at least two weeks in the past year, losing interest in or pleasure from usual activities, and experiencing a low mood. Additional symptoms could include trouble concentrating, making decisions, feeling worthless or hopeless, having thoughts of death or suicide, changes in sleep or eating habits, decreased energy, and physical slowness or restlessness (WHO, 2017a).

Road traffic accident and Non-Road Accident: The current STEPs survey categorized individuals based on their involvement in different types of accidents over the past 12 months. Those who were involved in road traffic crashes as drivers, passengers, pedestrians, or cyclists were considered to have experienced a road traffic crash. Individuals who encountered non-road traffic accidents, such as falls, burns, poisonings, cuts, near-drownings, or animal bites requiring medical attention, were considered to have experienced non-road traffic accidents. If someone experienced both types of accidents, they were categorized as having encountered both road traffic crashes and non-road traffic accidents.

High risk or with CVD among individuals aged 40-69years: Individuals aged 40–69 years were assessed for their risk of cardiovascular disease (CVD) using the WHO prediction chart. The parameters considered included country code, gender, age, smoking status, history of diabetes, systolic blood pressure, total cholesterol, and

body mass index. Those with a calculated CVD risk of 20% or higher, or a history of heart attack, angina, or stroke, were classified as high risk or having CVD(Kulothungan et al., 2024).

Raised Sodium: An individual was categorized as having elevated sodium if the concentration of sodium in their urine exceeded 220.0 mmol/L.

Raised Creatine: An individual was deemed to have elevated creatine in their urine if the creatine value exceeded 22.90 mmol/L.

Data weighting: To ensure the accuracy, reliability, credibility, representativeness, and trustworthiness of the survey findings, three types of data weighting techniques were employed. First, probability weights were assigned to each respondent based on their likelihood of being included in the survey, correcting for any over- or under-representation of certain individuals or groups. Second, non-response weights were applied to address bias from respondents who chose not to participate, with higher weights assigned to those less likely to respond. Finally, post-stratification weighting involved dividing the survey sample into subgroups based on characteristics such as age and gender, then applying weighting factors to align the distribution of these subgroups in the sample with that of the population. This comprehensive approach helps mitigate biases and ensures the reliability of the survey results. The processes for weighting are elaborated in detail below:

Sample weight: The sample weight was used to adjust for the probability of selection of each participant. Below are the procedures for calculating the sample weight (OUM Sophal; PRAK Piseth Raingsey; KHUON Eng Mony; MEY Vannareth; AIM Sothea; BOUNCHAN Youttiroung; CIN Sovannara; PEN Linda; LOUN Sathia, 2010; WHO, 2017b):

i) The probability of selection at all stages (Enumeration Areas, Household, and Individual within the household) was calculated. A total of 288 Enumeration Areas (252 from Tanzania Mainland and 36 from Zanzibar) were deemed sufficient to represent all Tanzanians aged 18 to 69 years. These EAs were distributed proportionally across all 26 regions of Tanzania Mainland and five regions of Zanzibar. Using Probability Proportional to Size (PPS), the required number of EAs per region was determined, and the respective probabilities of selection were documented.

$$\text{Prob EA} = \frac{\text{Number of households in the EA} \times \#\text{ of clusters required in the region}}{\text{Cumulative population households in each EA}}$$

ii) Probability for selecting households in each EA (Prob hhd) was calculated by dividing 15 (number of selected households) by total number of households in the EA.

$$\text{Prob hhd} = \frac{\text{Number of households selected in the EA}}{\text{Total number households in the EA}}$$

iii) Within-household probability of selection for each participant (Prob ind) was calculated by dividing the number of people selected (i.e. 1) by the number of eligible people in each household.

$$\text{Prob ind} = \frac{\text{Number of selected eligible member in the household (1)}}{\text{Total number eligible members in the household}}$$

The final sample weight (W1) for each participant was obtained by taking the inverse of the product of the probabilities calculated in steps i, ii and iii:

$$\text{Sample weight (W1)} = \frac{1}{\text{Prob EA} \times \text{Prob hhd} \times \text{Prob ind}}.$$

Non-Response Weight

The non-response weight is the inverse of the response rate for Step1and 3 in each cluster (EA). It was calculated using data in the interview tracking form responded in each EA.

The response rate for each step was calculated.

$$\text{Response rate for Step1} = \frac{1}{\text{Step1Response"Yes"} + \text{Step1Response"No"}}.$$

Response rate for Step3= $\frac{1}{\text{Step3 Response "Yes" + Step3 Response "No"}}$.

The inverse of the response rate was then used to obtain the non-response weights for Step 1 (W1) and Step 3 (W2), respectively. Since the majority of participants in Step 1 also participated in Step 2, the response rates for Steps 1 and 2 were considered equal.

Population weight/Post stratification (W3)

The population weight was used to correct for differences between the age-sex structure of our sample and the age-sex structure of the target population. It was calculated as follows:

a) The proportion of the sample comprised of three age categories (18-30, 31-45, and 46-69) for each sex group was calculated by dividing the total number of individuals in each age-sex group by the total number of individuals in the sample.

b) The proportion of the target population comprised of the same three age categories (18-30, 31-45, and 46-69) for each sex group was calculated by dividing the total number of individuals in each age-sex group by the total number of individuals in the target population.

c) The final population weight (W3) was calculated by dividing the population proportion by the sample proportion.

$$\text{Population weights(W3)} = \frac{\text{Population Proportion}}{\text{Sample proportion}}$$

Overall weights

The overall weight for each Step of the survey (WStep1&2 and WStep3) was obtained by multiplying together the sample, non-response, and population weights:

WStep1&2=W1 x W2 x W3

WStep3 =W1 x W2 x W3

The procedures for estimating weights and overall weights were applied consistently across all regions, including Tanzania, Tanzania Mainland, and Zanzibar. Once the overall weighting parameters were determined, a complex analysis was conducted to generate the desired indicator values. This standardized approach ensures the comparability and reliability of the results across different regions within Tanzania. Lastly, the comprehensive approach to sampling, weighting, data cleaning, and analysis strengthens the generalizability and robustness of the study's conclusions.

Discussion

Tanzania has conducted its second STEPS Survey as part of the NCD Global Monitoring Framework to establish national-level estimates for the burden of various NCD risk factors. The previous survey was carried out in 2011/2012, approximately ten years ago, which is contrary to the WHO recommendation of conducting this survey every 4 to 5 years. The overall study response rate of 82.5% is good and comparable to other surveys; however, it is much lower than the response rate observed in the 2012 survey. The main reason for this reduction was the use of a pre-existing sampling frame derived from the recent Census data, without repeat household listing. This led to some missing or unidentified households, as the STEPS survey does not allow for replacement.

The scope of the survey in this round covered STEPS 1 to 3, including both core and expanded items, as well as additional modules on injuries, mental health, cervical cancer screening, and oral health, which were prioritized in the national NCD strategic plan (URT, 2021), The survey will allow the country to report, for the first time, national-level prevalence and risk factors for these conditions, as well as access to healthcare services. The results will be used to monitor the progress of NCD prevention and treatment strategy implementation, with the new modules serving as the baseline national data for the respective programs. Additionally, the findings will be valuable for benchmarking progress against other countries and contributing to global policies. Capacity-building activities were a key aspect of the 2022/2023 STEPS Survey, including comprehensive documentation of the survey protocol. The training and involvement of a large number of personnel in field

staff training, data collection, data cleaning, and analysis during the 2022/2023 STEPS implementation significantly enhanced the in-country capacity to conduct future STEPS Surveys using local human resources.

The major lessons learned were that future surveys should include household listing as part of the STEPS survey implementation to improve the response rate. Additionally, engaging local governments and conducting prior community engagement at the national level had a significant impact on the success of the survey implementation. It is also recommended that sufficient resources be allocated to allow for more subgroup analysis, including additional age groupings and zonal/regional-level data aggregation, in line with the country's subnational planning processes.

Results Dissemination Plan

- Dissemination of the STEPS findings and recommendations to the policymakers will be done by the production of STEPS Country Report, FACT Sheet, and policy briefs using less technical language to reach a wider audience
- Dissemination of the STEPS findings and recommendations to the public through the media and community forums to raise awareness of NCDs and their related risk factors
- Dissemination of the STEPS findings to the scientific community through presentations at key National and International scientific meetings and peer-reviewed publications

Ethical consideration

Ethical approval for this study was sought from the National Health Research Ethics Committee (NatHREC) for the Tanzania mainland and Zanzibar Health Research Ethics Committee (ZAHREC) and the Second Vice President Office, Zanzibar for Zanzibar. This study followed ethical principles per the revised 1964 Declaration of Helsinki, including ethical approval and informed consent(Kori-Lindner, 2000). Written informed consent was obtained from participants upon confirmation of understanding of the research and goals for each step. Interviews and physical and Biochemical measurements were performed in a setting that ensured participants' confidentiality. Participants were permitted to stop the interview or refuse to participate without repercussion. Data are confidential; no personal identifiers were collected.

Reference

Aryal, K. K., Mehata, S., Neupane, S., Vaidya, A., Dhimal, M., Dhakal, P., Rana, S., Bhusal, C. L., Lohani, G. R., Paulin, F. H., Garg, R. M., Guthold, R., Cowan, M., Riley, L. M., & Karki, K. B. (2015). The burden and determinants of non communicable diseases risk factors in Nepal: Findings from a nationwide STEPS survey. *PLoS ONE*, *10*(8). https://doi.org/10.1371/journal.pone.0134834

Bennett, J. E., Stevens, G. A., Mathers, C. D., Bonita, R., Rehm, J., Kruk, M. E., Riley, L. M., Dain, K., Kengne, A. P., Chalkidou, K., Beagley, J., Kishore, S. P., Chen, W., Saxena, S., Bettcher, D. W., Grove, J. T., Beaglehole, R., & Ezzati, M. (2018). NCD Countdown 2030: worldwide trends in non-communicable disease mortality and progress towards Sustainable Development Goal target 3.4. In *The Lancet* (Vol. 392, Issue 10152, pp. 1072–1088). Lancet Publishing Group. https://doi.org/10.1016/S0140-6736(18)31992-5

Diabetes Federation International. (2019). IDF Diabetes Atlas Ninth edition 2019. In *International Diabetes Federation*. http://www.idf.org/about-diabetes/facts-figures

Habib, S. H., & Saha, S. (2010). Burden of non-communicable disease: Global overview. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *4*(1), 41–47. https://doi.org/10.1016/J.DSX.2008.04.005

Kagaruki, G. B., Mayige, M. T., Ngadaya, E. S., Kimaro, G. D., Kalinga, A. K., Kilale, A. M., Kahwa, A. M., Materu, G. S., & Mfinanga, S. G. (2014). *Magnitude and risk factors of non-communicable diseases among people living with HIV in Tanzania : a cross sectional study from Mbeya and Dar es Salaam regions*. 1–9.

Kori-Lindner, C. (2000). Ethical principles for medical research involving human subjects: World medical association declaration of Helsinki. *Klinische Pharmakologie Aktuell*, *11*(3), 26–28.

Kulothungan, V., Nongkynrih, B., Krishnan, A., & Mathur, P. (2024). Ten-year risk assessment for cardiovascular disease & associated factors among adult Indians (aged 40-69 yr): Insights from the National Noncommunicable Disease Monitoring Survey (NNMS). *Indian Journal of Medical Research*, *159*, 429–440. https://doi.org/10.25259/ijmr_1748_23

Lee, J., Tan, C. S., & Chia, K. S. (2009). A Practical Guide for Multivariate Analysis of Dichotomous Outcomes. *Ann Acad Med Singapore*, *38*, 714–719.

Mashili, F. L., Kagaruki, G. B., Mbatia, J., Nanai, A., Saguti, G., Maongezi, S., Magimba, A., Mghamba, J., Kamugisha, M., Mgina, E., Mweya, C. N., Kaushik, R., & Mayige, M. T. (2018). Physical Activity and Associated Socioeconomic Determinants in Rural and Urban Tanzania : Results from the 2012 WHO-STEPS Survey. *International Journal of Population Research*, *2018*, 7–10.

Mathebula, R. L., Maimela, E., & Ntuli, N. S. (2020). The prevalence of selected non-communicable disease risk factors among HIV patients on anti-retroviral therapy in Bushbuckridge sub-district, Mpumalanga province. *BMC Public Health*, *20*(1). https://doi.org/10.1186/s12889-019-8134-x

Mayige, M., Kagaruki, G., Ramaiya, K., & Swai, A. (2011). Non communicable diseases in Tanzania: a call for urgent action. *Tanzan J Health Res*, *13*(5 Suppl 1), 378–386. http://pesquisa.bvsalud.org/portal/resource/pt/mdl-26591992

Ministry of Finance and Planning, T. N. B. of S. and P. O.-F. and P. O. of the C. G. S. Zanzibar. (2022). *The 2022 Population and Housing Census: Age and Sex Distribution Report. Tanzania, December 2022*.

Moran, A., Forouzanfar, M., Sampson, U., Chugh, S., Feigin, V., & Mensah, G. (2013). The Epidemiology of Cardiovascular Diseases in Sub-Saharan Africa: The Global Burden of Diseases, Injuries and Risk Factors 2010 Study. *Prog Cardiovasc Dis*, *56*(3), 234–239. https://doi.org/10.1016/j.pcad

Msyamboza, K. P., Ngwira, B., Dzowela, T., Mvula, C., Kathyola, D., Harries, A. D., & Bowie, C. (2011). The burden of selected chronic non-communicable diseases and their risk factors in malawi: Nationwide steps survey. *PLoS ONE*, *6*(5). https://doi.org/10.1371/journal.pone.0020316

OUM Sophal; PRAK Piseth Raingsey; KHUON Eng Mony; MEY Vannareth; AIM Sothea; BOUNCHAN Youttiroung; CIN Sovannara; PEN Linda; LOUN Sathia. (2010). *Prevalence of Non-Communicable Disease Risk Factors In Cambodia*.

URT. (2021). *Strategic plan and action plan for the prevention and control of non communicable diseases in Tanzania 2016-2020 government of the united republic of Tanzania; Ministry of Health, Community Development, Gender, Elderly and Children*.

WHO. (2012). *Formal meeting of Member States to conclude the work on A/NCD/2 the comprehensive global monitoring framework, including 21 November 2012 indicators, and a set of voluntary global targets for the prevention and control of noncommunicable diseases Report of the Formal Meeting of Member States to conclude the work on the comprehensive global monitoring framework, including indicators, and a set of voluntary global targets for the prevention and control of noncommunicable diseases*.

WHO. (2013). *Tanzania Steps Survey Report final* (Issue November). file:///C:/Users/User/Downloads/UR_Tanzania_2012_STEPS_Report.pdf

WHO. (2017a). *Depression and Other Common Mental Disorders Global Health Estimates*.

WHO. (2017b). *WHO STEPS Surveillance Manual*.

World Health Organization. (n.d.). *World Health Statistics 2018 : monitoring health for the SDGs : sustainable development goals.*

Zou, G. (2004). A Modified Poisson Regression Approach to Prospective Studies with Binary Data. *American Journal of Epidemiology*, *159*(7), 702–706. https://doi.org/10.1093/aje/kwh090

Capacity Building

Undergraduate and graduate students will use the data from this survey to produce their thesis for their career development.

Funding Source

The survey was funded by WHO and the Ministry of Health Tanzania

Consent for publication
Not applicable.
Competing interests
The authors declare that they have no competing interests.
Acknowledgement
The National Institute for Medical Research (NIMR) was the main implementer / executing organization of the 2023 STEPS survey, in close collaboration with the Office of the Chief Government Statistician (OCGS)-Zanzibar, the MoH-Mainland and MoH-Zanzibar and Tanzania National Bureau of Statistics (NBS). A technical committee oversaw the daily implementation of the survey with local coordination done by the PORALG, and the STEPS Steering Committee did overall planning and supervision. We acknowledge the field supervisors, data collection teams and the participants for making this survey possible. Thanks to the WHO country office, WHO-AFRO, and HQ, who provided technical support.

Contributions
GBK, NK, AN, OSU, SM, ZSA, FEH, KLR, KMK, SGC, AK, HN, VPM, GTM and MTM designed the study and wrote the manuscript. GBK, SS, SM, KMK, SGC, FEH, AK and MTM were involved finalizing the method section. All authors assisted in the writing, reviewing and approval of the manuscript. All authors read and approved the manuscript.

Abbreviations
BP-Blood Pressure
CVD- cardiovascular diseases
DBP-Diastolic Blood Pressure
EA-Enumeration Area
GIS-Geographic Information Systems
GPAQ-Global Physical Activity Questionnaire
HPV-Human Papillomavirus
IDF-International Diabetes Federation
MET-Metabolic Equivalent of Task
MOH-Ministry of Health
NBS-National Bureau of Statistics
NBS-National Bureau of Statistics
NCDs- Non-communicable diseases
NIMR-National Institute for Medical Research
OCGS-Office of the Chief Government Statistician
OR-Odds Ratio
PO-RALG-President's Office – Regional Administration and Local Government
PPS-Probability Proportion to Size
PR-Prevalence Ratio
QC-Quality Control
TPHC-Tanzania Population and Housing Census
TZM-R-Tanzania Mainland Rural
TZM-U-Tanzania Mainland Urban
VEO-Village Executive Officers
VIA-Visual Inspection with Acetic Acid/Vinegar
WC-Waist Circumference
WHO -World Health Organization
ZNZ-R-Zanzibar Rural

ZNZ-U-Zanzibar Urban

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.2

Mosquito larvae abundance and adult productivity in an area of intensive malaria control in northeast Tanzania

*Eliningaya J. Kweka [1, 2, *], Frank Magogo [3], Filemoni Tenu [3], Ming-Chieh Lee [4], William N. Kisinza [3], Leonard E.G. Mboera [5+]*

[1] Department of Medical Parasitology and Entomology, School of Medicine, Catholic University of Health and Allied Sciences, P.O. Box 1464, Mwanza, Tanzania, [2] Tanzania Plant Health and Pesticides Authority, Department of Pesticides Management, Pesticides Bioefficacy Section, P.O. Box 3024, Arusha, Tanzania, [3] National Institute for Medical Research, Amani Medical Research Centre, P.O. Box 81, Muheza, Tanzania, [4] Program in Public Health, College of Health Sciences, University of California, Irvine, CA 92697-4050, USA, [5] National Institute for Medical Research, Headquarters, P.O. Box 9653, Dar es Salaam, Tanzania

ABSTRACT

Introduction: Targeting mosquito larval stages for malaria vector control is gaining more popularity in sub-Saharan Africa. Here we assessed mosquito species diversity and the effects of physicochemical parameters, distance to human habitation, and land use types on the productivity of larval habitats, with a focus on *Anopheles gambiae* (*sensu lato*).

Methods: A total of 21 habitats were surveyed for 15 weeks to evaluate species-specific oviposition preferences and species composition of *An. gambiae* (*s.l.*). Habitats were classified as drainage ditches, swamps, and man-made wells, whereas land types were classified as shrubs, farmland, and pasture. The distance to the nearest house and the habitat's physical characteristics and physicochemical parameters were recorded.

Results: A total of 4511 mosquito larvae were sampled during the survey period. Of these, 54.93% were *An. gambiae* (*s.l.*), 2.09% were *An. funestus*, and 42.98% were *Culex quinquefasciatus*. Among 2397 larvae of *Anopheles mosquitoes* sampled, 501 were identified to the species level using the TaqMan genotyping assay. A total of 251(50.10%) *Anopheles specimens* identified were *An. arabiensis*, 173(34.53%) were *An. gambiae* (*s.s.*) and 17(3.39%) were *An. coustani*; DNA was not successfully amplified for 60 (11.98%) *An. gambiae* (*s.l.*).

Conclusion: The presence of *An. gambiae* larvae was positively correlated with habitats located nearest to houses.

Keywords: Land-use; Larval abundance; Productivity; *Anopheles gambiae* (*s.s.*); *An. arabiensis*; *An. funestus*; Tanzania

Introduction

Land use changes in different areas have influenced the availability of potential mosquito larval habitats (Bezirtzoglou et al., 2011; Bueno-Mari & Jimenez-Peydro, 2013). Understanding larval habitat abundance in different land use types is critical for the management of mosquito oviposition sites. In western Kenya, targeted larvicide applications have contributed to decreased entomological inoculation rates (Fillinger et al., 2009; Kweka et al., 2011b; Ndenga et al., 2011).

Larval source management (LSM) has long been used in malaria control, although it has been practiced on a small scale (Imbahale et al., 2010; Kweka et al., 2012), particularly in tropical Africa. Effective LSM is a priority in reducing vector populations because of the following reasons: (i) increase

[*]**Corresponding author:** *E-mail address*: pat.kweka@gmail.com

[+] Deceased, May God Rest the Deceased in Piece, AMEN

of insecticide resistance for insecticide classes used in indoor residual spraying (IRS) or insecticide-treated mosquito nets (ITNs) (Padonou et al., 2012b; Okumu et al., 2013; Osse et al., 2013); (ii) changes in feeding and resting behaviour of adult mosquitoes due to widespread use of intervention tools (Padonou et al., 2012a); (iii) 'refuges' of vector populations through alternative outdoor blood-meal sources (Coetzee et al., 2000; Kweka et al., 2011b; Sinka et al., 2012); and (iv) LSM suppresses mosquito populations at their production site.

Effective utilization of LSM needs appropriate information and knowledge on land use types, larval abundance, and gravid female mosquito response to habitat resources (Ndenga et al., 2011; Kweka et al., 2012; Ndenga et al., 2012). Some human activities such as deforestation in the Muheza District have led to a substantial increase of areas better suited to *Anopheles gambiae* (*s.l.*). These open habitats provide more suitable mosquito oviposition sites and increase the risk of malaria transmission (Lindsay et al., 2000; Balls et al., 2004; Bødker et al., 2006). Despite the intensive research activities in the area, there is limited information on habitat larval density and productivity. Habitats in different land use types frequently show the existence of different larval densities (Munga et al., 2006a; Kweka et al., 2011b, 2012). This is, at least partially, caused by the oviposition site preferences of mosquito species (Bentley & Day, 1989). The preference of *An. gambiae* (*s.l.*) gravid females to specific habitats might be influenced by several of the following factors; food sources for larvae; habitat characteristics (pH, grass cover, and turbidity); organic pollutants (McCrae, 1984); predators (Kweka et al., 2011a); olfactory cues (Bentley & Day, 1989; Rejmánková et al., 2005); and debris and algae (Rejmánková et al., 1996; Kweka et al., 2011b). Mosquitoes of the *Anopheles funestus* group show a preference for wide habitats with vegetation cover such as swamps (Nambunga et al., 2020; Debrah et al., 2021).

This study was carried out to determine the larval abundance and adult productivity of several human-biting mosquito species in different habitat and land use types. Additionally, we determined habitat characteristics, physicochemical parameters, and the distance to the nearest houses. Until 2005, when the use of ITN was scaled-up, this region was considered a holoendemic area for malaria (WHO, 1975; Gillies & Coetzee, 1987). The objective of this study was to identify characteristics of productive larval habitats about distance to human dwellings to aid future community-wide larvicide efforts. In addition, we verified the species composition compared to historical data for the same area of Muheza (Kabula et al., 2011, Kweka et al., 2008).

Materials and methods

Study sites

The present study was conducted in Muheza District, Northeast Tanzania (Figure 1). Productive larval habitats were searched in different land use types in Muheza peri-urban areas using standard dipper methods. Twenty dips were made per habitat to estimate the larval abundance. For large water bodies, 20 dips were made randomly around the whole water body. Larvae were identified to the species level using a morphological key (Gillies & Coetzee, 1987). Twenty-one productive oviposition habitats containing larval stages of *Anopheles gambiae* (*s.l.*) were chosen. These twenty-one habitats were the only positive habitats found to be aquatic throughout as others had dried out. We focused on three frequently occurring habitat types in which *Anopheles* spp. could be observed: swamps; drainage ditches; and man-made wells (larval habitats such as water pits as described by Munga et al., 2007). The habitats occurred within three different land-use types: pastureland, farmland and shrubland; these were shown in previous studies to represent productive habitat types (Munga et al., 2006a, b; Kweka et al., 2011b). Habitat positions were marked with labelled pegs and georeferenced using a handheld Garmin Global Positioning System unit (eTrex Venture HC, USA).

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.2

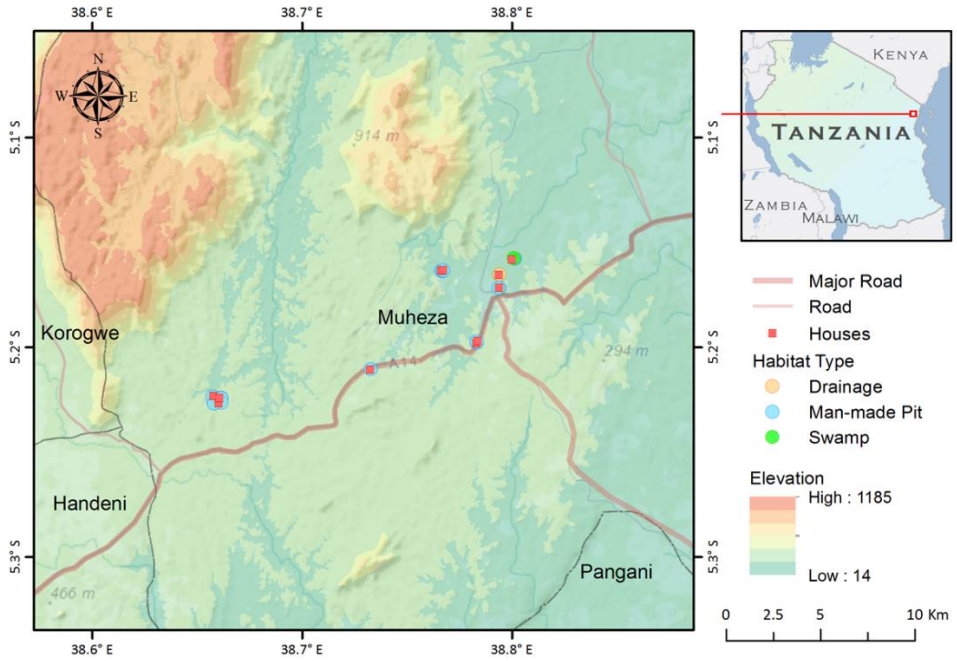


Figure 1: A map showing the study sites and habitat types examined during the study period in Muheza, Tanga Region, Tanzania.

Land use and habitat type definitions

Land use definition was based on ongoing activities; shrubland was considered as land covered by short vegetation and not used for agriculture or grazing; livestock grazing areas were considered as pastureland; and land used for crop production was considered as farmland (Munga et al., 2006b). The definition and classification of habitat types in the present study considered the categories established by a previous study (Minakawa et al., 2005). The habitat types used were swamp, man-made wells and drainage ditches.

Mosquito sampling and identification

A standard dipper (350 ml, BioQuip Products, Inc. California, USA) was used for weekly sampling of mosquito larvae and pupae (WHO, 1975). All mosquito larvae were immediately stored in absolute ethanol in separate vials after being identified to the species level according to the morphological key developed by Gillies & Coetzee (1987). Vials with larvae were kept at 4 °C until molecular identification. Pupae were kept separately in 250 ml paper cups filled with 200 ml of water from their original habitat. After emergence, individual adults were morphologically sorted according to sex and identified to the species level (Gillies & Coetzee, 1987). Anophelines (both larvae and adults) were further molecularly identified to the species level, utilizing the TaqMan single nucleotide polymorphism genotyping protocols (Bass et al., 2007; Walker et al., 2007).

Larval habitat characterization

We measured the depth, length and width in centimetres of the habitats weekly. The following parameters were also measured weekly from 8:30 h to 13:00 h during larval sampling: temperature; pH; conductivity, turbidity; and chlorophyll content. A Hanna® Instruments portable pH meter (SN 06592887; Woonsocket, RI, USA) was utilized for the registration of temperature, pH and conductivity. Chlorophyll and turbidity were determined with a portable turbidimeter (AquaFluor, Sunnyvale, CA, USA). Both instruments were calibrated fortnightly for accurate reading using the manufacturer's instructions.

Predator quantification and identification
Invertebrates found in the habitats during sampling were identified using the key by Needham & Needham (1941). The density of invertebrate predators was counted for 20 dips per habitat.

Habitat grass cover estimation
Grass cover was roughly estimated in percentages with a scale interval of 5%. Grass cover is defined as the percentage of habitats covered by emergent and/or floating vegetation. Sampling was done weekly on every Tuesday. Grass cover estimation has been used in previous studies and shown to be a good method for establishing the relationship between vegetation cover and larval abundance (Munga et al., 2009; Kweka et al., 2011b, 2012).

Abundance of larval stages and species diversity
Larval abundance was defined as the average number of aquatic stages of mosquitoes found in 20 dips (Munga et al., 2006b; Mutuku et al., 2006; Kweka et al., 2011b, 2012). The pupae sampled from each habitat were kept in paper cups with water from the same habitat; pupae were held until emergence. Habitat productivity was defined as the number of emerging adult female mosquitoes per square meter (Munga et al., 2006b; Kweka et al., 2011b). (The male mosquitoes' productivity was not considered as they are not disease vectors).

A diversity index was used to assess mosquito species composition and abundance. Diversity indices provide more detailed information about community composition than simply species richness. The Simpson diversity index is a quantitative measure reflecting both the number of species and individual species abundance. The value of a diversity index increases both when the number of species increases and when the evenness of their abundance increases. For a given number of species, the value of a diversity index is maximized when all types are equally abundant. Species diversity index (D) was computed using the Simpson's diversity index (Alatalo and Alatalo, 1977; Norris and Pollock, 1998) for all 15 weeks in different land use and habitat types using the formula:

$$D = \sum_{i=1}^{N} \left(P_i^2 \right)$$

where p_i is the relative abundance of the i-th species and N is the total number of species. D varies from 0 to 1, with values near zero corresponding to highly diverse or heterogeneous communities and values near one corresponding to more homogeneous ecosystems. When the D value is small, there is a dominant species (in terms of individual species); when D is larger, there is low species dominance.

Stepwise multivariate logistic regression analysis with backward elimination of variables was used to assess the strength of the association between mosquito larval abundance and land use types, grass cover percentage, habitat types, conductivity, chlorophyll level, temperature, turbidity, predator species abundance, and distance to the nearest house (less than 100 meters or more than 100 meters from household). Data analysis was performed using Stata version 12.1 (STATA Corp.2012, Texas, USA) and PWAS statistics version 26 (SPSS Inc., Chicago, IL, USA).

Results

Larval abundance and diversity
Larval habitats were found in all three land use types, i.e. farmland, shrubland and pastureland. A total of 4511 mosquito aquatic stages were sampled during the survey period. Of these, 4363 (96.72%) were larvae and 148 (3.28%) were pupae. From the sampled larvae, 2397 (54.94%) were *An. gambiae* (*s.l.*), 91 (2.09%) were *An. funestus*, and 1875 (42.98%) were *Culex quinquefasciatus*. Among all pupae sampled, 121 (81.76%) were *An. gambiae* (*s.l.*), and 27 (18.24%) were *Cx. quinquefasciatus*.

https://dx.doi.org/10.4314/thrb.v26i3.2

Based on habitat types considered in this study, a total of 696 larvae were sampled from two swamps; of these, 85 (12.2%) were *An. gambiae* (*s.l.*), and 611 (87.8%) were *Cx. quinquefasciatus*; *An. funestus was not found in either swamp studied*. In man-made wells (*n* = 18), a total of 3536 larvae were sampled; of these, 2215 (62.64%) were *An. gambiae* (*s.l.*), 89 (2.52%) were *An. funestus*, and 1232 (34.84%) were *Cx. quinquefasciatus*. A total of 121 pupae of *An. gambiae* (*s.l.*) were sampled from the man-made wells but no *Cx. quinquefasciatus* pupae were found during the study period. From the only studied drainage ditch, 131 larvae were sampled; of these, 97 (74.05%) were *An. gambiae* (*s.l.*), 2 (1.53%) were *Cx. quinquefasciatus*, and 32 (24.43%) were *An. funestus*. No pupae were sampled from the drainage ditch. In the shrubland, a total of 883 larvae were sampled; of these, 681 (77.12%) were *An. gambiae* (*s.l.*) and 202 (22.88%) *Cx. quinquefasciatus* and no *An. funestus* was found in drainage ditches. A total of 28 pupae of *Cx. quinquefasciatus* were sampled from shrubland. In pastureland, 1599 larvae were sampled; of these, 605 (37.84%) were *An. gambiae* (*s.l.*), 2 (0.13%) were *An. funestus*, and 992 (62.0%) were *Cx. quinquefasciatus*; 3 pupae of *An. gambiae* (*s.l.*) were also sampled. In farmland, 1881 larvae were sampled; of these, 1111 (59.06%) were *An. gambiae* (*s.l.*), 89 (4.74 %) were *An. funestus*, and 681 (36.20 %) were *Cx. quinquefasciatus*.

Species diversity varied between sampling weeks (Figure 2). In habitat types, swamps had a diversity index (DI) of 0.21, man-made wells 0.48 and drainage ditches 0.39. This indicates a high heterogeneity among species. When data was categorised by land use types, a high heterogeneity was observed among species (pasture DI = 0.21, shrub lands DI = 0.38; farmland DI = 0.39).

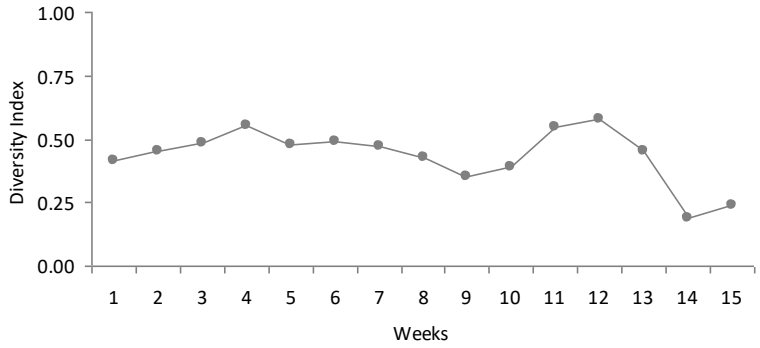


Figure 2: Simpson's diversity index for mosquito larvae during the survey period of 15 weeks.

Among 2397 larvae of *An. gambiae* (*s.l.*) collected, 501 were chosen for further molecular identification to the species level (Walker et al., 2007) as resources were limited for testing all specimens sampled. The selected proportion was selected regarding total samples collected weekly. A total of 251 (50%) specimens were identified as *An. arabiensis* (indicated in blue in Figure 3), 173 (35%) were identified as *An. gambiae* (*s.s.*) (indicated in red in Fig. 3), and 17 (3%) were *An. coustani* (Fig. 3). DNA amplification was not successful for 60 (12 %) specimens. The overall habitat productivity was found to be 0.004 adults/m^2/week for *An. gambiae* (*s.l.*) and 0.002 adults/m^2/week for *Cx. quinquefasciatus*.

https://dx.doi.org/10.4314/thrb.v26i3.2

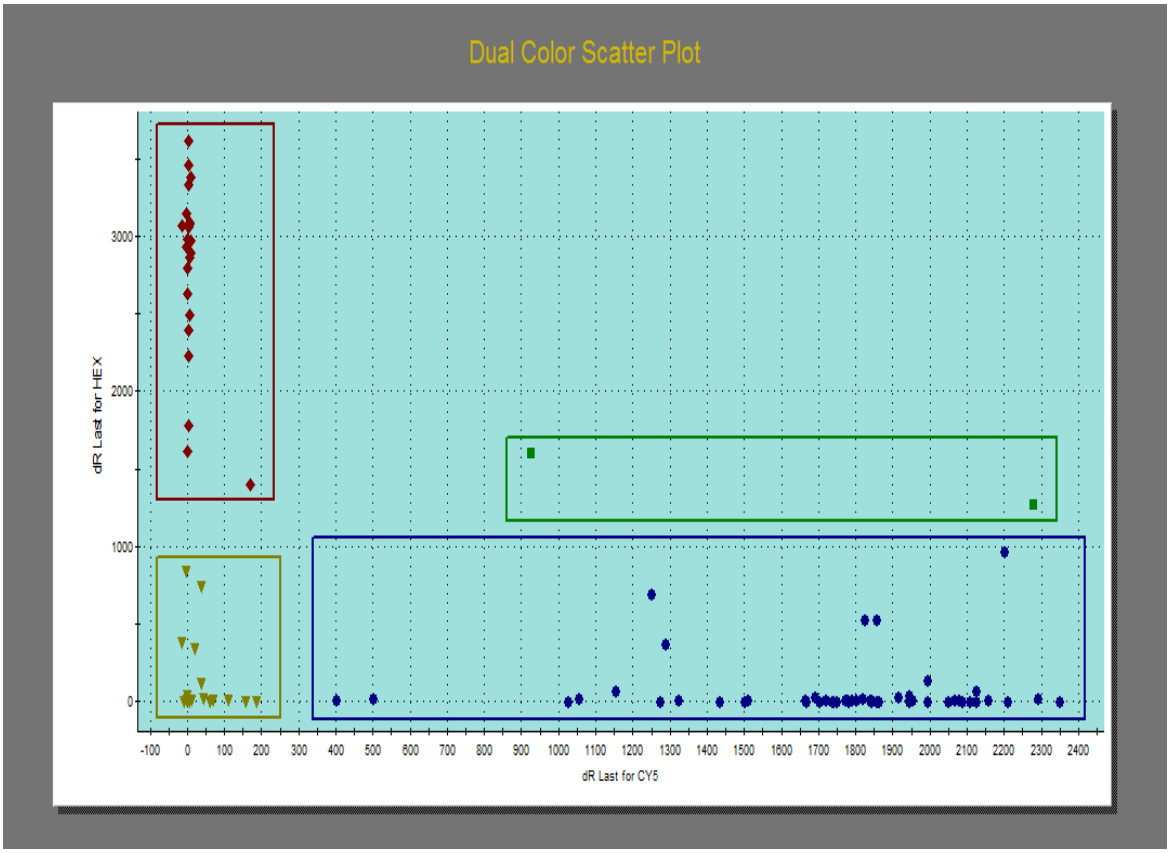


Figure 3: Allelic species discrimination results by TaqMan single nucleotide polymorphism genotyping for *Anopheles gambiae* (*s.s.*) (red), *An. arabiensis* (blue) and other *Anopheles* spp. (green squares) larvae sampled in Muheza, North-East Tanzania for 15 weeks. Controls are indicated by light green triangles.

Habitat types and larval abundance

The three habitat types studied here were swamps, drainage ditches and man-made wells. The larval abundance of *An. gambiae* was significantly associated with man-made wells when adjusted for other variables (Table 1 Factors associated with the presence of aquatic stages of *Anopheles gambiae s.l.* for both crude and adjusted odd ratio); the larval abundance of *An. funestus* as assessed separately because there were habitats without *An. funestus* larvae (Table 2Factors associated with presence of aquatic stages of *Anopheles funestus* for both crude and adjusted). The larval abundance of *Cx. quinquefasciatus* was significantly associated with the man-made wells and swamps, but not with drainage ditches as crude OR when adjusted for covariables (Table 3 Factors associated with presence of aquatic stages of Culicine species for both crude and adjusted odds ratio).

https://dx.doi.org/10.4314/thrb.v26i3.2

Parameter	Crude OR	P-value	95% C. I. Lower	95% C. I. Upper	Adjusted OR	P-value	95% C. I. Lower	95% C. I. Upper
Habitat type								
Swamp	1	-	-	-	1	-	-	-
Man-made well	**2.04**	**0.277**	**0.56**	**7.43**	**0.13**	**0.035**	**0.02**	**0.87**
Drainage system	1.45	0.667	0.26	8.01	0.13	0.075	0.01	1.22
Conductivity (µS/cm)	**6.45**	**<0.001**	**3.50**	**11.90**	0.83	0.780	0.22	3.14
pH	**1.52**	**<0.001**	**1.27**	**1.81**	1.39	0.146	0.89	2.16
Temperature (°C)	**1.11**	**<0.001**	**1.06**	**1.15**	1.02	0.788	0.90	1.14
Grass cover (%)	**1.01**	**0.225**	**1.00**	**1.01**	**0.99**	**0.030**	**0.97**	**1.00**
Land use								
Pasture	1	-	-	-	1	-	-	-
Shrub	0.91	0.855	0.32	2.56	3.57	0.134	0.67	18.96
Farmland	**3.92**	**<0.001**	**1.82**	**8.45**	**14.01**	**<0.001**	**3.70**	**53.04**
Chlorophyll (µg/L)	1.68	0.092	0.92	3.08	0.52	0.144	0.21	1.25
Turbidity (NTU)	**77.41**	**<0.001**	**21.74**	**275.61**	**69.88**	**0.007**	**3.12**	**1564.10**
Presence of predators								
No	1	-	-	-	1	-	-	-
Yes	1.52	0.336	0.65	3.55	0.73	0.526	0.27	1.96
Distance to house in meters								
More than 100m	1	-	-	-	1	-	-	-
100m or less	**2.20**	**0.003**	**1.29**	**3.73**	1.70	0.182	0.78	3.71

Associated factors	Crude OR	P-value	95% C. I. Lower	95% C. I. Upper	Adjusted OR	P-value	95% C. I. Lower	95% C. I. Upper
Conductivity (µS/cm)	1.66	0.117	0.88	3.13	0.56	0.569	0.08	4.14
pH	1.77	0.070	0.95	3.29	1.62	0.293	0.66	3.95
Temperature (°C)	**1.09**	**0.047**	**1.00**	**1.18**	1.06	0.636	0.84	1.32
Grass cover (%)	1.01	0.218	0.99	1.02	1.01	0.423	0.99	1.03
Chlorophyll (µg/L)	2.06	0.158	0.75	5.64	1.49	0.552	0.40	5.56
Turbidity (NTU)	3.48	0.068	0.91	13.30	5.21	0.370	0.14	192.86
Presence of predators								
No								
Yes	**10.96**	**<0.001**	**3.92**	**30.61**	**8.65**	**<0.001**	**2.93**	**25.56**
Distance to house in meters								
More than 100m								
100m or less	1.50	0.42	0.56	4.01	1.06	0.92	0.34	3.34

** **Note:** In some levels of habitat and land use types do not have *Anopheles funestus*. So they were omitted as comparison could not be possible.

https://dx.doi.org/10.4314/thrb.v26i3.2

Grass cover and larval abundance

Increase in percentage grass cover was found to result in significantly decreased larval abundance of *An. gambiae* (*s.l.*) only when adjusted for other parameters. The decrease in productivity was not statistically significant when grass cover was considered alone (crude odds ratio, OR; Tables 1) while for *An.funestus* the association with grass cover was not statistically significant (Table 2). In contrast, the larval abundance of *Cx. quinquefasciatus* increased significantly with vegetation cover when correlated singly; when adjusted for other variables, the vegetation cover was found to not affect larval density (Table 3).

Land use and larval abundance

The three land use types characterised in this study were farmland, pastureland and shrubland. Larval abundance of *An. gambiae* (*s.l.*) was positively associated with farmland (Table 1), whereas that of *Cx. quinquefasciatus* was significantly positively associated with shrubland but not with farmland (Table 3). In the farmland, maize (*Zea mays*) was the dominant crop in all areas, with other crops being paddy, vegetables and cassava.

Physicochemical characteristics and larval abundance

In *An. gambiae* (*s.l.*), the increase in larval abundance was significantly associated with a unit increase of conductivity, pH, and temperature when considered singly, but not when adjusted for other parameters (Tables 1) while for *An.funestus* the only temperature on unadjusted odds ratio was significantly associated with larval abundance (Table 2). Importantly, turbidity was associated with the increase of *An. gambiae* (*s.l.*) but not for *An. funestus* larvae (Tables 1 and 2). In *Cx. quinquefasciatus*, the increase in conductivity and pH were significantly associated with an increase in larval abundance when treated singly, but not when adjusted (Table 3). Both turbidity and temperature were significantly associated with *Cx. quinquefasciatus* larval abundance both about crude and adjusted OR

			95% C. I.				95% C. I.	
Associated factors	**Crude OR**	**P-value**	**Lower**	**Upper**	**Adjusted OR**	**P-value**	**Lower**	**Upper**
Habitat type								
Swamp								
Man-made well	**0.29**	**0.024**	0.10	0.85	0.50	0.340	0.12	2.07
Drainage system	0.24	0.072	0.05	1.13	0.28	0.184	0.04	1.85
Conductivity (µS/cm)	**3.40**	**<0.001**	1.96	5.88	0.45	0.324	0.09	2.19
pH	**1.38**	**<0.001**	1.20	1.58	0.90	0.608	0.59	1.36
Temperature (°C)	**1.11**	**<0.001**	**1.07**	**1.17**	**1.17**	**0.007**	**1.04**	**1.31**
Grass cover (%)	1.02	<0.001	1.01	1.03	1.01	0.140	1.00	1.02
Land use								
Pasture								
Shrub	**0.07**	**<0.001**	**0.02**	**0.24**	**0.08**	**0.002**	**0.02**	**0.41**
Farm land	0.62	0.120	0.34	1.13	0.54	0.176	0.22	1.32
Chlorophyll (µg/L)	0.88	0.709	0.47	1.68	0.56	0.181	0.24	1.31
Turbidity (NTU)	**20.32**	**<0.001**	**6.49**	**63.66**	**30.31**	**0.040**	**1.16**	**792.42**
Presence of predators								
No								
Yes	**2.78**	**0.017**	**1.20**	**6.47**	2.30	0.087	0.89	5.97
Distance to house in meters								
More than 100m								
100m or less	0.70	0.16	0.43	1.15	1.22	0.60	0.57	2.62

ratios (Table 3). Chlorophyll levels were not significantly associated with larval abundance in any of the species, using crude or adjusted OR (Tables 1, 2 and 3).

Habitat distance to the nearest house and larval abundance

The habitat distance to the nearest house was significantly associated with an increase in *An. gambiae* (*s.l.*) larval abundance when analysed singly but not when adjusted for covariables. When treated singly, the probability of having more larvae of *An. gambiae* (*s.l.*) was 2.2 times in habitats close to the houses (distance to the nearest house ≤ 100 m); when adjusted for other variables, this probability decreased to 1.7 times and was not significant (Table 1). In *An. funestus*, when the distance from habitats to the nearest house was treated singly, the crude OR was 1.5 times greater than for habitats located at > 100 m from houses. However, when adjusted for other parameters, the larval abundance of *An. funestus* decreased to 1.06 times when compared with the habitats located at > 100 m from houses (Table 2). However, sample size, i.e. the number of *An. funestus* found was consistently very low. In *Cx. quinquefasciatus*, the larval abundance had no significant association with the distance to the nearest house in crude odds ratio or when adjusted (Table 3). The larval abundance for all species was not associated with livestock abundance as there were no animal sheds around the considered houses.

Predators and larval abundance

The identified predators were tadpoles, backswimmers (Notonectidae), *Gambusia affinis*, *Belestoma* and dragonfly nymphs (Odonata). These were larval mosquito predators elsewhere in natural mosquito oviposition habitats and in confined experiments (Kweka et al., 2011b, 2012). Counts of individual predators in mosquito oviposition sites were low and were therefore pooled together irrespective of species. In *An. gambiae* (*s.l.*), the density of predators had no significant association with larval mosquito abundance (both crude and adjusted OR; Table 1). The larval abundance of *An. funestus* was significantly positively associated with predator density (both crude and adjusted OR; Table 2). The high abundance of *Cx. quinquefasciatus* was associated with a significant reduction of predator abundance (crude OR), but the association was not significant when adjusted for covariables (Table 3).

Discussion

The objective of this study was to determine larval abundance and adult productivity of mosquito species in different habitat types under different land use types in Muheza District, Tanga Region, northeastern Tanzania. The study in addition determined habitat characteristics, physicochemical parameters and distance to the nearest houses. Among different land use and habitat types, farmland and man-made wells had the highest mosquito larval abundance. This is similar to findings in western Kenya (Kweka et al., 2011b, 2012; Munga et al., 2006b, 2009; Ndenga et al., 2011). Larval abundance of *An. gambiae s.l.* was found to be highest in farmland, followed by pastureland and lowest in shrubland. The highest larval abundance in farmland is likely to be associated with the crop type cultivated in crude odds ratio and adjusted analysis. Where the main crop on farmland was maize, habitats had high larval and pupal densities. Maize pollens have been described as an important food source for anopheline mosquitoes in Kenya (Kweka et al., 2012) and in Ethiopia (Ye-Ebiyo et al., 2000, 2003a, b). The high density of larvae in farmland habitats may be associated with food availability, as well as with the nearness of farmlands to housing. This means that the adjusted odds ratio has shown that, the combination of all variables could not change the fact that, farming land has more larvae in habitats than other land types.

Vector species composition in this study revealed higher proportions of *An. arabiensis* than *An. gambiae* (*s.s.*). In previous studies during the 1970s, this area was predominantly occupied by *An. gambiae* (*s.s.*) (White & Magayuka, 1972; White, 1974). In later studies conducted in the 1990s, the mosquito population had shifted from *An. gambiae* (*s.s.*) to *An. arabiensis* following massive distributions of ITNs and IRS coverage started in the early 1990s (Mnzava et al., 1995; Magesa et al.,

1991; Maxwell et al., 2002; Curtis et al., 2006; Kitau et al., 2012; Kweka et al., 2020). The previous studies found *An. gambiae* (*s.s.*) to occur at a proportion of 41.9% *vs* 39.1% for *An. arabiensis.* In the following survey, the proportion of *An. gambiae* (*s.s.*) was found to be 7.7% while that of *An. arabiensis* had doubled (Derua et al., 2012). *Anopheles gambiae* (*s.s.*) is an endophilic and endophagic species (Futami et al., 2014; Iwashita et al., 2014). The long-term suppression of the human-feeding population through LLINs use and the exciton-repellence effect of LLINs have caused an elevated mortality in *An. gambiae* (*s.s.*) due to having contact with insecticides and partial or no blood-meal access (Mutuku et al., 2006). A similar trend was reported in western Kenya where the LLINS have been used for decades (Bayoh et al., 2010) and in Tanzania (Kitau et al., 2012; Kreppel et al., 2020). The population increase in *An. arabiensis* in our study in Muheza district could be attributed to the following factors: (i) availability of bovines as blood-meal sources for *An. arabiensis*, which has been observed in other sites with the same report of *An. arabiensis* increase (Bayoh et al., 2010); and (ii) *An. arabiensis*, which is primarily zoophilic and exophagic, cannot be targeted easily with LLINs and IRS.

The pH of habitat water was positively associated with the larval abundance of both *An. gambiae* (*s.s.*) and *Cx. quinquefasciatus* but not of *An. funestus when analyzed* in crude odds ratio but when odds ratio was adjusted with other variables none of the species was correlated positively with habitat water pH. Previous studies showed that the abundance of larvae of *An. gambiae* (*s.l.*), *Cx. quinquefasciatus* and *An. funestus* were not associated with pH (Kweka et al., 2012; Ndenga et al., 2012), but a study conducted by Emidi et al. (2017) in this study area showed that anopheline larvae decreased with increase in habitat water pH. A previous study in western Kenya showed an increase in larval abundance two weeks after fertilizer application in farmland during maize cultivation (Kweka et al., 2012). In the first days of fertilizer application, the habitats became clear by increased decomposition and sedimentation of debris. This influences positively the abundance of *An. gambiae* (*s.l.*) larvae whereas four weeks after application, the sedimentation rate of materials increases organic matter pollutants which in turn supports the survivorship of aquatic stages of *Cx. quinquefasciatus* (Victor & Reuben, 2000; Mutero et al., 2004; Muturi et al., 2007; Mwangangi et al., 2006a, b, 2007). The causes of pH variations during the cropping season are unknown since farmers of the studied region do not use synthetic fertilisers.

In the present study, the conductivity of habitat water were found to be associated with the abundance of *An. gambiae* (*s.l.*) and *Cx. quinquefasciatus* aquatic stages but not of *An. funestus* in both crude and adjusted odds ratio while for conductivity, the crude odds ratio was associated with abundance of *An. funestus* and An. gambiae s.l. while adjusted odd ratio had no such influence. The *An. funestus* abundance could not be influenced with either crude or adjusted odds ratio of habitat water conductivity. In a previous study in Mwea, rice irrigation schemes in central Kenya, it was found that in sunlit ephemeral habitats *An. gambiae* (*s.l.*) survived better with higher conductivity and turbidity. It is not well understood why *An. funestus* larvae seem not to be associated with a decrease or increase in turbidity or conductivity. Similar observations have been reported from studies elsewhere (Kweka et al., 2011b; Ndenga et al., 2012). One reason could be the comparatively small number of *An. funestus* found, which may be challenging to identify statistically significant associations.

In contrast to a previous report (Kweka et al., 2011b), the present study did not find any strong association between larval abundance (*Cx. quinquefasciatus, An. gambiae* s.l. and *An. funestus*) and habitat chlorophyll concentrations in both crude and adjusted odds ratio. This might be the results of the short study period of 15 weeks (one rainy season) compared to other studies which took up to two years (four seasons; rainy, short-rainy, dry, and semi-dry seasons of the year, repeated twice) of monitoring habitat physicochemical parameters and larval abundance (Kweka et al., 2011b, 2012).

In the present study, the increase in one degree Celsius was found to be associated with an increase in larval abundance by 1.01, 1.11 and 1.09 for *An. gambiae* (*s.l.*), *Cx. quinquefasciatus* and *An. funestus,* respectively. Temperature is a key factor for the development of mosquito aquatic stages (Lyons et al., 2013). In other field studies, *An. funestus* larval abundance in swamps was found to be positively correlated with an increase in temperature (Kweka et al., 2012). In other laboratory findings,

both *An. gambiae* (*s.l.*) and *An. funestus* have shown a similar trend of aquatic stages development and growth period length to be governed by temperature (Bayoh & Lindsay, 2004; Lyons et al., 2013). In *Cx. quinquefasciatus*, an increase of temperature from 16 °C to 24 °C resulted in a 2.9-fold shortening of the developmental time (Ciota et al., 2014). Usually, insect aquatic life stage development is directly proportional to an increase in temperature (Bayoh & Lindsay, 2004).

The increase in percentage of grass cover was positively associated with the abundance of aquatic stages of *Cx. quinquefasciatus*, but not of *An. gambiae* (*s.l.*) or *An. funestus*. This study is contrary to previous studies reported that *An. funestus* preferentially breed in shaded habitats with high grass cover (Wamae et al., 2010; Kweka et al., 2011b). In this study area it was observed that, the more the percentage cover of grasses, the more decomposing organic which supports the culec oviposition attractation and larvae abundance.

In terms of land use types, *An. gambiae* (*s.l.*) larval abundance was associated with farmland, while *Cx. quinquefasciatus* abundance was associated with shrubland. The abundance of *An. gambiae* (*s.l.*) in farmland was similar to what was reported previously in Ethiopia and Kenya (YE-ebiyo et al., 2003b; Kweka et al., 2012). Shrubland, where *Cx quinquefasciatus* larvae were most abundant, is associated with low sunlight exposure and high levels of organic pollutants. The positive association fits with known preferred oviposition sites of *Cx. quinquefasciatus* (Ansari et al., 2004; Impoinvil et al., 2008). Most of these habitats in the Muheza region are not permanent, but only last for a short period after the long rainy season. This is different to other areas, where habitats are frequently permanent and inhabited by larvae throughout the year (Kweka et al., 2011b, 2012; Mala & Irungu, 2011; Ndenga et al., 2012)

The presence of predators influenced mosquito species abundance differently. In this study the findings showed that the predator density did not influence the abundance of *An. gambiae* (*s.l.*). This is likely due to the generally low abundance of predators for the majority of studied habitats. Gravid females may actively avoid habitats occupied by predators as shown in laboratory studies (Munga et al., 2006a; Warburg et al., 2011). In contrast, the larval abundance of *An. funestus* and *Cx. quinquefasciatus* increased with predator density (Kweka et al., 2011a; Warburg et al., 2011).

Studies conducted in West Africa, revealed that predation pressure plays a major role in the adaptation of different *An. gambiae* s.l. species to different habitats (Diabate et al., 2008; Gimonneau et al., 2010; Roux et al., 2014). *Anopheles gambiae* (*s.l.*) was more frequently found in shallow and sunlit ephemeral habitats. Predators might encounter difficulties in colonising these different from long-lasting habitats where *An. funestus* and *Cx. quinquefasciatus* occur. High larval survivorship and subsequently higher productivity of *An. gambiae* (*s.l.*) than *Cx. quinquefasciatus* and *An. funestus* was sometimes reported in the past (Munga et al., 2006b; Kweka et al., 2011b; Ndenga et al., 2011). *Anopheles gambiae* (*s.l.*) larvae were also frequently found in higher proportions compared to *Cx. quinquefasciatus* in our study and inhabited even polluted habitats, similar to what has been documented in other African peri-urban areas in other studies (Awolola et al., 2007; Tene Fossog et al., 2013). In Kumasi, Ghana, the polluted habitats in urban vegetable gardens have been found to be potential oviposition sites and colonised with *An. gambiae* (*s.l.*) (Afrane et al., 2004, 2012).

This study demonstrated species heterogeneity during the whole study period in all habitat and land use types. No species was found to dominate throughout the study period. Species variations occurred between habitat types. Seasonality is a major determinant of temporal heterogeneity in the distribution of such habitats and land use types, and consequently contribute to the heterogeneity in the distribution of mosquito aquatic stages (Walker & Lynch, 2007).

The nearest habitats to human dwellings (< 100 m) in our study had higher abundances of *An. gambiae* (*s.l.*) aquatic stages than those further away (≥ 100 m). Other studies similarly showed that *An. gambiae* (*s.s*) is anthropophilic and utilizes those habitats near human dwellings for oviposition (Minakawa et al., 2002). This might be an evolutionary optimization to reduce flight time and thus costs of energy and predation.

Anopheles gambiae (*s.l.*) habitat productivity in the study area was found to be twice as high as that of *Cx. quinquefasciatus.* Yet, 0.0004 *An. gambiae* (*s.l.*) females per m^2 is much lower than that

reported in other areas, such as in the western Kenya highlands (1.8–16.93/m^2) (Kweka et al., 2011b; Ndenga et al., 2011). The low productivity of both *Cx. quinquefasciatus* and *An. gambiae* (*s.l.*) possibly reflects a decline of vector and non-vector species reported in the Tanga region for the past two decades (Meyrowitsch et al., 2011; Derua et al., 2012).

Conclusions

The findings of this study show that the abundance of mosquito aquatic stages in Muheza peri-urban areas is composed of higher proportions of *An. arabiensis* as compared to *An. gambiae* (*s.s.*) and indicates that larval control of *An. gambiae* (*s.l.*) should prioritize targeting drainage ditches and man-made wells close to human habitation.

Funding

This study was funded by the TASENE project (a collaborative programme of COSTECH, WOTRO and SIDA) granted to EJK as a southern partner (grant number TASENE/Sida/2/2012).

Ethical approval

This study was granted ethical approval by the Medical Research Coordinating Committee of the National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/1584). In the field, individual field owners were consulted for permission to use the habitats in their fields for 15 weeks and were informed about the aim of the study.

CRediT authorship contribution statement.

Eliningaya J. Kweka: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Validation, Writing - original draft, Writing - review & editing, Visualization. **Frank Magogo:** Formal analysis, Investigation, Resources, Writing - original draft, Visualization. **Filemoni Tenu:** Formal analysis, Visualization. **Ming-Chieh Lee:** Formal analysis. **William N. Kisinza:** Writing - review & editing. **Leonard E.G. Mboera:** Writing - original draft, Writing - review & editing, Supervision.

Data availability

The data supporting the conclusions of this article are included within the article and its supplementary files.

Declaration of competing interests

he authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors wish to thank Thobias Sekanyika, Irene Semkiwa, Isaya Kibwana and Arno Nkinga for their devotion in field work, mosquito rearing, and experimental work. Jeremiah Mushi is acknowledged for statistical advice. Dr Stephen Munga is acknowledged for critical comments to an earlier version of this manuscript. We particularly thank all community members who granted permission to select habitats within their fields.

References

Afrane, Y., Lawson, B., Brenya, R., Kruppa, T., Yan, G., 2012. The ecology of mosquitoes in an irrigated vegetable farm in Kumasi, Ghana: Abundance, productivity and survivorship. Parasites Vectors 5, 233.

Afrane, Y.A., Klinkenberg, E., Drechsel, P., Owusu-Daaku, K., Garms, R., Kruppa, T., 2004. Does irrigated urban agriculture influence the transmission of malaria in the city of Kumasi, Ghana? Acta Trop. 89, 125-134.

Alatalo, R., Alatalo, R., 1977. Components of diversity: Multivariate analysis with interaction. Ecology 58, 900-906.

Ansari, M.A., Mittal, P.K., Razdan, R.K., Dhiman, R.C., Kumar, A., 2004. Evaluation of pirimiphos-methyl (50% EC) against the immatures of *Anopheles stephensi*/*An. culicifacies* (malaria vectors) and *Culex quinquefasciatus* (vector of bancroftian filariasis). J. Vector Borne Dis. 41, 10-16.

Awolola, T.S., Oduola, A.O., Obansa, J.B., Chukwurar, N.J., Unyimadu, J.P., 2007. *Anopheles gambiae s.s.* breeding in polluted water bodies in urban Lagos, southwestern Nigeria. J. Vector Borne Dis. 44, 241-244.

Balls, M.J., Bødker, R., Thomas, C.J., Kisinza, W., Msangeni, H.A., Lindsay, S.W., 2004. Effect of topography on the risk of malaria infection in the Usambara Mountains, Tanzania. Trans. R. Soc. Trop. Med. Hyg. 98, 400-408.

Bass, C., Williamson, M., Wilding, C., Donnelly, M., Field, L., 2007. Identification of the main malaria vectors in the *Anopheles gambiae* species complex using a TaqMan real-time PCR assay. Malar. J. 6, 155.

Bayoh, M.N., Lindsay, S.W., 2004. Temperature-related duration of aquatic stages of the Afrotropical malaria vector mosquito *Anopheles gambiae* in the laboratory. Med. Vet. Entomol. 18, 174-179.

Bayoh, M.N., Mathias, D., Odiere, M., Mutuku, F., Kamau, L., Gimnig, J., et al., 2010. *Anopheles gambiae*: Historical population decline associated with regional distribution of insecticide-treated bed nets in western Nyanza Province, Kenya. Malar. J. 9, 62.

Bentley, M.D., Day, J.F., 1989. Chemical ecology and behavioral aspects of mosquito oviposition. Ann. Rev. Entomol. 34, 401-421.

Bezirtzoglou, C., Dekas, K., Charvalos, E., 2011. Climate changes, environment and infection: Facts, scenarios and growing awareness from the public health community within Europe. Anaerobe 17, 337-340.

Bødker, R., Msangeni, H.A., Kisinza, W., Lindsay, S., 2006. Relationship between the intensity of exposure to malaria parasites and infection in the Usambara Mountains, Tanzania. Am. J. Trop. Med. Hyg. 74, 716-723.

Bueno-Mari, R., Jimenez-Peydro, R., 2013. Global change and human vulnerability to vector-borne diseases. Front. Physiol. 4, 158.

Ciota, A.T., Matacchiero, A.C., Kilpatrick, A.M., Kramer, L.D., 2014. The effect of temperature on life history traits of *Culex* mosquitoes. J. Med. Entomol. 51, 55-62.

Coetzee, M., Craig, M., le Sueur, D., 2000. Distribution of African malaria mosquitoes belonging to the *Anopheles gambiae* complex. Parasitol. Today 16, 74-77.

Curtis, C.F., Maxwell, C.A., Magesa, S.M., Rwegoshora, R.T., Wilkes, T.J., 2006. Insecticide-treated bed-nets for malaria mosquito control. J. Am. Mosq. Control Assoc. 22, 501-506.

Debrah, I., Afrane, Y.A., Amoah, L.E., Ochwedo, K.O., Mukabana, W.R., Zhong, D., et al., 2021. Larval ecology and bionomics of *Anopheles funestus* in highland and lowland sites in western Kenya. PLoS One 16, e0255321.

Derua, Y., Alifrangis, M., Hosea, K., Meyrowitsch, D., Magesa, S., Pedersen, E., Simonsen, P., 2012. Change in composition of the *Anopheles gambiae* complex and its possible implications for the transmission of malaria and lymphatic filariasis in north-eastern Tanzania. Malar. J. 11, 188.

Diabate, A., Dabire, R., Heidenberger, K., Crawford, J., Lamp, W., Culler, L., Lehmann, T., 2008. Evidence for divergent selection between the molecular forms of *Anopheles gambiae*: Role of predation. BMC Evol. Biol. 8, 5.

Emidi, B., Kisinza, W.N., Mmbando, B.P., Malima, R., Mosha, F.W., 2017. Effect of physicochemical parameters on *Anopheles* and *Culex* mosquito larvae abundance in different breeding sites in a rural setting of Muheza, Tanzania. Parasites Vectors 10, 304.

Fillinger, U., Ndenga, B., Githeko, A., Lindsay, S.W., 2009. Integrated malaria vector control with microbial larvicides and insecticide-treated nets in western Kenya: A controlled trial. Bull. World Health Org. 87, 655-665.

Futami, K., Dida, G., Sonye, G., Lutiali, P., Mwania, M., Wagalla, S., et al., 2014. Impacts of insecticide treated bed nets on *Anopheles gambiae s.l.* populations in Mbita district and Suba district, Western Kenya. Parasites Vectors 7, 63.

Gillies, M.T., Coetzee, M., 1987. A supplement to the Anophelinae of Africa, South of the Sahara. Publication No. 55. South African Institute of International Medicine and Research.

Gimonneau, G., Bouyer, J., Morand, S., Besansky, N.J., Diabate, A., Simard, F., 2010. A behavioral mechanism underlying ecological divergence in the malaria mosquito *Anopheles gambiae*. Behav. Ecol. 21, 1088-1092.

Imbahale, S.S., Fillinger, U., Githeko, A., Mukabana, W.R., Takken, W., 2010. An exploratory survey of malaria prevalence and people's knowledge, attitudes and practices of mosquito larval source management for malaria control in western Kenya. Acta Trop. 115, 248-256.

Impoinvil, D.E., Keating, J., Mbogo, C.M., Potts, M.D., Chowdhury, R.R., Beier, J.C., 2008. Abundance of immature *Anopheles* and culicines (Diptera: Culicidae) in different water body types in the urban environment of Malindi, Kenya. J. Vector Ecol. 33, 107-116.

Iwashita, H., Dida, G., Sonye, G., Sunahara, T., Futami, K., Njenga, S., Chaves, L., Minakawa, N., 2014. Push by a net, pull by a cow: Can zooprophylaxis enhance the impact of insecticide treated bed nets on malaria control? Parasites Vectors 7, 52.

Kitau, J., Oxborough, R.M., Tungu, P.K., Matowo, J., Malima, R.C., Magesa, S.M., et al., 2012. Species shifts in the *Anopheles gambiae* complex: Do LLINs successfully control *Anopheles arabiensis*? PLoS One 7, e31481.

Kreppel, K.S., Viana, M., Main, B.J., Johnson, P.C.D., Govella, N.J., Lee, Y., et al., 2020. Emergence of behavioural avoidance strategies of malaria vectors in areas of high LLIN coverage in Tanzania. Sci. Rep. 10, 14527.

Kweka, E., Zhou, G., Gilbreath, T., Afrane, Y., Nyindo, M., Githeko, A., Yan, G., 2011a. Predation efficiency of *Anopheles gambiae* larvae by aquatic predators in western Kenya highlands. Parasites Vectors 4, 128.

Kweka, E.J., Mazigo, H.D., Lyaruu, L.J., Mausa, E.A., Venter, N., Mahande, A.M., Coetzee, M., 2020. Anopheline mosquito species composition, kdr mutation frequency, and parasite infectivity status in northern Tanzania. J. Med. Entomol. 57, 933-938.

Kweka, E.J., Zhou, G., Lee, M.C., Gilbreath, T.M., 3rd, Mosha, F., Munga, S., et al., 2011b. Evaluation of two methods of estimating larval habitat productivity in western Kenya highlands. Parasites Vectors 4, 110.

Kweka, E.J., Zhou, G., Munga, S., Lee, M.-C., Atieli, H.E., Nyindo, M., et al., 2012. Anopheline larval habitats seasonality and species distribution: A prerequisite for effective targeted larval habitats control programmes. PLoS One 7, e52084.

Lindsay, S.W., Bødker, R., Malima, R., Msangeni, H.A., Kisinza, W., 2000. Effect of 1997/98 EI Niño on highland malaria in Tanzania. Lancet 355, 989-990.

Lyons, C., Coetzee, M., Chown, S., 2013. Stable and fluctuating temperature effects on the development rate and survival of two malaria vectors, *Anopheles arabiensis* and *Anopheles funestus*. Parasites Vectors 6, 104.

Magesa, S.M., Wilkes, T.J., Mnzava, A.E.P., Njunwa, K.J., Myamba, J., Kivuyo, M.D.P., et al., 1991. Trial of pyrethroid impregnated bednets in an area of Tanzania holoendemic for malaria. Part 2. Effects on the malaria vector population. Acta Trop. 49, 97-108.

Mala, A.O., Irungu, L.W., 2011. Factors influencing differential larval habitat productivity of *Anopheles gambiae* complex mosquitoes in a western Kenyan village. J. Vector Borne Dis. 48, 52-57.

Maxwell, C.A., Msuya, E., Sudi, M., Njunwa, K.J., Carneiro, I.A., Curtis, C.F., 2002. Effect of community-wide use of insecticide-treated nets for 3–4 years on malarial morbidity in Tanzania. Trop. Med. Int. Health 7, 1003-1008.

McCrae, A., 1984. Oviposition by African malaria vector mosquitoes. II. Effects of site tone, water type and conspecific immatures on target selection by freshwater *Anopheles gambiae* Giles, *sensu lato*. Ann. Trop. Med. Parasitol. 78, 307.

Meyrowitsch, D., Pedersen, E., Alifrangis, M., Scheike, T., Malecela, M., Magesa, S., et al., 2011. Is the current decline in malaria burden in sub-Saharan Africa due to a decrease in vector population? Malar. J. 10, 188.

Minakawa, N., Munga, S., Atieli, F., Mushinzimana, E., Zhou, G., Githeko, A.K., Yan, G., 2005. Spatial distribution of anopheline larval habitats in Western Kenyan highlands: Effects of land cover types and topography. Am. J. Trop. Med. Hyg. 73, 157-165.

Minakawa, N., Seda, P., Yan, G., 2002. Influence of host and larval habitat distribution on the abundance of African malaria vectors in western Kenya. Am. J. Trop. Med. Hyg. 67, 32-38.

Mnzava, A.E., Rwegoshora, R.T., Wilkes, T.J., Tanner, M., Curtis, C.F., 1995. *Anopheles arabiensis* and *An. gambiae* chromosomal inversion polymorphism, feeding and resting behaviour in relation to insecticide house-spraying in Tanzania. Med. Vet. Entomol. 9, 316-324.

Munga, S., Minakawa, N., Zhou, G., Githeko, A.K., Yan, G., 2007. Survivorship of immature stages of *Anopheles gambiae s.l.* (Diptera: Culicidae) in natural habitats in western Kenya highlands. J. Med. Entomol. 44, 758-764.

Munga, S., Minakawa, N., Zhou, G., Barrack, O-O.J., Githeko, A.K., Yan, G., 2006a. Effects of larval competitors and predators on oviposition site selection of *Anopheles gambiae sensu stricto*. J. Med. Entomol. 43, 221-224.

Munga, S., Minakawa, N., Zhou, G., Mushinzimana, E., Barrack, O.O., Githeko, A.K., Yan, G., 2006b. Association between land cover and habitat productivity of malaria vectors in western Kenyan highlands. Am. J. Trop. Med. Hyg. 74, 69-75.

Munga, S., Yakob, L., Mushinzimana, E., Zhou, G., Ouna, T., Minakawa, N., et al., 2009. Land use and land cover changes and spatiotemporal dynamics of anopheline larval habitats during a four-year period in a highland community of Africa. Am. J. Trop. Med. Hyg. 81, 1079-1084.

Mutero, C.M., Ng'ang'a, P.N., Wekoyela, P., Githure, J., Konradsen, F., 2004. Ammonium sulphate fertiliser increases larval populations of *Anopheles arabiensis* and culicine mosquitoes in rice fields. Acta Trop. 89, 187-192.

Mutuku, F.M., Bayoh, M.N., Gimnig, J.E., Vulule, J.M., Kamau, L., Walker, E.D., et al., 2006. Pupal habitat productivity of *Anopheles gambiae* complex mosquitoes in a rural village in western Kenya. Am. J. Trop. Med. Hyg. 74, 54-61.

Muturi, E.J., Shililu, J.I., Gu, W., Jacob, B.G., Githure, J.I., Novak, R., 2007. Larval habitat dynamics and diversity of *Culex* mosquitoes in rice agro-ecosystem in Mwea, Kenya. Am. J. Trop. Med. Hyg. 76, 95-102.

Mwangangi, J., Muturi, E., Shililu, J., Muriu, S., Jacob, B., Kabiru, E., et al., 2006a. Survival of immature *Anopheles arabiensis* (Diptera: Culicidae) in aquatic habitats in Mwea rice irrigation scheme, central Kenya. Malar. J. 5, 114.

Mwangangi, J., Shililu, J., Muturi, E., Gu, W., Mbogo, C., Kabiru, E., et al., 2006b. Dynamics of immature stages of *Anopheles arabiensis* and other mosquito species (Diptera: Culicidae) in relation to rice cropping in a rice agro-ecosystem in Kenya. J. Vector Ecol. 31, 245-251.

Mwangangi, J.M., Muturi, E.J., Shililu, J.I., Muriu, S., Jacob, B., Kabiru, E.W., et al., 2007. Environmental covariates of *Anopheles arabiensis* in a rice agroecosystem in Mwea, Central Kenya. J. Am. Mosq. Control Ass. 23, 371-377.

Nambunga, I.H., Ngowo, H.S., Mapua, S.A., Hape, E.E., Msugupakulya, B.J., Msaky, D.S., et al., 2020. Aquatic habitats of the malaria vector *Anopheles funestus* in rural south-eastern Tanzania. Malar. J. 19, 219.

Ndenga, B.A., Simbauni, J.A., Mbugi, J.P., Githeko, A.K., 2012. Physical, chemical and biological characteristics in habitats of high and low presence of anopheline larvae in western Kenya highlands. PLoS One 7, e47975.

Ndenga, B.A., Simbauni, J.A., Mbugi, J.P., Githeko, A.K., Fillinger, U., 2011. Productivity of malaria vectors from different habitat types in the western Kenya highlands. PLoS One 6, e19473.

Needham, G., Needham, R., 1941. A guide to the study of freshwater biology with special refference to aquatic insects and other invertebrate animals and phyto-plankton, 5th ed. (Revised and Enlarged Edition). Comstock Pub. Co., Ithaca, NY, USA.

Norris, J.L., Pollock, K.H., 1998. Non-parametric MLE for Poisson species abundance models allowing for heterogeneity between species. Env. Ecol. Stat. 5, 391-402.

Okumu, F., Mbeyela, E., Lingamba, G., Moore, J., Ntamatungiro, A., Kavishe, D., et al., 2013. Comparative field evaluation of combinations of long-lasting insecticide treated nets and indoor residual spraying, relative to either method alone, for malaria prevention in an area where the main vector is *Anopheles arabiensis*. Parasites Vectors 6, 46.

Osse, R., Aikpon, R., Gbedjissi, G.L., Gnanguenon, V., Sezonlin, M., Govoetchan, R., et al., 2013. A shift from indoor residual spraying (IRS) with bendiocarb to long-lasting insecticidal (mosquito) nets (LLINs) associated with changes in malaria transmission indicators in pyrethroid resistance areas in Benin. Parasites Vectors 6, 73.

Padonou, G., Gbedjissi, G., Yadouleton, A., Azondekon, R., Razack, O., Oussou, O., et al., 2012a. Decreased proportions of indoor feeding and endophily in *Anopheles gambiae s.l.* populations following the indoor residual spraying and insecticide-treated net interventions in Benin (West Africa). Parasites Vectors 5, 262.

Padonou, G., Sezonlin, M., Osse, R., Aizoun, N., Oke-Agbo, F., Oussou, O., et al., 2012b. Impact of three years of large scale indoor residual spraying (IRS) and insecticide treated nets (ITNs) interventions on insecticide resistance in *Anopheles gambiae s.l.* in Benin. Parasites Vectors 5, 72.

Rejmánková, E., Higashi, R., Grieco, J., Achee, N., Roberts, D., 2005. Volatile substances from larval habitats mediate species-specific oviposition in *Anopheles* mosquitoes. J. Med. Entomol. 42, 95-103.

Rejmánková, E., Roberts, D.R., Manguin, S., Pope, K.O., Komárek, J., Post, R.A., 1996. *Anopheles albimanus* (Diptera: Culicidae) and cyanobacteria: An example of larval habitat selection. Env. Entomol. 25, 1058-1067.

Roux, O., Diabaté, A., Simard, F., 2014. Divergence in threat sensitivity among aquatic larvae of cryptic mosquito species. J. Animal Ecol. 83, 702-711.

Sinka, M., Bangs, M., Manguin, S., Rubio-Palis, Y., Chareonviriyaphap, T., Coetzee, M., et al., 2012. A global map of dominant malaria vectors. Parasites Vectors 5, 69.

Tene Fossog, B., Antonio-Nkondjio, C., Kengne, P., Njiokou, F., Besansky, N., Costantini, C., 2013. Physiological correlates of ecological divergence along an urbanization gradient: Differential tolerance to ammonia among molecular forms of the malaria mosquito *Anopheles gambiae*. BMC Ecology 13, 1.

Victor, T.J., Reuben, R., 2000. Effects of organic and inorganic fertilisers on mosquito populations in rice fields of southern India. Med. Vet. Entomol. 14, 361-368.

Walker, E., Thibault, A., Thelen, A., Bullard, B., Huang, J., Odiere, M., et al., 2007. Identification of field caught *Anopheles gambiae s.s.* and *Anopheles arabiensis* by TaqMan single nucleotide polymorphism genotyping. Malar. J. 6, 23.

Walker, K., Lynch, M., 2007. Contributions of *Anopheles* larval control to malaria suppression in tropical Africa: Review of achievements and potential. Med. Vet. Entomol. 21, 2-21.

Wamae, P., Githeko, A., Menya, D., Takken, W., 2010. Shading by napier grass reduces Malaria vector larvae in natural habitats in western Kenya highlands. EcoHealth 7, 485-497.

Warburg, A., Faiman, R., Shtern, A., Silberbush, A., Markman, S., Cohen, J.E., Blaustein, L., 2011. Oviposition habitat selection by *Anopheles gambiae* in response to chemical cues by *Notonecta maculata*. J. Vector Ecol. 36, 421-425.

White, G.B., 1974. *Anopheles gambiae* complex and disease transmission in Africa. Trans. R. Soc. Trop. Med. Hyg. 68, 278-298.

White, G.B., Magayuka, S.A., 1972. Population dynamics and vectorial importance of species A and species B of the *Anopheles gambiae* complex. Trans. R. Soc. Trop. Med. Hyg. 66, 533-534.

WHO, 1975. Manual on practical entomology in malaria. Part II. Methods and techniques. Division of Malaria and Other Parasitic Diseases, World Health Organization, Geneva.

Ye-Ebiyo, Y., Pollack, R.J., Kiszewski, A., Spielman, A., 2003a. A component of maize pollen that stimulates larval mosquitoes (Diptera: Culicidae) to feed and increases toxicity of microbial larvicides. J. Med. Entomol. 40, 860-864.

YE-ebiyo, Y., Pollack, R.J., Kiszewski, A., Spielman, A., 2003b. Enhancement of development of larval *Anopheles arabiensis* by proximity to flowering maize (*Zea mays*) in turbid water and when crowded. Am. J. Trop. Med. Hyg. 68, 748-752.

Ye-Ebiyo, Y., Pollack, R.J., Spielman, A., 2000. Enhanced development in nature of larval *Anopheles arabiensis* mosquitoes feeding on maize pollen. Am. J. Trop. Med. Hyg. 63, 90-93.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.3

A Rare Case of Iron Deficiency Anemia Manifesting with Xylophagia

Adamu Kilungu[1,4], Beatrice Thadei[2,4], Maguzu Nganga[3,4]*

[1]Department of Internal Medicine, Mbeya Zonal Referral Hospital, [2]Department of Psychiatry and Mental Health, Mbeya Zonal Referral Hospital, [3]Department of Obstetrics and Gynaecology, Mbeya Zonal Referral Hospital, [4] Mbeya College of Health and Allied Sciences, University of Dar es Salaam, Mbeya, Tanzania

Abstract
Pica is an unusual condition in which patients develop cravings for non-nutritive substances. We present a 34-year-old female with severe iron deficiency anaemia and xylophagia (paper eating) who was treated with iron supplements and folic acid. Her anaemia symptoms and pica were resolved after three months, highlighting the importance of addressing nutritional deficiencies in managing pica.
Key message: A rare case of iron deficiency anaemia with xylophagia was successfully managed through a multidisciplinary approach involving a haematologist, psychiatrist, and gynaecologist. This highlights the importance of collaborative care in addressing complex conditions and ensuring comprehensive treatment.
Keywords: pica, iron deficiency anaemia, xylophagia.

Introduction

Pica is an eating disorder characterised by the persistent ingestion of non-food items with no nutritional value, such as soil, chalk, charcoal, and paper. Xylophagia is a rare form of pica characterised by an unusual craving for ingesting wood, typically paper. Pica can manifest in various forms, including geophagia (eating earth or clay), pagophagia (eating ice), and amylophagia (eating starch). The aetiology of pica is multifactorial, often associated with nutritional deficiencies, particularly iron and zinc, as well as mental health conditions such as obsessive-compulsive disorder (OCD) and schizophrenia. Treatment of the underlying cause, such as iron deficiency anaemia, often leads to the resolution of pica symptoms (Gowda M et al, 2014), (Kurtz D et al, 2020).

Case Presentation

A 34-year-old female presented with a history of recurrent anaemia for more than ten years. She had no significant background history, no chronic illnesses, no bleeding symptoms, and no history of blood transfusion. She reported regular menstrual cycles and had two live births (P2L2). The patient complained of epigastric pain but denied any history of peptic ulcer disease. She also reported a miscarriage at nine weeks of gestation, which occurred five months before presentation. Her blood pressure was normotensive at 120/85 mmHg.

The patient disclosed a history of eating paper and threads from her handkerchief. She typically sought hiding places, such as the washroom at work, to satisfy her cravings. She denied experiencing perceptual disturbances, extreme mood swings, or fixed false beliefs.

* **Corresponding Author:** Adamu Kilungu, **Email:** adam.kilungu@gmail.com

 https://dx.doi.org/10.4314/thrb.v26i3.3

Clinical findings

Physical Examination: The physical examination was unremarkable except for severe pallor observed on both palms and the sub-conjunctiva. Laboratory Results were as follows: **F**ull Blood Picture: Hb 6 g/dL, MCV 52.2 fL, MCH 14.2 pg (27.0 – 32.0), RDW 25.2% (11.0 – 16.0), platelet count 1145 x 10^9/L (150 – 450), normal total white blood cells and differentials. ESR: 3 mm/hour. Peripheral Blood Smear as shown in Figure 1 revealed microcytic hypochromic anemia with thrombocytosis. Reticulocyte Count: 0.82%. Ferritin: 1.651 ng/mL (13.00 – 300.00). Serum Iron: 2.9 µmol/L (3.500 – 30.00). H. pylori Stool Antigen: Negative. Stool for Occult Blood: Negative. Abdominal-Pelvic ultrasound was Normal. She was diagnosed with severe iron deficiency anaemia, manifesting as xylophagia. The patient was prescribed iron supplements and folic acid. After three months of treatment, she reported a significant reduction in anaemia symptoms and a cessation of her compulsion to eat paper and threads. Follow-up blood tests showed substantial improvement: Hemoglobin (Hb): 10.0 g/dL; Mean Corpuscular Volume (MCV): 79 fL; Mean Corpuscular Hemoglobin (MCH): 25.6 pg; Mean Corpuscular Hemoglobin Concentration (MCHC): 32.5 g/dL; Platelet Count: 533 x 10^9/L.

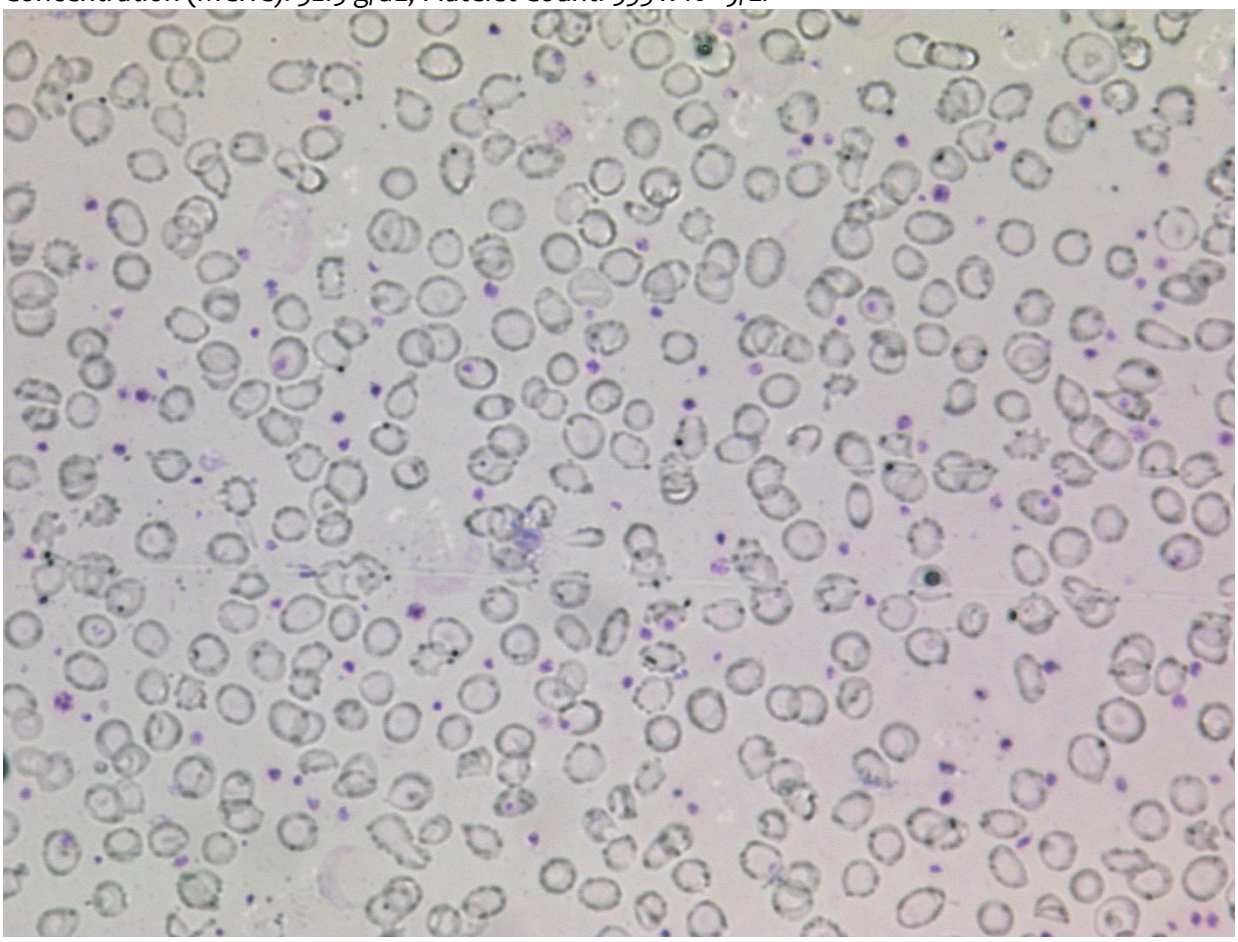


Figure 1: Peripheral blood smear morphology shows microcytic hypochromic anaemia with thrombocytosis due to severe iron deficiency anaemia.

Discussion

This case highlights the importance of considering iron deficiency anaemia as a potential underlying cause of pica, specifically xylophagia. The patient's unusual craving for paper was resolved following

appropriate treatment for iron deficiency. This case underscores the need for thorough clinical evaluation and appropriate management of patients presenting with pica to address any underlying nutritional deficiencies.

Pica, including xylophagia, has been associated with various nutritional deficiencies, particularly iron deficiency anaemia (Kurtz et al., 2020), (Shah et al., 2023), (Khan et al., 2010), (Ganesan et al., 2023). Studies have shown that pica is significantly associated with iron deficiency, and treating the deficiency often leads to the resolution of pica symptoms (Gowda et al, 2014), (Kurtz et al., 2020), (Denue et al., 2013), (Ganesan et al., 2023). The exact aetiology of pica remains unclear, but it is believed to be an effect rather than a cause of iron deficiency. Pica can pose significant health risks, including gastrointestinal obstruction, lead poisoning, and parasitic infections (Kurtz et al., 2020), (Denue et al., 2013), (Shah et al., 2023).

Conclusion

Xylophagia, although rare, can be effectively managed by treating the underlying nutritional deficiencies, such as iron deficiency anemia. This case illustrates the resolution of pica symptoms following targeted iron therapy, emphasizing the necessity of thorough clinical evaluation and appropriate management of patients presenting with pica.

Acknowledgements: We express our gratitude to all members of the departments of internal medicine, psychiatry, as well as Obstetrics and Gynecology at the Mbeya Zonal Referral Hospital for their support, which made this work possible.

Institutional Ethical Committee Approval: The case study was approved by the Ethics Committee at Mbeya Zonal Referral Hospital. This case study
was conducted by the Declaration of Helsinki

Conflict of interest: None.

Funding/Sponsorship: None

Informed consent: Written informed consent was obtained from the patients for publication of this case report.

Data availability statement: The data that support the findings of this case report are available from the corresponding author upon reasonable request.

Authors contributions: AK: Conceptualization, Investigation, Methodology, Writing - original draft, **BT**: writing- review & editing. **MN**: Writing – review & editing.

References

Denue BA, Kida IM, Hammagabdo A, Dayar A, Sahabi MA. Prevalence of Anemia and Immunological Markers in HIV-Infected Patients on Highly Active Antiretroviral Therapy in Northeastern Nigeria. *Infect Dis Res Treat.* 2013;6.S10477. doi:10.4137/idrt.s10477

Ganesan PR, Vasauskas AA. The Association Between Pica and Iron-Deficiency Anemia: A Scoping Review. *Cureus.* 2023;15(4). doi:10.7759/cureus.37904

Gowda M, Patel B, Preeti S, Chandrasekar M. An unusual case of xylophagia (paper-eating). *Indian Psychiatry Journal.* 2014;23(1):65. doi:10.4103/0972-6748.144972

Khan Y, Tisman G. Pica in iron deficiency: A case series. *Journal of Medical Case Reports.* 2010;4:2-4. doi:10.1186/1752-1947-4-86

Kurtz D, Azar I, Khan H, Lilley K, Woldie I. Xylophagia (paper eating): A rare form of pica. *Clinical Case Reports.* 2020;8(12):3547-3548. doi:10.1002/ccr3.3157

Shah YR, Narsapuram P, Krishnamoorthy G, Mansour R. Beyond the Usual Diet: A Challenging Case of Xylophagia Resulting in Intestinal Obstruction From Xylobezoar. *ACG Case Reports Journal.* 2023;10(11). doi:10.14309/crj.0000000000001196

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.5

Molecular characterization of urogenital schistosomiasis in Shinyanga and Misungwi districts, North-Western Tanzania

Yasinta D. Sylivester[1*], Maria Zinga[2], Coleman Kishamawe[1], Charles Mangya[1], Bonnie L. Webster[3], Humphrey D. Mazigo[2], Safari M. Kinung'hi[1]

[1]National Institute for Medical Research (NIMR), Mwanza Centre, Mwanza, Tanzania, [2] Department of Medical Parasitology and Entomology, Catholic University of Health and Allied Sciences, Mwanza, Tanzania, [3] Department of Science, Natural History Museum, London, United Kingdom

Abstract

Background: Schistosomiasis is a major parasitic disease, second only to malaria in its global socio-economic impact. In regions like Tanzania, praziquantel (PZQ) is the primary treatment. Recent studies in West Africa suggest the presence of Schistosoma hybrids, potentially influencing the disease's epidemiology. Understanding the prevalence of urogenital schistosomiasis and schistosome hybrids is essential for improving targeted interventions and disease management strategies. This study aimed to investigate the effect of praziquantel on urogenital schistosomiasis prevalence and assess the molecular epidemiology of both *Schistosoma haematobium* and its hybrid with *Schistosoma bovis*.

Methods: In a cross-sectional study, urine samples from 1,910 individuals in southern Lake Victoria villages were tested for *S. haematobium* eggs using urine filtration and microscopy. Genetic analysis of individual miracidia from egg-positive samples was conducted using Rapid Diagnostic Multiplex PCR.

Results: Pre-treatment, *S. haematobium* prevalence was 6.4%, with significant variation across villages. Post-treatment prevalence dropped to 0.3%, indicating a praziquantel cure rate above 90%. Hybrid infections of *S. haematobium* and *S. bovis* were detected in one village at a prevalence of 3.5%, all successfully treated with praziquantel. These results highlight praziquantel's effectiveness against both *S. haematobium* and hybrid infections.

Conclusion: Praziquantel treatment resulted in a significant reduction in *S. haematobium* prevalence and the complete elimination of *S. haematobium-S. bovis* hybrids, indicating successful disease burden reduction. Further studies are needed to evaluate the long-term effectiveness and broader implications of this intervention.

Keywords: Efficacy, hybridization, schistosomiasis, *S. bovis*, *S. haematobium*, praziquantel, Tanzania.

Introduction

Schistosomiasis is a waterborne parasitic disease of medical and veterinary importance caused by trematodes worms of the genus *Schistosoma* (Southgate et al., 1998). It is the second among the top two world's most important parasitic diseases with the highest socioeconomic impact after Malaria (Emery et al., 2020; Mazigo et al., 2012). Approximately 200 million people and 165 million domestic livestock worldwide are affected by schistosomiasis (Leger &

[*]**Corresponding author:** Email: yasintas220@gmail.com

Webster, 2016; Ross, 2002) and nearly 800 million people are at risk of infection (Mwanga et al., 2020). Over 90% of the world's estimated cases of schistosomiasis occur in Sub-Saharan Africa including Tanzania (Kinung'hi et al., 2017; Mazigo et al., 2012).

Epidemiological studies show that human intestinal and urogenital schistosomiasis is highly endemic throughout Tanzania (Mazigo et al., 2012) caused by *S. mansoni* and *S. haematobium* respectively. Regions bordering Lake Victoria in the South, Southeast and Northwestern parts are more prevalent for *S. haematobium* with an estimated prevalence above 50% (Mazigo et al., 2012), whereas for *S. mansoni* the presence was concentrated near the shores of Lake Victoria, especially in the South-western region of the lake (Clements et al., 2006). Preventive chemotherapy has been used as the main intervention to control and eliminate schistosomiasis in endemic countries including Tanzania by 2025 (WHO, 2013). However, schistosomiasis persists to be a major public health problem (Mazigo et al., 2012) with re-infection, non-susceptibility of juvenile schistosomes to praziquantel and possible reduced praziquantel efficiency hampering control efforts.

Tanzania is also endemic for livestock schistosomiasis with S. *bovis* distributed in the areas bordered to the West by Lake Victoria (Kinoti, 1964; Mwambungu, 1988; Southgate et al., 1998). Livestock schistosomiasis causes significant economic loss but the true burden is unknown (Gower et al., 2017). Moreover, many studies now report the widespread hybridization of *S. haematobium* and *S. bovis* raising concerns for zoonotic schistosomiasis transmission in Africa and the possible impact on treatment outcomes (Emery et al., 2020; Huyse et al., 2009; Leger & Webster, 2016; Stothard JR, 2020). However, no studies have investigated the occurrence of *S. haematobium-bovis* in Tanzania. Little is known about the natural consequences of *Schistosoma* hybrid species on human health and environment. A study conducted in Zanzibar (Tanzania Island) revealed the genomic intermixture between *S. haematobium* and *S. bovis* suggesting an introgression event between the two parasites (Rey et al., 2021).

This study aimed to investigate the changing prevalence of urogenital schistosomiasis in Northwestern Tanzania related to Praziquantel treatment together with an assessment of the molecular epidemiology of *S. haematobium* and *S. haematobium-bovis* hybrids among the infected communities.

Materials and methods

Study area and population

This study was conducted in Misungwi and Shinyanga districts, South of Lake Victoria in the Northwestern part of Tanzania (Figure 1). The predominant ethnic group in both regions is Sukuma and the majority of the inhabitants are involved in subsistence farming and livestock keeping (Angelo et al., 2018, 2019). Two districts of Misungwi and Shinyanga are drought-prone areas characterized by the presence of seasonal water bodies. Residents in these districts collect water from seasonal wells or man-made ponds and pools which are shared by domestic livestock (Angelo et al., 2018). Four villages from the two districts were purposively selected based on previous records, which showed a higher prevalence of urogenital schistosomiasis among school-aged children (Angelo et al., 2018).

Animal schistosomiasis is also known to occur in the study area with *S. bovis* infections identified in the local snail populations (Southgate et al., 1980). Of the four chosen villages, three were from Misungwi district namely Ibongoya A, Ibongoya B and Koromije and one was from Shinyanga rural district namely Butini village.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.5

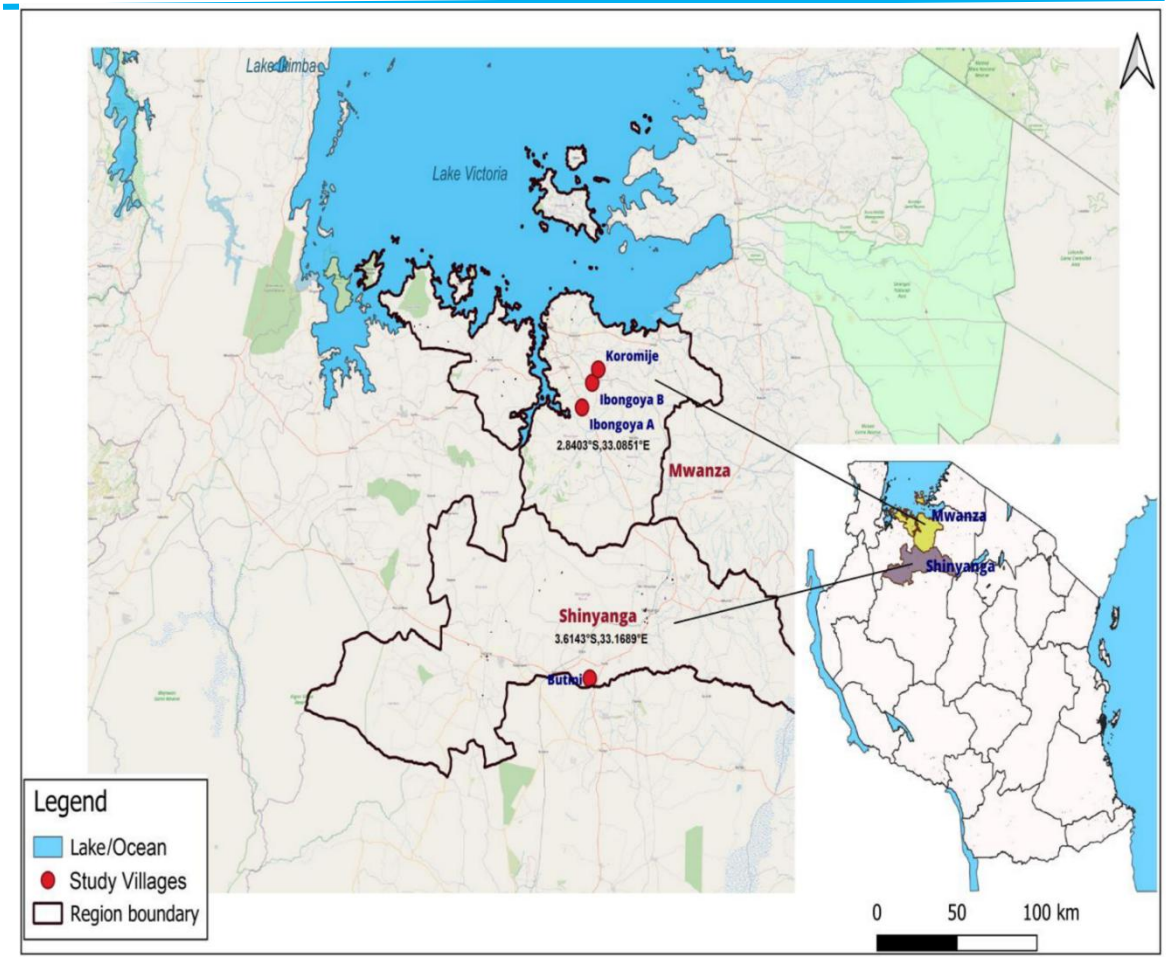


Figure 1: *S. haematobium hotspots in Misungwi and Shinyanga districts. These districts are located in Mwanza and Shinyanga regions respectively, where participants for this study were recruited.*

Study design, sampling procedures, inclusion and exclusion criteria

Analytical cross-sectional study (pre and post-treatment) was conducted from August to October 2021 among preschool-aged children (4-6 years), school-aged children (7-14 years) and adults (15 years and above). Primary schools in selected villages were visited to enrol children from grades 1 to 7 (age 7-14 Years). Household visits were also conducted to enroll Preschool children, out of school children and adults. Study participants who have been living in the selected villages were enrolled. Written informed consent was obtained from individual adult participants while parents or guardians consented on behalf of children. An assent form was developed for children 7-14 years and they were informed about the study procedures before participation in the study. Participants with chronic diseases such as liver and kidney disorders or those with known allergic reactions to PZQ were excluded from the study to prevent any adverse effects.

Data collection methods

Demographic information (age, gender, place of residence and occupation), anthropometric measurement (body weight and height) and history of PZQ treatment during the past 6

months were collected using standardized data collection forms. For Preschool children (4-6) years, their parents/caregivers were asked to respond to the questionnaire on their behalf during school registration.

Field procedures for collection and examination of urine samples

All participants who consented to participate in the study were provided with a sterilized urine collection container and requested to provide a urine sample between 10:00 AM and 2:00 PM (WHO, 2013). Children were involved in a physical exercise for ~10 minutes prior to providing urine samples to increase the chances of providing enough volume of urine and passing *Schistosoma* eggs. From each urine sample, two microscopic slides were prepared using the urine filtration method (Doehring et al., 2017) and microscopically examined for *Schistosoma* eggs (per 10 mls of urine) at 10x magnification (Tukahebwa et al., 2013).

Praziquantel administration

Praziquantel treatment was given to participants who tested positive for urogenital schistosomiasis. We provided a standardized meal (Juice and sweet fried dough) to each study participant before taking the medication to minimize the occurrence of side effects of praziquantel like nausea, vomiting, headache, dizziness and body weakness (Pica-mattoccia, 2014). Thereafter, a single dose of 40 mg/kg body weight (Batch TZ11H047, Shelys Pharmaceuticals Ltd, Tanzania) was administered to each study participant (Zulkifli, 2005). Following drug administration, study participants were closely monitored for four hours in case of any side effects (Zulkifli, 2005). We conducted a follow-up examination of urine samples from all study participants 21 days post-treatment to assess the efficacy of praziquantel treatment and identify all those still infected.

Pre-treatment isolation of *Schistosoma* larvae (*miracidia*) from egg positive urine samples

For *S. haematobium* detection, 10ml of urine from each sample was utilized for urogenital schistosomiasis egg microscopy using a Nucleopore filter. Eggs were harvested from the remaining urine of each positive sample using the Pitchford funnel method (Pitchford & Visser, 1975). The remaining urine was passed through a Pitchfold funnel to wash and concentrate any remaining eggs. About 500 ml of chlorine-free water was used to wash the eggs in the Pitchford funnel, which was allowed to pass through the funnel whilst the eggs were caught in about 15-20 ml of water at the bottom of the funnel. This was then tapped into a petri dish and any eggs were stimulated to hatch into miracidia by exposure to freshwater and light, a process that took about 30 minutes at room temperature. Using a stereo compound microscope, individual miracidia from each urine sample were collected in 3µl of water using a Gilson micropipette and then placed in separate 1.5 ml Eppendorf tubes containing 40µl of EtOH (70%) and stored at room temperature before DNA extraction (Van den Broeck et al., 2011; Webster, 2009).

mtDNA genotyping *Schistosoma* identification

Eppendorf tubes containing the miracidia samples were centrifuged for 1 minute to collect the sample at the bottom of the tube. Ethanol was evaporated by placing the tubes with the lids open on a heat block at 70°C for 1 hour. Then genomic DNA from each miracidium was extracted using the DNeasy animal tissue extraction (Qiagen), according to the manufacturer's protocol (Webster et al., 2010) and eluted in 60µl of AE buffer (10mM Tris-HCl).

The partial cox1 mtDNA multiplex PCR amplifications for *S. bovis* (306pb) and *S. haematobium* (543pb) were conducted in a total reaction volume of 25 µl. This reaction mixture comprised 12.5 µl of Master Mix (New England Biolabs, UK), 4.5 µl of nuclease-free water, 1 µl (0.4 mM)

of the universal forward primer Asmit 1 (25), 0.5 µl (0.2 mM) of each species-specific reverse primer, SbR and ShR, and 6 µl of genomic DNA (Boon et al., 2018; Webster et al., 2010).

The PCR consisted of a 1-minute denaturation step at 94°C, 35 cycles of 30 seconds at 94°C, 1 minute at 58°C, 1 minute at 68 with the final extension of 5 minutes at 68°C. 10µ1 of each PCR product was visualized on a 2% RedSafe agarose gel for 58 minutes at 120V with images taken with an AlphaImager® HP computer software. 100 base pair ladder was used to size the mt amplicons as either *S. haematobium* (543 bp) or *S. bovis* (306 bp).

Data management and statistical analysis

Data were processed and entered into an Excel file. After data cleaning, the analysis was carried out using Stata version 15 (Stata Corp, Texas USA). Descriptive statistics were used to analyze baseline characteristics against infection status and results were summarized in tables. The median Wilcoxon rank-sum test was used to assess the distribution of infection intensity. The Chi-square test was used to compare proportions. Multivariate logistic regression was used to identify predictors of *S. haematobium* infection. The intensity of *S. haematobium* infection was categorized as low (1-49 eggs/10ml) and heavy (≥50 eggs/10ml of urine). Statistical significance was considered at a p-value of < 0.05.

Ethical statement

Ethical approval to conduct this study was obtained from the joint (BMC/CUHAS) Ethical Review Committee (Ethics Approval Certificate Reference number CREC/479/2021). Permission to conduct the study in respective regions and districts was obtained from regional and district authorities. Participants were given information on the purpose of the study, procedures of the study, expected duration of participation and on expected benefits and discomforts of the study. Study identification numbers were used in place of participant's names and the information collected was kept confidential. The respondent's right to withdraw from participating in the study was highly guaranteed.

Results

Social demographic characteristics of study participants

A total of 1910 participants were enrolled into this study at baseline of whom 958 (50.2%) were males. The mean age for Preschool children was 5.0 (SD±0.84, range 4–6 years). The mean age for school-aged children was 10.3 (SD±2.2 range 7-14 years) and the mean age for adults was 36.8 (SD±16.5, range 15–89 years). The majority of the participants 858 (44.9%) were school-aged children. The distribution of study participants from the four villages was Ibongoya A 28.06% (n = 536), Ibongoya B 21.10% (n = 403), Koromije 30.84% (n = 589) and Butini 20% (n = 382). There were no significant differences between genders (χ^2 = 1.0, P > 0.05) (Table 1) however, demographics varied significantly among age groups and occupations (P <0.001) (Table

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.5

Table 1: *Demographic characteristics of the study population and the prevalence of urogenital schistosomiasis pre and 21 days post-treatment by village, gender, age group and occupation (N = 1910)*

	Village					Pre-treatment				Post-treatment			
Explanatory variables	**Butini**	**Ibongoya A**	**Ibongoya B**	**Koromije**	**P value**	**n**	**No. positive%**	**χ^2**	**P value**	**No. Positive %**	**χ^2**	**P value**
Overall 1910												
Sex												
Female	187 (49.0)	260 (48.5)	207 (51.4)	298 (50.6)	0.799	952	38 (4.0)	19.5	<0.001	0 (0.0)	2.85	0.09
Male	195 (51.1)	276 (51.5)	196 (48.6)	291 (49.4)		958	85 (8.9)			6 (7.1)		
Age (years)												
4 to 6	24 (6.3)	82 (15.3)	74 (18.4)	114 (19.4)	< 0.001	294	12 (4.1)	7.4	0.025	0 (0.0)	0.69	0.71
7 to 14	227 (59.4)	258 (48.1)	160 (39.7)	213 (36.2)		858	69 (8.0)			4 (5.8)		
15+	131 (34.3)	196 (36.6)	169 (41.9)	262 (44.5)		758	42 (5.5)			2 (4.8)		
Mean age ± SD	19.7(16.0)	18.8 (16.7)	20.3 (17.5)	20.7 (18.2)								
Occupations												
School aged children	229 (60.0)	291 (54.3)	170 (42.2)	225 (38.2)	<0.001	846	69 (20.5)	12.9	0.012			
Pre school	21 (5.5)	61 (11.4)	61 (15.1)	112 (19.0)		244	11 (4.3)					
Farmers	132 (34.6)	184 (34.3)	172 (42.7)	252 (42.8)		697	43 (9.2)					
Villages												
Butini						382	5 (1.3)	24.4	<0.001	0 (0.0)	2.8	0.422
Ibongoya A						536	50 (9.3)			4 (9.5)		
Ibongoya B						403	28 (7.0)			0 (0.0)		
Koromije						589	36 (6.8)			2 (5.3)		
Baseline intensity of S. haematobium (eggs/10ml urine)	4	7	2	5	<0.001							
Low 1 – 49	5	45	28	37	0.339		115 (93.50)	123	<0.001	4 (66.7)		
High ≥ 50	0	5	0	3			8 (6.50)			2 (33.3)		

 https://dx.doi.org/10.4314/thrb.v26i3.5

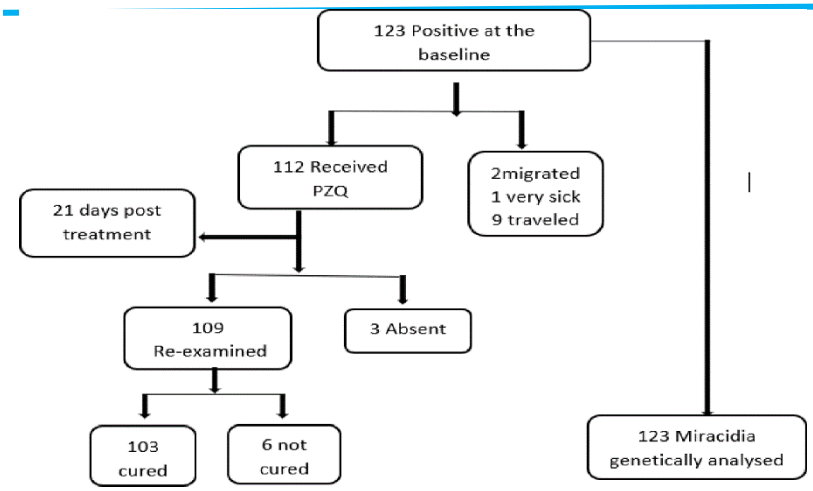


Figure 2: *Study profile showing the number of participants who tested positive for urogenital schistosomiasis at baseline, those who received praziquantel treatment and re-examined 21 days post-treatment.*

Prevalence and infection intensity of urogenital schistosomiasis

The overall prevalence of urogenital schistosomiasis in all four villages at baseline was 6.4% (range 1.3%-9.3%) with significant differences between villages (χ^2= 24.4, P < 0.001) (Table 1), age groups and gender (P <0.001) (Table 1). The mean infection intensity of *S. haematobium* was 4.5 (1.6 – 6.8 eggs/10ml urine) but there was significant variation in intensity between villages (P<0.001) (Table 1). The prevalence of *S. haematobium* at 21 days post-treatment was 0.3% (n=6) with no significant differences observed between villages (χ^2= 2.8, P = 0.422) (Table 1). Out of 123 infected individuals, 93.5% (n = 115) had light-intensity infections and 6.5% (n = 8) had heavy infections. All females had light infection intensities (<50 eggs per 10ml of urine). The mean *S. haematobium* intensity was low in preschool children (4-6 years) and adults (>15 years) but high in school-aged children (7-14 years), males had higher *S. haematobium* intensity of infections compared to females before and after treatment (Figure 3).

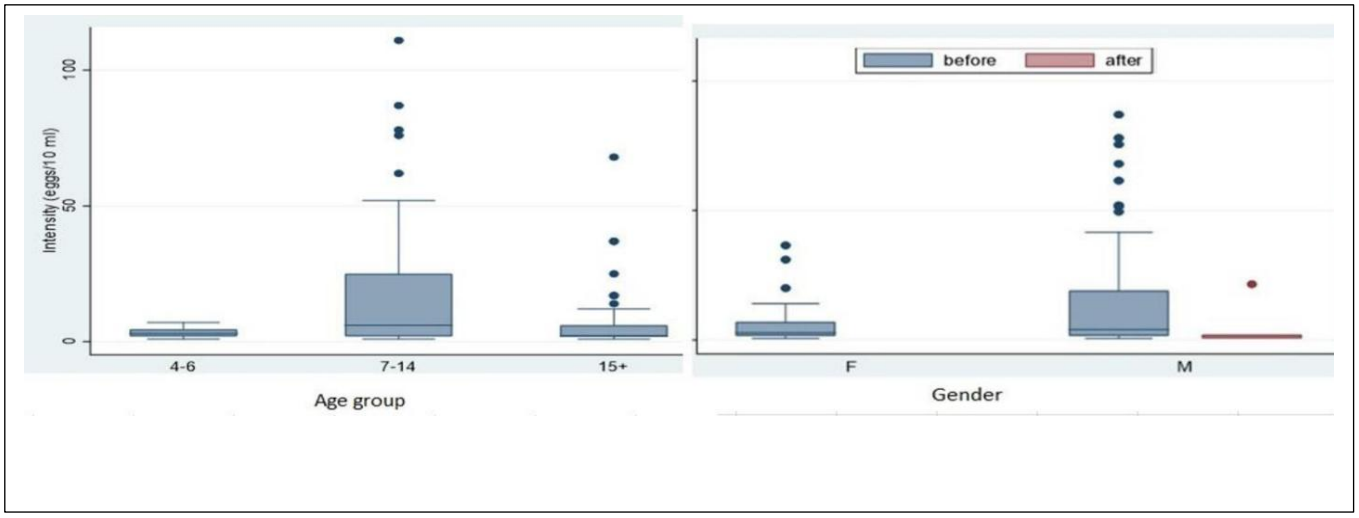


Figure 3: *Box and whisker plot showing the mean S. haematobium infection intensity (egg/10ml urine) by age group and gender before and after treatment (n =123). Whereas all females showed a 100% cure rate while 4.5% (n=6) of the males remained egg-positive 21 days post-treatment.*

Predictors of *Schistosoma haematobium* infection

A Multivariate logistic regression analysis was used to assess the association of *S. haematobium* infection and the demographic characteristics of participants. Only sex was a significant predictor of *S. haematobium* infection for all age categories. The odds of being infected with *S. haematobium* for males was 2.4 times higher compared to females (OR=2.4, 95% CI: 1.6-3.5, P < 0.001). Neither occupation nor age group were observed to be significant risk factors for *S. haematobium* infection (P>0.05) (Table 2).

Table 2: *Multivariate logistic regression analysis of predictors of S. haematobium infection among preschool, school-aged children and adults in the study areas (n =123)*

	Unadjusted**		**Adjusted****	
Explanatory variable	**OR (95% CI)**	**P-value**	**OR (95% CI)**	**P-value**
Sex				
Female	1		1	
Male	2.4 (1.6-3.5)	< 0.001	2.4 (1.6-3.5)	<0.001
Age (years)				
4-6	1		1	
7-14	4.6 (0.6-39.0)	0.16	1.8 (0.7-4.5)	0.218
15+			0.7 (0.1-3.7)	0.664
Occupations				
Farmer	1			
School children	3.7 (0.4-32.6)	0.25	0.5 (0.1-2.3)	0.387
Preschool	3.8 (0.2-66.2)	0.36	0.4 (0.1-2.5)	0.345
Out of school	3.5 (0.2-59.8)	0.39	0.9 (0.2-4.5)	0.941

Cure rate and egg reduction rate

The cure rate was defined as the proportion of treated persons who were egg positive at baseline but become negative 21 days post-treatment. Out of 1910 participants examined, 123 were urinary egg positive at baseline of whom 88.6% (n=109) participants received praziquantel treatment and were re-examined 21 days post-treatment (figure2). 94% (103/109) became egg negative with only six participants remaining egg positive. However, praziquantel appeared to be significant superior for those who had light infection (Table 3). The egg reduction rate (ERR) was defined as a reduction of the mean egg count among positive patients after treatment compared with the respective mean egg count before treatment. All participants who were eggs positive at day 21 post-treatment had a significant reduction in infection intensities compared to baseline 4.5eggs/10ml urine vs 1eggs/10ml urine) (P> 0.05). Yielding and egg reduction rate ≥ 90%.

Table 3: *Cure rates of praziquantel treatment by gender, age group and baseline S. haematobium intensity (n=109)*

	N	Cured (%)	P
Overall			
Sex			
Male	75	92.00	0.090
Female	34	100.00	
Age, years			
4-6	10	100.0	0.708
7-14	62	93.6	
≥ 15	37	94.6	
Baseline intensity (eggs/10ml)			
Low 1- 49	101	96.0	0.012
High ≥ 50	8	75.0	

The occurrence of *S. haematobium* x *S. bovis* hybrid species

From the 123 egg positive individuals at baseline, cox1 profiles were successfully obtained from 115 miracidia with 111 presenting *S. haematobium* (*S.h*) cox1 profile, three presenting *S. bovis* (*S.b*) cox1 profile and 1 presenting a double-banded Sh/Sb cox1 profile, probably due to this being more than one miracidia captured within that sample (Polovina et al., 2020). The three samples (3.3%) that displayed a *S. bovis* (*S.b*) cox1 could be *S. haematobium-bovis* hybrids (28); however, this cannot be confirmed without analysis of the nuclear DNA (Figure 4). The suspected hybrids were collected from individuals from two sub-villages, namely Ikilikili and Ilungu, located in Koromije village, Misungwi District (Table 4). All four participants from which potential hybrid miracidia were identified were egg-negative 21 days post-treatment, showing 100% cure rates. Most individuals treated for pure *S. haematobium* exhibited egg-negative results post-treatment, indicative of the effectiveness of Praziquantel as the primary treatment.

Table 4: *The occurrence of S. haematobium (S.h) and S. bovis (S.b) mt cox1 profile by gender, age group and village*

Variable	No. urinary egg positive	S. h mt Cox1 profile	S. b mt Cox1 profile	P value
Sex				
Male	85	76	3	
Female	38	35	1	
Age (years)				
4 to 6	12	10	0	
7 to 14	69	64	1	
15+	42	37	3	
Village				
Butini		5	0	0.035
IbongoyaA		48	0	
Ibongoya B		24	0	
Koromije		34	4	

 https://dx.doi.org/10.4314/thrb.v26i3.5

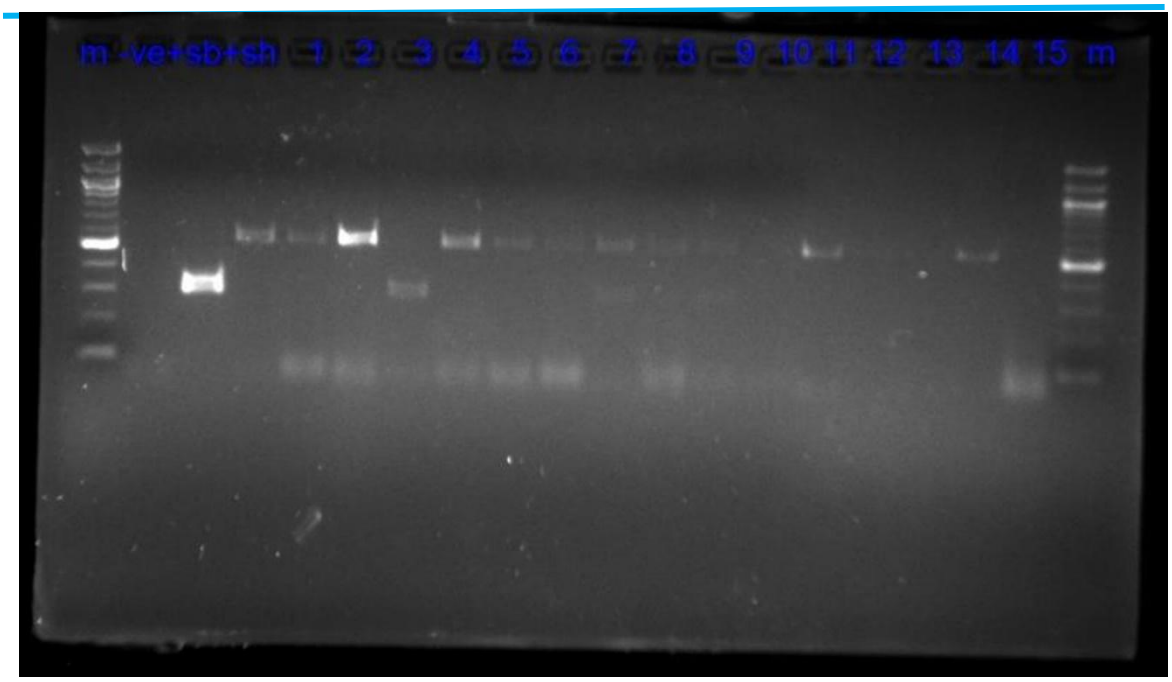


Figure 4: *Mt cox1 profiled for individual miracidia. S. haematobium cox1 =543bp and S. boviscox1 = 306bp.*

Discussion

This study has shown that urogenital schistosomiasis is still a public health problem in Shinyanga and Misungwi districts Northwestern Tanzania. The prevalence of *S. haematobium* observed in this study was significantly lower compared to a previous study conducted in Shinyanga, the most prevalent region for urogenital schistosomiasis in Tanzania, where prevalence for school-aged children was 34.8% and 16.8% before and after treatment respectively (Angelo et al., 2018). This is probably due to the continuous rounds of Preventive Chemotherapy provided to primary school children which may have resulted into reductions in both the prevalence and infection intensity (Mazigo et al., 2022; Mnkugwe et al., 2020).

Another factor potentially influencing our findings could be the methodology employed for diagnosis. Our study relied on a single urine sample from each participant for diagnostic purposes. While this approach yielded valuable insights into infection status, it may not have fully captured the variability in egg excretion rates and intermittent shedding patterns characteristic of light-intensity infections.

Our finding is supported by the previous study conducted in Niger whereby the egg detection method had a sensitivity of 59% and specificity 100% while molecular (qPCR) detection had a sensitivity of 84% and specificity was 97% (Ibironke et al., 2011). It would be good to re-test urines of several days (2-3) from participants to get more accurate data on prevalence and infection intensity.

We found that males had higher infection intensities compared to females. This is consistent with several other studies where males are reported to have high infection levels due to engagement in high-risk activities such as irrigation, fishing,

watering animals and swimming compared to females (Angelo et al., 2018; Mazigo et al., 2012; Ndyomugyenyi & Minjas, 2017). Males also showed a reduced cure rate after treatment compared to females, 92% and 100% respectively.

The egg reduction rate (ERR) observed in this study was above 90% which is considered satisfactory according to WHO (WHO, 2013). However few individuals remained egg-positive, this could be explained by the presence of immature (juvenile) worms which are insensitive to PZQ (Boon et al., 2018; Danso-appiah et al., 2002; Tchuenté et al., 2013). ERRs did not differ significantly with infection intensity which is contrary to the findings of Calvin Bisong Ebai in Southwestern Cameroon which reported ERRs of (96.1%) in individuals with heavy infections and (60.4%) in those with light infections and suggested that PZQ has a higher efficacy on heavy infection than light infections one (Ebai et al., 2017).

With regard to the molecular epidemiology of the *Schistosoma* populations, the majority of the infections were identified as *S. haematobium.* Suspected *S. haematobium-bovis* hybrids occurred in two sub-villages and at a low level of 3.5% which is 17% less than the frequency of hybrids among school-age children observed along the Senegal River Basin (21%) (Boon et al., 2018; Webster et al., 2013). This lower frequency observed could be attributed to the limited number of miracidia analysed compared to previous studies conducted in West Africa (Boon et al., 2018; Webster et al., 2013), together with the limited genetic profiling of the miracidia (only cox1 profiling). More widespread sampling would support the mapping of the intensity and focality of these *S. haematobium-bovis* hybrid across Tanzania. However, the finding that all individuals carrying *S. haematobium-bovis* hybrid infections showed 100% cure rates after PZQ treatment is beneficial in terms of human schistosomiasis interventions.

The presence of a small percentage of individuals who remained infected post-treatment may stem from various factors, including the developmental stage of the parasite during treatment. Additionally, there exists a possibility of the emergence of resistance genes within the schistosome parasite population (Melman et al., 2009). Therefore, it is imperative to persist in exploring any genetic alterations within the parasite population. Such investigations are crucial for advancing our understanding of schistosomiasis and enhancing interventions against it.

Conclusions

The findings of this study suggest that schistosomiasis remains a public health problem in Shinyanga and Misungwi districts despite regular MDA with Praziquantel. *S. haematobium-bovis* hybrids were found at a low frequency in two sub-villages but these did not show any adverse effects on PZQ treatment with 100% cure rates achieved. The suspected hybrids were detected at a low frequency before treatment; however, molecular analysis was not done post-treatment for egg-positive people.

Availability of data and materials: Available upon request from the corresponding author

Competing interests: The authors declare no conflicts of interest

Author's contributions

Yasinta Sylivester: Conceptualization, Methodology, Formal analysis, Investigation, Data curation & Writing – original draft. Maria Zinga: Conceptualization, Writing—review & editing & supervision. Coleman Kishamawe: Formal analysis, Data curation & Visualization. Charles Mangya: Formal analysis, Visualization. Bonnie Webster: Methodology, resources & Writing – review & editing. Humphrey Mazigo: Writing—review & editing. Safari Kinung'hi: Conceptualization, Methodology, Investigation, Writing—review & editing, Supervision, Funding acquisition. All authors have read and agreed to the published version of the manuscript.

Acknowledgements

We are grateful to the management of the Catholic University of Health and Allied Sciences (CUHAS), the National Institute for Medical Research (NIMR), Mwanza Centre and the Regional and District Authorities in Mwanza and Shinyanya regions for their assistance during field data collection.

Reference

Angelo, T., Buza, J., Methusela, S., Kariuki, H. C., Mwanga, J. R., Munisi, D. Z., & Wilson, S. (2018). *Geographical and behavioral risks associated with Schistosoma haematobium infection in an area of complex transmission*. 1–9.

Angelo, T., Kinung'hi, S. M., Buza, J., Mwanga, J. R., Kariuki, H. C., & Wilson, S. (2019). Community knowledge, perceptions and water contact practices associated with transmission of urinary schistosomiasis in an endemic region: A qualitative cross-sectional study. *BMC Public Health*, *19*(1), 1–10. https://doi.org/10.1186/s12889-019-7041-5

Boon, N. A. M., Broeck, F. V. A. N. D. E. N., Faye, D., Volckaert, A. M., Mboup, S., Polman, K., & Huyse, T. (2018). *Barcoding hybrids : heterogeneous distribution of Schistosoma haematobium × Schistosoma bovis hybrids across the Senegal River Basin*. 634–645. https://doi.org/10.1017/S0031182018000525

Clements, A. C. A., Lwambo, N. J. S., Blair, L., Nyandindi, U., Kaatano, G., Kinung'hi, S., Webster, J. P., Fenwick, A., & Brooker, S. (2006). Bayesian spatial analysis and disease mapping: Tools to enhance planning and implementation of a schistosomiasis control programme in Tanzania. *Tropical Medicine and International Health*, *11*(4), 490–503. https://doi.org/10.1111/j.1365-3156.2006.01594.x

Danso-appiah, A., Vlas, S. J. De, Danso-appiah, A., & Vlas, S. J. De. (2002). *Interpreting low praziquantel cure rates of Schistosoma mansoni infections in Senegal*. *18*(3), 125–129.

Doehring, E., Feldmeier, H., & Daffalla, A. A. (2017). *Annals of Tropical Medicine & Parasitology Day-to-day variation and circadian rhythm of egg excretion in urinary schistosomiasis in the Sudan Day-to-day variation and circadian rhythm of egg*. *4983*(July), 82. https://doi.org/10.1080/00034983.1983.11811757

Ebai, C. B., Kimbi, H. K., Ule, I., Sumbele, N., Yunga, J. E., & Lehman, L. G. (2017). *Efficacy*

and safety of praziquantel against Schistosoma haematobium in the Ikata- Likoko area of southwest Cameroon. 1–8. https://doi.org/10.1186/s41182-017-0071-8

Emery, A., Morrell, A., Rabone, M., Ndao, M., Faye, B., Rollinson, D., Rudge, J. W., Sène, M., & Webster, J. P. (2020). Articles Prevalence and distribution of schistosomiasis in human , livestock , and snail populations in northern Senegal : a One Health epidemiological study of a multi-host system. *The Lancet Planetary Health*, *4*(8), e330–e342. https://doi.org/10.1016/S2542-5196(20)30129-7

Gower, C. M., Gehre, F., Marques, S. R., Lamberton, P. H. L., Lwambo, N. J., & Webster, J. P. (2017). *Phenotypic and genotypic monitoring of Schistosoma mansoni in Tanzanian schoolchildren five years into a preventative chemotherapy national control programme*. 1–12. https://doi.org/10.1186/s13071-017-2533-6

Huyse, T., Webster, B. L., Geldof, S., Stothard, J. R., Diaw, O. T., Polman, K., & Rollinson, D. (2009). Bidirectional introgressive hybridization between a cattle and human schistosome species. *PLoS Pathogens*, *5*(9). https://doi.org/10.1371/journal.ppat.1000571

Ibironke, O. A., Phillips, A. E., Garba, A., Lamine, S. M., & Shiff, C. (2011). Diagnosis of Schistosoma haematobium by detection of specific DNA fragments from filtered urine samples. *American Journal of Tropical Medicine and Hygiene*, *84*(6), 998–1001. https://doi.org/10.4269/ajtmh.2011.10-0691

Kinoti, G. (1964). *Observations on the Transmission of Schistosoma haematobium and Schistosoma bovis in the Lake Region of Tanganyika*. 815–823.

Kinung'hi, S. M., Mazigo, H. D., Dunne, D. W., Kepha, S., Kaatano, G., Kishamawe, C., Ndokeji, S., Angelo, T., & Nuwaha, F. (2017). Coinfection of intestinal schistosomiasis and malaria and association with haemoglobin levels and nutritional status in school children in Mara region, Northwestern Tanzania: A cross-sectional exploratory study. *BMC Research Notes*, *10*(1), 1–11. https://doi.org/10.1186/s13104-017-2904-2

Leger, E., & Webster, J. P. (2016). *Hybridizations within the Genus Schistosoma : implications for evolution , epidemiology and control*. *August*. https://doi.org/10.1017/S0031182016001190

Mazigo, H. D., Nuwaha, F., Kinung'hi, S. M., Morona, D., Moira, A. P. De, Wilson, S., Heukelbach, J., & Dunne, D. W. (2012). *Epidemiology and control of human schistosomiasis in Tanzania*. 1–20.

Mazigo, H. D., Zinga, M. M., Kepha, S., Yard, E., Mckee, K. M., Kabona, G., Ngoma, D. D., & Nshala, A. (2022). Precision and geographical prevalence mapping of schistosomiasis and soil - transmitted helminthiasis among school - aged children in selected districts of north - western Tanzania. *Parasites & Vectors*, 1–16. https://doi.org/10.1186/s13071-022-05547-6

Melman, S. D., Steinauer, M. L., Cunningham, C., Kubatko, L. S., Mwangi, I. N., Wynn, N. B., Mutuku, M. W., Karanja, D. M. S., Colley, D. G., Black, C. L., Secor, W. E., Mkoji, G. M., & Loker, E. S. (2009). Reduced susceptibility to praziquantel among naturally occurring Kenyan isolates of Schistosoma mansoni. *PLoS*

Neglected Tropical Diseases, *3*(8). https://doi.org/10.1371/journal.pntd.0000504

Mnkugwe, R. H., Minzi, O. S., Kinung'hi, S. M., Kamuhabwa, A. A., & Aklillu, E. (2020). *Efficacy and Safety of Praziquantel for Treatment of Schistosoma mansoni Infection among School Children in Tanzania*. https://doi.org/10.3390/pathogens9010028

Mwambungu, J. A. (1988). Transmission of schistosoma bovis in mkulwe (mbozi district, mbeya region, southern highlands of tanzania). *Journal of Helminthology*, *62*(1), 29–32. https://doi.org/10.1017/S0022149X00011159

Mwanga, J. R., Kinung'hi, S. M., Mosha, J., Angelo, T., Maganga, J., & Campbell, C. H. (2020). Village response to mass drug administration for schistosomiasis in mwanza region, Northwestern Tanzania: Are we missing socioeconomic, cultural, and political dimensions? *American Journal of Tropical Medicine and Hygiene*. https://doi.org/10.4269/ajtmh.19-0843

Ndyomugyenyi, R., & Minjas, J. N. (2017). *Urinary schistosomiasis in schoolchildren in Dar- es-Salaam , Tanzania , and the factors influencing its transmission Urinary schistosomiasis in schoolchildren tn*. *4983*(August). https://doi.org/10.1080/00034983.2001.11813687

Pica-mattoccia, D. C. Æ. L. (2014). *Praziquantel*. *May*, 2–9. https://doi.org/10.1007/s00436-002-0751-z

Pitchford, R. J., & Visser, P. S. (1975). A simple and rapid technique for quantitative estimation of helminth eggs in human and animal excreta with special reference to Schistosoma sp. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *69*(3), 318–322. https://doi.org/10.1016/0035-9203(75)90126-1

Polovina, E., Parakatselaki, M., & Ladoukakis, E. D. (2020). Paternal leakage of mitochondrial DNA and maternal inheritance of heteroplasmy in Drosophila hybrids. *Scientific Reports*, 1–9. https://doi.org/10.1038/s41598-020-59194-x

Rey, O., Toulza, E., Chaparro, C., & Webster, B. L. (2021). *Diverging patterns of introgression from Schistosoma bovis across S . haematobium African lineages*. 1–21. https://doi.org/10.1371/journal.ppat.1009313

Ross, A. G. P. (2002). *Schistosoma haematobium, S. mansoni,*. *346*(16), 1212–1220.

Southgate, V. R., Jourdane, J., & Tchuem Tchuenté, L. A. (1998). Recent studies on the reproductive biology of the schistosomes and their relevance to speciation in the Digenea. *International Journal for Parasitology*, *28*(8), 1159–1172. https://doi.org/10.1016/S0020-7519(98)00021-6

Southgate, V. R., Rollinson, D., Ross, G. C., Knowles, R. J., Road, C., & Kensington, S. (1980). *Parasitenkunde*. *249*, 241–249.

Stothard JR, W. B. (2020). *Acute schistosomiasis: Which molecular diagnostic test is best and why*. *39*(10), 4444–4455.

Tchuenté, L. T., Momo, S. C., Stothard, J. R., & Rollinson, D. (2013). Efficacy of praziquantel and reinfection patterns in single and mixed infection foci for intestinal and urogenital schistosomiasis in Cameroon. *Acta Tropica*. https://doi.org/10.1016/j.actatropica.2013.06.007

Tukahebwa, E. M., Vennervald, B. J., Nuwaha, F., Kabatereine, N. B., & Magnussen, P. (2013). Comparative efficacy of one versus two doses of praziquantel on cure rate of Schistosoma mansoni infection and re-infection in Mayuge District, Uganda. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *107*(6), 397–404. https://doi.org/10.1093/trstmh/trt024

Van den Broeck, F., Geldof, S., Polman, K., Volckaert, F. A. M., & Huyse, T. (2011). Optimal sample storage and extraction procotols for reliable multilocus genotyping of the human parasite Schistosoma mansoni. *Infection, Genetics and Evolution*, *11*(6), 1413–1418. https://doi.org/10.1016/j.meegid.2011.05.006

Webster, B. L. (2009). *Parasites & Vectors Isolation and preservation of schistosome eggs and larvae in RNA later ® facilitates genetic profiling of individuals*. *6*, 1–6. https://doi.org/10.1186/1756-3305-2-50

Webster, B. L., Diaw, O. T., Seye, M. M., Webster, J. P., & Rollinson, D. (2013). *Introgressive Hybridization of Schistosoma haematobium Group Species in Senegal : Species Barrier Break Down between Ruminant and Human Schistosomes*. *7*(4). https://doi.org/10.1371/journal.pntd.0002110

Webster, B. L., Rollinson, D., Stothard, J. R., & Huyse, T. (2010). Rapid diagnostic multiplex PCR (RD-PCR) to discriminate Schistosoma haematobium and S. bovis. *Journal of Helminthology*, *84*(1), 107–114. https://doi.org/10.1017/S0022149X09990447

WHO. (2013). *World Health Organization. Assessing the Efficacy of Anthelminthic drugs against Schistosomiasis and Soil-transmitted Helminthiases. (accessed 09 Nov 2021)*. https://apps.who.int/iris/handle/10665/79019

Zulkifli, Z. (2005). *The WHO dose pole for the administration of praziquantel is also accurate in non-African populations*.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.6

Ebola Virus Disease Outbreak Prevention and Control Preparedness: A Qualitative Experience from High-Risk Regions in Tanzania

Hussein Mohamed[1], Emmy Metta[2], Tumaini Nyamhanga[3], Priscilla Kusena[4], Deodatus Kakoko[2], Nathanael Sirili[2], Awet Araya[4], Allan Rwechungura[4], Gasto Frumence[3]*

[1]Department of Environmental and Occupational Health, School of Public Health and Social Sciences, Muhimbili University of Health and Allied Sciences, P O Box 65015, Dar es Salaam, [2]Department of Behavioral Science, School of Public Health and Social Sciences, Muhimbili University of Health and Allied Sciences, P O Box 65015, Dar es Salaam, [3]Depatment of Development Studies, School of Public Health and Social Sciences, Muhimbili University of Health and Allied Sciences, P O Box 65015, Dar es Salaam, [4]UNICEF Tanzania, P.O BOX: 4076 Dar Es Salaam | Plot 133 Karume Road, Oyster Bay, Dar es Salaam,
[5]Department of Epidemiology and Biostatistics, School of Public Health and Social Sciences, Muhimbili University of Health and Allied Sciences, P O Box 65015, Dar es Salaam

Abstract

Introduction: Although rare, Ebola virus disease is one of the deadliest viral infections, with a case fatality rate of up to 50%. The virus was first identified in 1976 in the Democratic Republic of the Congo. Since then, outbreaks have been reported in various African countries, primarily in Central Africa, with the largest and most complex outbreak occurring between 2014 and 2016. The most recent outbreak was in Uganda in 2022, which posed a significant public health threat to both the Ugandan population and neighbouring countries, including Tanzania, due to the high risk of cross-border transmission caused by daily movement of people. However, there is limited information on how well-prepared communities in high-risk regions are in the event of an Ebola virus disease outbreak.

Method: This ethnographic study investigated community preparedness for an Ebola virus disease outbreak and the preventive measures in place in high-risk regions of Tanzania, including Kagera, Mwanza, Songwe, and Kigoma. Data were collected through observations, interviews, and focus group discussions.

Results: Community members showed awareness of Ebola prevention through risk communication and community engagement efforts. However, observations revealed a disconnect between this awareness and cultural practices. Many continued engaging in risky behaviours, such as large gatherings, physical contact (e.g., hugging and handshaking), and traditional funeral practices, which increased transmission risks. Healthcare workers at facilities and ports of entry were well-prepared, with preventive measures in place.

Conclusion: The study findings indicate that community members in high-risk regions for Ebola transmission possess some knowledge of the disease and its preventive measures. However, further efforts are needed to ensure that individuals are not only well-informed but also implementing these preventive measures in preparation for a potential outbreak.

Keywords: Ebola outbreak, preparedness, risk communication, community engagement

Introduction

* **Corresponding Author:** E mail: hmohameds1@gmail.com

Ebola virus disease (EVD) is a rare but deadly illness in humans. The average case fatality rate of the disease is 50%, however, early supportive care with rehydration and symptomatic treatment improves survival (WHO, 2022). The name Ebola originates from the Democratic Republic of the Congo where the Ebola virus was first discovered in 1976 near the Ebola River. Since then, EVD outbreaks have been reported in many African countries. The largest and most complex outbreak occurred between 2014 to 2016 in West Africa where 28 600 people were infected and 11 325 died (WHO, 2016).

The natural reservoir host of Ebola viruses remains unknown. However, based on the nature of similar viruses, it is likely that the virus is animal-borne, with fruit bats (family Pteropodidae) being the most likely reservoir. The fruit bats are believed to spread the Ebola virus to chimpanzees, gorillas, monkeys, and humans. Human-to-human transmission of EVD occurs through direct contact with infected blood, body fluids, contaminated objects, and handling of dead bodies. Sexual intercourse with previously infected person even after recovery from the disease is a risk factor (Bausch et al., 2014), specifically, 155 days after the clearance of the Ebola virus from his blood (.

The 2022 Uganda EVD outbreak which was declared on the 20th of September was a public health threat not only to Ugandan people but also to those in the neighboring countries including Tanzania. The importation of the disease from one country to another can be facilitated by cross-border movements of people as part of usual socioeconomic activities or official visits. Moreover, within individual countries deeply rooted cultural practices such as taking care of the sick at home and at traditional healers, handling of the dead bodies and burial ceremonies could be at the center of EVD transmission.

Immediately as the EVD was confirmed in Uganda, Tanzanian government issued EVD alert requesting all regions to take all necessary precautions against the outbreak. The focus was mainly to the regions identified as high risk of Ebola transmission that included: Kagera, Mwanza, Kigoma, Songwe, Arusha regions in the mainland, and Zanzibar; due to their proximity to and/or incoming passengers from neighboring countries. This underlines the need for instituting effective EVD outbreak preparedness measures for timely detection and containment of outbreaks.

Public health epidemic emergency requires rapidly generated information to inform the design, contextualization of interventions and implementation of effective and appropriate measures. Increasing the efficiency of public health interventions requires rigorous evidence about the effectiveness of interventions to change Behavioural determinants, behaviors, and their impact on health outcomes (Davidson,et al., 2003; Michie et al., 2004; Claude & Hawkes, 2018). Knowledge, attitude, and practice (KAP) studies are famous to assess awareness and knowledge of a particular disease and several KAP studies on EVD among populations have been conducted (Nyakarahuka, 2017; Mbaye et al, 2019; Rolison, 2015). However, anthropological data on EVD vulnerability and response preparedness in Tanzania is lacking. A social anthropological study was carried out to generate evidence on how some of the social and cultural norms, values and practices may play a role not only in the spread of Ebola disease but also in its prevention and control.

Materials and methods

Study design

It was a cross-sectional study that employed anthropological research methodology to describe the social and cultural context of preventive and control measures for Ebola Virus Disease (EVD). The study used rapid ethnography, incorporating focus group discussions, in-depth interviews, and participant observations. Focused ethnographic studies allow researchers to explore cultural contexts and practices in emerging settings of interest (Wall, 2015), such as during epidemics.

Study Sites

The study was conducted in the regions of Kagera, Mwanza, Kigoma, and Songwe. Kagera and Mwanza are near the border with Uganda, which was experiencing an EVD outbreak at the time. Kigoma shares a border with the Democratic Republic of Congo (DRC), which has a history of frequent EVD outbreaks. Songwe was identified by the Ministry of Health as a high-risk region due to its airport and large bus terminal, which receive passengers from neighboring countries. Additionally, the study was carried out in two regions of Zanzibar, selected due to the high influx of people visiting for business, official duties, and tourism.

Sampling Approach and Data Collection Methods

A purposive sampling approach was used to recruit participants at various levels, from households to the national level, based on their status and roles within the community. The sample size was determined in the field upon reaching saturation (Dahlgren, 2004; Sandelowski, 1995). Four data collection methods were employed: Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), In-depth Interviews (IDIs), and Observation.

The FGDs targeted participants based on their status and roles in the community, with each group consisting of 8 to 12 individuals. The FGDs were facilitated by experienced social scientists and supported by a note-taker, who was responsible for audio recording and documentation. Each FGD session lasted between 60 and 90 minutes. IDIs were conducted with purposively selected individuals based on their positions within the community. Like the FGDs, these interviews were audio-recorded for detailed documentation, lasting between 45 and 60 minutes. Similarly, KIIs involved in-depth interviews with community leaders and other key figures.

During data collection, the research team observed and interacted with participants in their real-life environments, which helped deepen the understanding of cultural practices and norms. These included practices related to caring for the sick, handling the deceased, funeral ceremonies, health-seeking behaviours, and religious practices that might contribute to the risk of an EVD outbreak and transmission. Whenever possible, the research team attended social events such as funeral ceremonies, visited areas where the deceased were being prepared for burial, and observed common marketplaces, local brew clubs, and bus terminals.

Recruitment and Training of Research Assistants

To ensure the quality of the data, a team of research assistants with backgrounds in sociology and medical anthropology, and experience in qualitative health research were recruited, oriented and trained on the study's objectives, data collection processes, and ethical considerations.

Data management

The audio-recorded interviews were transcribed verbatim in Kiswahili, with non-verbal cues also considered during transcription. Researchers extracted significant statements, and formulated meanings from these statements. These were divided into meaning units that were later condensed into more abstract forms of text, creating codes, categories, and themes.

Ethical consideration

The Muhimbili University of Health and Allied Sciences Institutional Ethical Review Board and the Zanzibar Health Research Institute granted Ethical approval (MUHAS-REC-11-2022-1442 and ZAHREC/04/PR/FEB/2023/06 respectively).

The permission to conduct the study was sought from the President's Office, Regional Administration and Local Government (PORALG) and the Second Vice President's Office in Zanzibar (OMPR). All study participants were informed in detail about the study objectives and were provided with the opportunity to ask questions for clarification before consenting to take part in the study. Participants were informed of their right to agree or refuse to participate in the study or freely withdraw from the study at any time if they wished to do so with no cost.

Findings

The study findings reveal that participants described their varying opinions pointing out various measures for EVD preparedness and control that were linked to either risk communication, community engagements and management measures or adherence to various EVD preventive measures. These generic categories arose from a range of participants' expressions of the presence of different preparedness and control efforts targeted for Ebola they had come across. In addition, our findings shows that there were EVD preventive measures that were implemented by health care personnel both at the health care facilities and the ports of entry.

Risk Communication Measures: The study found that various risk communication methods were recognized as effective in reaching different groups within the community. This presents an opportunity to ensure that Ebola Virus Disease (EVD) prevention information is easily disseminated to all groups, including women, youth, elders, and school children. Participants identified several commonly used communication methods for conveying information about disease risks, including EVD. The choice of communication channel depends on factors such as the target audience, the severity of the disease, and sometimes the cost involved. Additionally, the communication channel may vary based on the geographical location, socio-cultural beliefs, and lifestyle of the target population.

For instance, one participant shared an example from Zanzibar:

> *"There is a rapid risk communication and coordination unit responsible for communicating disease risks to communities. They collaborate with community health volunteers who can easily reach people with the necessary information. Fliers and other IEC materials are distributed to communities. They also work with influential figures, such as religious leaders, to spread messages. Furthermore, media outlets like TV and local radio play a crucial role. In Zanzibar, there is a special TV program called 'TVZ Doctor,' which educates communities on various health issues" (IDI-Zanzibar).*

Other common communication methods include interpersonal communication during social gatherings, such as formal meetings, funerals, and seminars for local leaders on disseminating information to the community. Social media platforms, public address systems, and folk media are also employed depending on the situation. As one participant explained:

> *"We normally raise awareness about disease outbreaks during any gathering, whether it's a religious or funeral ceremony, so people can take preventive measures" (KII 7, Mwanza).*

Another participant from Misenyi District Council said,

"We provide health education on Ebola prevention during meetings and funerals" (KII 3, Misenyi), while a participant from Songwe added,
"We offer health education on how to prevent diseases like Ebola during funeral ceremonies" (KII 3, Songwe).

Community Engagement: The study explored how Ebola prevention and preparedness measures have been implemented in Tanzania Mainland and Zanzibar, focusing on community involvement through local leaders and community health workers. Findings showed that community leaders, defined as government officials at lower levels (Ward, Village/Mtaa) and influential figures such as religious leaders, community health workers, and traditional healers, were trained on various Ebola Virus Disease (EVD) preventive measures. They, in turn, played a vital role in raising awareness among community members about practicing preventive measures, such as hand hygiene, in the event of an outbreak. One participant explained:

"The local leaders normally mobilize community members to take preventive measures against the disease through meetings, especially community meetings" (KII 1, Zanzibar).

The study also highlighted that these community leaders were key figures in disseminating crucial information on Ebola prevention and control. As one participant noted:

"When we want to communicate with community members, we normally meet community leaders and request them to distribute leaflets about EVD preventive measures" (FGD 3, Participant 1, Zanzibar).

Local leaders were also instrumental in enforcing Ebola prevention measures. For instance, when "the Minister of Health announced the presence of Ebola in a neighbouring country and asked us to take necessary precautions, local leaders emphasized these instructions to community members" (KII 6, Misenyi).

Another participant shared,

"The Ministry of Health has been announcing about the disease and the risk of infection if we do not take preventive measures. Our local leaders kept reminding us of these statements, which helped us understand what to do in case Ebola is reported in Tanzania" (KII 8, Mwanza).

Participants emphasized the importance of involving trusted and credible sources of information for effective EVD prevention. This is because community members are more likely to adhere to preventive measures when communicated by trusted local figures. As one participant stated:

"If you want to effectively communicate preventive messages to the community, you must first engage local leaders. Once they understand, it becomes easier for them to positively influence others or even provide health education themselves, as people trust them more" (KII 3, Misenyi).

Religious leaders were also recognized as crucial and reliable sources of information. One participant explained:

"Religious leaders can easily communicate Ebola preventive messages in churches and mosques, as some people do not attend village meetings but will go to pray in these places" (KII 3, Misenyi).

Generally, it was suggested that leaders across all levels, from local to national, should collaborate for successful EVD prevention. As one participant put it:

"If government leaders, from the street or village level up to the Minister, can work together on this issue, it could help reduce the risk of EVD transmission in our country if it emerges" (IDI 5, Zanzibar).

Risk management measures: Participants pointed out the existence of Ebola risk management measures such as special health teams that could be deployed in case of an outbreak and were in alert mode for the entire period of EVD outbreak in Uganda. Similarly, the team for developing, and disseminating Information Education and Communication (IEC) materials was in place to ensure that clear messages are developed and reach the community to avoid distortion and confusion. In addition, disaster committee exist both in Tanzania Mainland under the Prime Ministers Office and in Zanzibar where there is a special disaster commission. One respondent had this to say:

> *"Zanzibar has a top-down approach which is used during epidemics. There is also a disaster commission which coordinates all matters related to epedemics in Zanzibar"(KII-head for quality improvement-Zanzibar).*

Health facility measures

At the health facility level, our observation revealed presence of EVD preventive and control preparedness measures moslty infection prevention and control (IPC) initiatives such as the provision of disinfectants and sanitizers, availability of hand wash facilities with running water and soap, and the provision of educational materials with key messages to remind people to take necessary precautions. Almost all visited health facilities, particularly health centres and hospitals were found to be prepared to deal with EVD outbreak.

In addition, healthcare workers reported taking precautionary measures such as avoiding physical contact, maintaining the cleanliness of the health facility environment, frequent hand washing and use of sanitiser, and use of PPE such as gloves, masks, and medical coats when attending to patients and dead bodies. One of the respondents in Kagera region had this to say

> *"We insist workers wear gloves and masks while attending a suspected EVD patient" (KII 1: Missenyi)*

Ebola disease preventive measures at the ports of entry

The study findings revealed that at the ports of entry, several preventive measures are carried out including temperature screening for passengers, the presence of functional hand wash facilities, and the presence of educational materials. A health worker in one of the ports of entry had this to say

> *"we continuously screen travellers for temperature and observe common infectious disease symptoms such as excessive coughing or sweating" (IDI-Misenyi).*

It was also revealed that health workers at the ports of entry are under alert all the time and have active and fast means of communication. One respondent had this to say:

> *"People working at the ports of entry communicate frequently in case of an alert through a WhatsApp group. In addition, we always have a 72 h plan which describes what to do in case of disease outbreak or any public health emergency of international concern" (IDI-Zanzibar).*

However, despite these efforts the researchers observed sub-standard practices in some of the ports of entry that include poor handling of luggage and excessive crowding of passengers in the waiting areas and check-in points. The ports of entry health personnel also described some risk factors for EVD transmission. One of the main risk factors is the presence of unofficial entry points (porous borders) where people use to cross from one country to the other.

Discussion

The aim of this study was to explore the preparedness measures for Ebola Virus Disease (EVD) prevention and control in regions identified by the Ministry of Health as high-risk for EVD transmission. The study focused on two key objectives: first, to assess community engagement, risk communication, and risk management measures, and second, to evaluate the preparedness of both communities and healthcare facilities in the event of an outbreak. The findings from this study provided valuable insights into the practices surrounding EVD prevention and control in Tanzania Mainland and Zanzibar.

The results emphasized the critical role of community engagement, especially through local leadership, in ensuring that EVD prevention and control measures are effectively implemented. Community leaders, including religious leaders, health workers, and traditional healers, were well-informed and played an integral role in raising awareness and preparing the community for a potential outbreak. Previous studies have highlighted the importance of community leaders in controlling the spread of EVD in their communities (Abramowitz et al., 2015). For instance, the involvement of local leaders such as chiefs, parliament members, and district commissioners in educating people and disseminating preventive messages has proven effective (Richards et al., 2015). Traditional healers, being the first point of contact for many individuals in these communities, also play a vital role in early disease identification, diagnosis, and patient referral (Schioldann et al., 2018). Involving them in prevention efforts can lead to early detection and alerts, which is crucial in epidemic control.

Religious leaders were also identified as key figures in disseminating EVD prevention messages. Their influence within the community makes them effective communicators, especially in times of health crises (Manguvo & Mafuvadze, 2015). The involvement of both health workers and community leaders in health education campaigns was shown to foster trust and encourage community participation in prevention efforts, as seen in studies conducted during the Liberia EVD outbreak (Abramowitz et al., 2015; Sharma et al., 2014).

Moreover, the study identified several effective risk communication methods, including interpersonal communication during social gatherings, community meetings, funerals, and seminars for local leaders. These methods also included the use of social media platforms, public address systems, and folk media. However, for risk communication to be successful, it is crucial that messages are delivered by trusted individuals such as community leaders and local authorities (Richards et al., 2015). This is consistent with findings from Uganda, where extensive use of media and door-to-door education was implemented to raise awareness about EVD (Musaazi et al., 2022). However, the approach in Tanzania was preventive, focused on preparing communities for a potential outbreak, which put the country in a stronger position to respond swiftly if an outbreak occurred.

The study also highlighted differences in risk management measures between Tanzania and West African countries. In West Africa, community care centers (CCCs) were established for case management and containment during outbreaks (Idowu, 2020). Tanzania, however, has not yet experienced an EVD outbreak, which likely explains the absence of such facilities.

Healthcare workers, especially those at ports of entry, were found to adhere to preventive measures more effectively than the general public. These measures included avoiding physical contact, maintaining cleanliness, frequent handwashing, wearing protective gear, and using sanitizers. In contrast, adherence to preventive practices in the general population was less consistent, particularly in regard to social interactions such as hugging, handshakes, and attending large gatherings. These behaviors, rooted in cultural norms, present a challenge for effective outbreak control. People's reluctance to change long-established social practices, such as shaking hands or participating in communal

events, could increase the risk of EVD transmission during an outbreak. This aligns with other studies that have noted the role of social practices in facilitating disease transmission during EVD outbreaks (Adongo et al., 2016).

Future outbreak control strategies should address these cultural practices and provide targeted education to help communities understand how such behaviors contribute to disease transmission. Educational efforts should emphasize the risks associated with mass gatherings, physical contact, and traditional practices related to caring for the sick and handling the deceased.

Conclusion and Recommendations

This study aimed to identify sociocultural practices that may both prevent and increase the risk of EVD transmission. The findings suggest that while many traditional practices are deeply rooted in communities, they can contribute significantly to the spread of EVD. Engaging local and religious leaders, as well as traditional healers, has proven effective in raising awareness and promoting adherence to preventive measures. Therefore, it is recommended that these leaders continue to play an active role in the community's preparedness and response efforts. Building strong communication channels between community members and their leaders is essential for successful social mobilization and ensuring compliance with EVD prevention measures.

Moreover, while communities in Tanzania were informed about EVD prevention, adherence to these measures, especially among the general population, remains insufficient. This poses a risk for EVD transmission if an outbreak occurs. Therefore, risk communication and community engagement efforts should be paired with strategies to change social norms, particularly those that contribute to EVD transmission, such as mass gatherings, physical contact, and traditional funeral practices. Ensuring that communities understand the risks associated with these practices and encouraging alternative behaviors will be critical for effective outbreak control.

Competing interests: No competing interests
Authors contribution: Wrote the first draft and edited it: HM, TM, EM; contributed intellectually: PK, DK, NS, AA, AR, MK, GF
Funding: This research was funded by UNICEF as part of Humanitarian Programme

Acknowledgement

The authors would like to express their sincere gratitude to the President's Office, Regional Administration, and Local Government Tanzania (PORALG), and the Ministry of Health for granting permission to conduct the study. Our appreciation extends to the regional and district government teams for ensuring smooth and productive fieldwork. We are also deeply thankful to the study participants and contact persons from Tanzania's high-risk EVD regions, whose insights were invaluable to this research.

Additionally, we would like to acknowledge the dedicated research assistants whose hard work and commitment made data collection possible. Special thanks to the local leaders and health officials who facilitated access to communities and provided essential guidance throughout the study. Finally, we express our heartfelt gratitude to the experts in socio-cultural anthropology and public health, whose technical support and advice significantly contributed to the success of this research.

References

Abramowitz, S. A., McLean, K. E., McKune, S. L., Bardosh, K. L., Fallah, M., Monger, J., Omidian, P. A. (2015). Community-centered responses to Ebola in urban Liberia: The view from below. PLoS Neglected Tropical Diseases, 9(4), 1-11. doi:10.1371/journal.pntd.0003706.

Adongo PB, Tabong PT, Asampong E, Ansong J, Robalo M, Adanu RM. (2016). Preparing towards Preventing and Containing an Ebola Virus Disease Outbreak: What Socio-cultural Practices May Affect Containment Efforts in Ghana? PLoS Negl Trop Dis. 18;10(7):e0004852. doi: 10.1371/journal.pntd.0004852. PMID: 27428069; PMCID: PMC4948768.

Almutairi K. M, Alodhayani A. A, Moussa M, Aboshaiqah A. E, Tumala, R. B, & Vinluan J. M. (2016). Ebola outbreak preparedness and preventive measures among healthcare providers in Saudi Arabia. Journal of Infections in Developing Countries 10: 829– 836. doi:10.3855/jidc.6941.

Bausch, D.G.; Schwarz, L. (2014). Outbreak of Ebola virus disease in Guinea: Where ecology meets economy. PLoS Negl. Trop. Dis. 2014, 8, e3056.

Claude, K. M. Underschultz, J. & Hawkes, M.T. (2018). Ebola virus epidemic in war-torn eastern Democratic Republic of Congo. Lancet, 392, 1399–1401. http://dx.doi.org/10.1016/ S0140-6736(18)32419-X.

Dahlgren L, Emelin M, Winkvist A. (2004). Qualitative methodology in international public health; Umea: Umea University. [Google Scholar].

Davidson, K.W.; Goldstein, M.; Kaplan, R.M.; Kaufmann, P.G.; Knatterud, G.L.; Orleans, C.T.; Spring, B.; Trudeau, K.J.; Whitlock, E.P. (2003). Evidence-based behavioral medicine: What is it and how do we achieve it? Ann. Behav. Med. 26, 161–171.

DOI: 10.1056/NEJMoa1509773. VOL. 373 NO. 25.

Idowu, A. B., Okafor I. P., Oridota E. Sofela & Okwor T. J. (2020). Ebolavirus disease in the eyes of a rural, agrarian community in Western Nigeria: a mixed method study. BMC PublicHealth. https://doi.org/10.1186/s12889-020-09441- 7.

Manguvo, A., & Mafuvadze, B. (2015). The impact of traditional and religious practices on the spread of Ebola in West Africa: time for a strategic shift. The Pan African Medical Journal, 22(Supp 1), 1–4. https://doi.org/10.11694/pamj.supp.2015.22.1.6190.

Mbaye D. K, Fortes L, Lakhe N. A, Cisse D. V.M.P, Ka D, Kémi R, Massaly A, Thioub D, Badiane A. S, Fall N. M, Ndour C. T, Soumaré M and Seydi M. (2019). Knowledge, attitudes and practices regarding ebola virus disease among students at a school of medicine in Dakar, Senegal. Journal Infectious Disease and Epidemiology 5(6):104. doi.org/.

Michie, S.; Abraham, C. (2004). Interventions to change health behaviours: Evidence-based or evidence-inspired? Psychol. Health, 19, 29–49.

Musaazi J, Namageyo-Funa A, Carter V. M, Carter R. J, Lamorde M, Apondi R, Bakyaita T, Boore AL, Brown V. R, Homsy J, Kigozi J, Koyuncu A, Nabaggala M. S, Nakate V, Nkurunziza E, Stowell D. F, Walwema R, Olowo A, Jalloh M. F. (2022). Evaluation of Community Perceptions and Prevention Practices Related to Ebola Virus as Part of Outbreak Preparedness in Uganda, 2020. Glob Health Science Practice. 10(3):e2100661. doi: 10.9745/GHSP-D- 21-00661. PMID: 36332065; PMCID: PMC9242603.

Nyakarahuka, L.; Skjerve, E.; Nabadda, D.; Sitali, D.C.; Mumba, C.; Mwiine, F.N.; Lutwama, J.J.; Balinandi, S.; Shoemaker, T.; Kankya, C. (2017). Knowledge

and attitude towards Ebola and Marburg virus diseases in Uganda using quantitative and participatory epidemiology techniques. PLoS Negl. Trop. Dis. 11, e0005907.

Richards P, Amara J, Ferme M. C, Kamara P, Mokuwa E, Sheriff A. I, Suluku, R & Voors M. (2015). Social Pathways for Ebola Virus Disease in Rural Sierra Leone, and Some Implications for Containment. PLoS Negl Trop Dis 9(4): e0003567. doi:10.1371/journal.pntd.0003567.

Rolison J. J, Hanoch Y. (2015). Knowledge and risk preceptions of the Ebola virus in the United States. Prev Med Rep 2: 262-264. 10.23937/2474-3658/1510104.

Sandelowski M. (1995). Sample size in qualitative research. Res Nurs Health. ; 18: 175–83. [Crossref], [Web of Science ®], [Google Scholar]Centers for Disease Control and Prevention (CDC), The Social Ecological Model: (https://www.cdc.gov/violenceprevention/pdf/sem_framewrk-a.pdf).

Schioldann E, Mahmood M. A, Kyaw M. M, Halliday D, Thwin K. T, Chit N. N, et al., (2018). Why snakebite patients in Myanmar seek traditional healers despite availability of biomedical care at hospitals? Community perspectives on reasons. PLoS Neglected Tropical Diseases. 12(2): e0006299. https://doi.org/10.1371/journal.pntd.0006299 PMID: 29489824.

Sharma, A., Heijenberg, N., Peter, C., Bolongei, J., Reeder, B., Alpha, T., Sterk, E., Robert, H., Kurth, A., Cannas, A., Bocquin, A., Strecker, T., Logue, C., Di Caro, A., Pottage, T., Yue, C., Stoecker, K., Wölfel, R., Gabriel, M., Damon, I. (2014). Evidence for a decrease in transmission of Ebola virus — Lofa County, Liberia, June 8–November 1, 2014. Morbidity and Mortality Weekly Report, 63(46), 1067-1071.

Suzanne E. Mate, Jeffrey R. Kugelman, Tolbert G. Nyenswah, Jason T.Ladner, MichaelR.Wiley,Thierry Cordier- Lassalle, Athalia Christie, Gustavo Palacios, et a., 2015. Molecular Evidence of Sexual Transmission of Ebola Virus. N Engl J Med 2015;373:2448-2454

Wall, Sarah Stahlke. (2015). "Focused ethnography: A methodological adaptation for social research in emerging contexts." Forum Qualitative Sozialforschung/Forum: Qualitative Social Research. Vol. 16. No. 1.

WHO. (2016). Ebola outbreak 2014-2016 - West Africa https://www.who.int/emergencies/situations/ebola-outbreak-2014-2016-West-Africa). Accessed on 4 October 2023.

WHO. (2022). Ebola Virus Disease. Available online: https://www.who.int/news-room/fact-sheets/detail/ebola-virus-disease. Accessed on 4 October 2023.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.7

Factors Influencing Modern Contraceptive Use among Women of Reproductive Age in Rural Areas of Tanzania

Anicet Rwezaula, Edmund Zakayo and Nsajigwa Mwalupani*

Institute of Rural Development Planning, P.O. Box 138, Dodoma-Tanzania

Abstract

Introduction: The use of modern contraceptives among women of reproductive age in rural areas helps space pregnancies, reducing the risk of complications and enhancing maternal health. Identifying the factors influencing the use of modern contraceptives in rural settings is crucial for designing effective and appropriate interventions.

Objectives and Methods: This study aimed to identify factors associated with the use of modern contraception among women of reproductive age in rural Tanzania. Data was sourced from the 2022 Tanzania Demographic and Health Survey and Malaria Indicator Survey (2022 TDHS-MIS), available at https://www.dhsprogram.com. The data were analyzed using STATA Version 16, with a multilevel logistic regression model as the statistical approach.

Results: The findings revealed that more than two-thirds of rural women did not use modern contraceptives, while one-third did. The study identified several factors associated with contraceptive use, including the women's education level, their partner's education, exposure to family planning information through radio or newspapers/magazines, decision-making regarding contraceptive use, and the number of living children.

Conclusions and recommendations: The study concludes that modern contraceptive use among rural women in Tanzania is low. To address this, the government, in collaboration with stakeholders, should implement sensitization and educational programs to change misconceptions about contraceptives. Additionally, enhancing the capacity of local health workers to provide accurate information and counseling is essential to increasing contraceptive use in rural areas.

Keywords: TDHS-MIS, Modern contraceptive, Women, Reproductive Age, Rural areas, Tanzania

Introduction

Modern contraceptive use has garnered significant attention as an important factor that has substantial implications on total fertility rates and reproductive health outcomes, like unintended pregnancies (Budu, et al., 2023). Contraceptive use has been the prominent measure for family planning among women of reproductive age. Globally, modern contraceptive use is fast increasing (63%) but continues to be low in Sub-Saharan Africa (Tessema, et al., 2021). Contraception use is important since it can reduce teen pregnancies in urban and rural communities (Bishop et al., 2025). Despite its importance, the use of contraceptives has been low among women in rural areas compared to urban areas. The latest 2022 Demographic and Health Survey and Malaria Indicator Survey (DHS-MIS) in Tanzania report the prevalence of modern contraceptive use among women of reproductive age to be 38%. The use of modern contraceptives is low among women in rural areas (29.3%) compared to those in urban areas (35.1%) (URT, 2022).

Several studies have been conducted to determine the factors leading to the low use of modern contraceptives. In Sub-Saharan Africa, level of education, employment status and access

*Corresponding Author email: arwezaula@irdp.ac.tz

to family planning information have been influencing the use of contraceptives (Budu, et al., 2023). In Ethiopia, age, women's educational level, religion, marital status, number of living children, wealth status, gender and age of household head, community poverty, maternal education and religion were found to be the factors influencing contraceptive use among rural women (Beyene, et al., 2023; Zeleke & Zemedu, 2023; Hailegebreal, et al., 2023).

Other factors influencing contraceptive use were mentioned to be maternal age, maternal educational level, partner's educational level, number of living children, and women's fertility preferences (Boah et al., 2023). Similarly, the education level of women and employment status increases the rate of contraceptive use among women in Chake Chake, Tanzania (Abeid et al., 2023). Women with college/university education are twice more likely to use modern contraceptive methods compared to those with primary or not attended school; meanwhile, employed women were twice as likely to use modern contraceptives compared to unemployed/housewives (Abeid et al., 2023). Similarly, residential status, household wealth disparities and rural-rich categories are more likely to influence modern contraceptive use among rural women in Ghana (Tampah-Naah, et al., 2023). In India, adverse socioeconomic and cultural factors like low levels of education, no exposure to mass media, and lack of or limited knowledge about family planning, wealth status, religion, and ethnicity remain impediments to the use of modern contraceptives (Srivastava et al., 2023).

Although there is much literature on the factors of using modern contraceptive use among women of reproductive age, not much in the Tanzanian context (Beyene, et al., 2023; Zeleke & Zemedu, 2023; Hailegebreal, et al., 2023; Boah, et al., 2023; Tampah-Naah, et al., 2023; Srivastava, et al., 2023), little is known about the factors influencing modern contraceptive use among women of reproductive age in rural areas of Tanzania. Therefore, this study will add to the understanding of the factors influencing the use of modern contraceptives among women of reproductive age in rural areas in the following ways. First, this study examines the extent to which social factors influence the use of modern contraceptives among women of reproductive age in rural areas of Tanzania. Second, it examines the extent to which economic factors influence the use of modern contraceptives among women of reproductive age in rural areas of Tanzania. Based on these objectives, the study provides robust and viable recommendations to policymakers and stakeholders to increase the use of modern contraceptives in rural areas in Tanzania and elsewhere.

This study contributes to understanding the factors influencing the use of modern contraceptives in rural areas, which helps in designing interventions to improve access and availability. Empowering women to plan their families, modern contraceptives can contribute to economic stability and growth. Women who control their reproductive health are more likely to participate in the workforce and pursue education. Rural areas have different cultural and social attitudes towards contraception compared to urban areas. Studying these factors helps in creating culturally sensitive educational programs and policies.

Likewise, this study is conducted in the Tanzanian context, where there is scanty literature on the use of modern contraceptives among women of reproductive age, particularly those in rural areas, and thus contributes to the literature base. The study contributes to policymakers differently; understanding factors influencing contraceptive use in rural areas helps policymakers allocate resources more effectively. This includes funding for healthcare facilities, training for healthcare providers, and the distribution of contraceptives. The study informs the development of targeted interventions that address the unique challenges faced by rural populations; this ensures that policies are not one-size-fits-all but are adapted to the local context.

Materials and methods

Data sources and sampling

The 2022 Tanzania Demographic and Health Survey and Malaria Indicator Survey (2022 TDHS-MIS) is the 7th DHS survey in Tanzania to be conducted through The DHS Program. The survey was carried out across Tanzania's mainland and Zanzibar. The DHS is a nationally representative survey conducted periodically to collect demographic and health information from households across Tanzania. The datasets were acquired through the DHS program measure at https://www.dhsprogram.com. The study population included women of reproductive age (15-49 years) who reside in rural areas of Tanzania. 29,214 women aged 15-49 years and residing in rural areas were involved in the study.

Data analysis

Descriptive data, especially categorical variables, were analysed and presented as percentages and frequencies. The chi-square test was employed for bivariate analysis to examine the association between the response and predictors. Variables with p-values less than 5% in the bivariate analysis were considered for inclusion in the regression modelling. Given that the outcome variable is binary, a logistic regression model was chosen to explore the factors of modern contraceptive use.

Study variables

Outcome variable

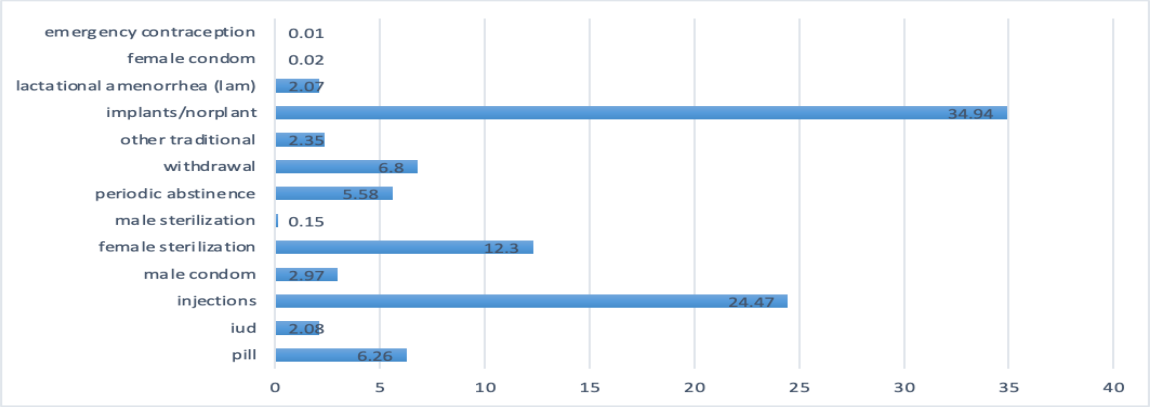
The study response variable is binary (dummy) outcome, namely modern use of contraceptive methods; we coded "1" for the responses "pill", "IUD", injections, male condom, female sterilization, male sterilization, periodic abstinence, withdrawal, implants/Norplant, lactational amenorrhea (lam), female condom, emergency contraception, or standard days method (SDM) and termed as modern contraceptive methods while "0" for not using modern contraceptive methods.

Independent variables

Similar to the literature, the resulting predictors of contraceptive use among women in rural areas are age, marital status, education level, husband/partner's education level and hearing of family planning on the radio. Other predictors are hearing about family planning on television, hearing about family planning in newspapers/magazines in the last few months, wealth index, decision makers for using contraception, frequency of using the internet last month and number of living children.

Results

Figure 1 illustrates the type of contraceptives used. The most common contraceptives used were implanted/Norplant, used by 36.94% of women, followed by injections (24.47%), and emergency contraception was the least used (0.01%). Interestingly, the study found that more than two-thirds (67%) of rural women did not use modern contraceptive methods, while one-third (33%) used modern contraceptives, as shown in Figure 2.



 https://dx.doi.org/10.4314/thrb.v26i3.7

Fig 1: Distribution of contraceptive methods used by women

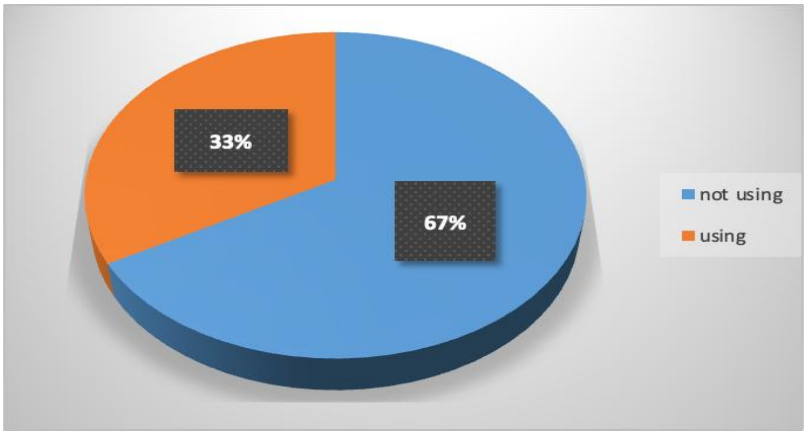


Fig 2: Distribution on the use of modern contraceptives among women in rural areas

Table 1 outlines various characteristics of rural women involved in the study. More than half (59.39%) of the women were aged between 35 and 49 years, and 62.01% were married. For the case of education level, around 57.06% had primary education, and a similar percentage (64.4%) of their husbands or partners also had primary education. Interestingly, most women (58.01%) had not heard about family planning on the radio in the last few months, and more than three-quarters (83.56%) had not heard about it on television. Additionally, 86.35% did not come across family planning information in newspapers or magazines recently. The majority of women in rural areas (52.79%) fall under the category of being economically poor. Half of the women (51.86%) make joint decisions regarding contraceptive use. Surprisingly, almost all women (96.29%) did not use the internet frequently in the last month. A significant proportion (70.65%) of women had four or more living children, and most women took between 0 and 30 minutes to reach the nearest healthcare facility (refer to Table 1 for details).

In addition, the study investigated the association between the use of modern contraceptive methods and different predictors. Factors namely, marital status, education level, husband/partner's education, exposure to family planning information through media, wealth index, decision-making on contraceptive use, internet usage, number of living children, and proximity to healthcare facilities showed significant associations with the use of modern contraceptives at 5%. However, age was not found to be significantly associated and was excluded from further statistical analysis (Table 1).

Table 1: Distribution of independent variables and use of modern contraceptive methods (n=29,214)

Variable	using modern contraceptive		All N (%)	p-value
	No n (%)	Yes n (%)		
Overall				
Age				0.093
25-34	7852(26.88)	4013(13.74)	11865(40.61)	
35-49	11645(39.86)	5704(19.52)	17349(59.39)	
marital status				<0.001
never in union	464(1.59)	286(0.98)	750(2.57)	
married	11972(40.98)	6143(21.03)	18115(62..01)	
living with partner	4116(14.09)	2056(7.04)	6172(21.13)	
widowed	883(3.02)	270(0.92)	1153(3.95)	
divorced	1324(4.53)	639(2.19)	1963(6.72)	
no longer living together	738(2.53)	323(1.11)	1061(3.63)	
education level				<0.001

https://dx.doi.org/10.4314/thrb.v26i3.7

no education	6562(22.46)	2148(7.35)	8710(29.81)	
primary	10616(36.34)	6054(20.72)	16670(57.06)	
secondary	2289(7.84)	1481(5.07)	3770(12.9)	
higher	30(0.1)	34(0.12)	64(0.22)	
Husband/partner's education level				<0.001
no education, preschool	3675(15.13)	1089(4.48)	4764(19.62)	
Primary	10043(41.36)	5599(23.05)	15642(64.4)	
secondary	1973(8.12)	1307(5.38)	3280(13.51)	
Higher	125(0.51)	99(0.41)	224(0.92)	
don't know	272(1.12)	105(0.43)	377(1.55)	
heard family planning on the radio				<0.001
No	11774	5172	16946	
Yes	7723	4545	12268	
heard family planning on television				<0.001
No	16707(54.19)	7704(26.37)	24411(83.56)	
Yes	2790(9.55)	2013(6.89)	4803(16.44)	
heard of family planning in newspaper/magazine in the last few months				<0.001
No	17128(58.63)	8097(27.72)	25225(86.35)	
Yes	2369(8.11)	1620(5.55)	3989(13.65)	
wealth index				<0.001
Poor	11135(38.12)	4287(14.67)	15422(57.79)	
Middle	4691(16.06)	2875(9.84)	7566(25.9)	
Rich	3671(12.57)	2555(8.75)	6226(21.31)	
decision maker for using contraception				<0.001
respondent	5416(22.3)	2290(9.43)	7706(31.73)	
husband/partner	3112(12.81)	631(2.6)	3743(15.41)	
joint decision	7332(30.19)	5263(21.67)	12595(51.86)	
someone	35(0.14)	3(0.01)	38(0.16)	
Other	193(0.79)	12(0.05)	205(0.84)	
frequency of using the internet last month				<0.001
not at all	18900(64.7)	9229(31.59)	28129(96.29)	
less than once a week	116(0.4)	80(0.27)	196(0.67)	
at least once a week	232(0.79)	176(0.6)	408(1.4)	
almost every day	249(0.85)	232(0.79)	481(1.65)	
Number of living children				<0.001
0	61(0.21)	1(0)	62(0.21)	
1—5	5424(18.57)	3087(10.57)	8511(29.13)	
6+	14012(47.96)	6629(22.69)	20641(70.65)	
minutes to the nearest healthcare facility				<0.001
0-30	11585(39.66)	6392(21.88)	17977(6154)	
31-60	4445(15.22)	1922(6.58)	6367(21.79)	
61+	3467(11.87)	1403(4.8)	4870(16.67)	

Multivariate logistic regression results

The multivariate logistic regression was conducted on the predictors for the use of modern contraceptive methods among rural women of reproductive age. Table 2 presents the results of the multivariate logistic regression examining predictors of modern contraceptive use. The analysis results indicate that women with primary education (OR=1.3, 95% CI: 1.23-1.42, p<0.00), secondary education (OR=1.2, 95% CI: 1.13-1.40, p<0.00), or higher education (OR=1.99, 95% CI: 1.12-

 https://dx.doi.org/10.4314/thrb.v26i3.7

3.55, p<0.019) had higher odds of using modern contraceptives compared to those with no education. Similarly, women whose husbands/partners had primary (OR=1.4, 95% CI: 1.29-1.52, p<0.00) or secondary (OR=1.34, 95% CI: 1.20-1.51, p<0.00) education had higher odds of using modern contraceptives.

Hearing about family planning on the radio was associated with higher odds of use (OR=1.11, 95% CI: 1.04-1.18, p<0.001), as was hearing about it in newspapers/magazines (OR=1.17, 95% CI: 1.07-1.28, p<0.05). Wealth index played a role, with middle (OR=1.44, 95% CI: 1.34-1.54, p<0.00) or rich (OR=1.43, 95% CI: 1.32-1.56, p<0.00) women having higher odds of using modern contraceptives compared to the poor. Women making joint decisions (OR=1.59, 95% CI: 1.49-1.69, p<0.00) were more likely to use modern contraceptives, while those whose husband/partner (OR=0.51, 95% CI: 0.46-0.56, p<0.00) or someone else (OR=0.22, 95% CI: 0.06-0.72, p<0.013) made the decision had lower odds. Furthermore, women with 1 to 5 (OR=29.9, 95% CI: 4.10-218.56, p<0.001) or 6+ (OR=28.8, 95% CI: 3.95-210.6, p<0.001) children had higher odds of using modern contraceptives compared to women with no children.

Table 2. Multivariate logistic regression using modern contraceptive methods

Variable	Odds Ratio	Std. Err.	z	p-value	95% confidence interval	
Marital status						
Never in union	**Reference**					
living with partner	1.0066	0.033263	0.2	0.842	0.943471	1.073952
Education level						
no education	**Reference**					
Primary	1.325385	0.046291	8.07	<0.001	1.237692	1.419292
Secondary	1.262523	0.069493	4.24	<0.001	1.133409	1.406345
Higher	1.994463	0.585941	2.35	0.019	1.12139	3.547278
Husband/partner's education level						
no education	**Reference**					
Primary	1.402601	0.057662	8.23	<0.001	1.294018	1.520295
Secondary	1.346717	0.079163	5.06	<0.001	1.200166	1.511164
Higher	1.353764	0.208855	1.96	0.05	1.000511	1.831742
don't know	0.880503	0.1091	-1.03	0.304	0.690656	1.122534
heard family planning on the radio						
No	**Reference**					
Yes	1.111376	0.035686	3.29	0.001	1.043588	1.183567
heard family planning on television						
No	**Reference**					
Yes	1.070934	0.048509	1.51	0.13	0.979958	1.170357
heard of family planning in newspaper/magazine in the last few months						
No	**Reference**					
Yes	1.176819	0.053926	3.55	<0.001	1.075733	1.287404
wealth index						
Poor	**Reference**					
Middle	1.444749	0.050091	10.61	<0.001	1.349834	1.546338
Rich	1.439205	0.060615	8.64	<0.001	1.325173	1.563049
decision maker for using contraception						
Respondent	**Reference**					
husband/partner	0.511324	0.026122	-13.13	<0.001	0.462606	0.565173
joint decision	1.592231	0.050015	14.81	<0.001	1.49716	1.693339
someone else	0.221549	0.133942	-2.49	0.013	0.067742	0.724568
Other	0.182723	0.054868	-5.66	<0.001	0.101438	0.329147
Frequency of using the internet last month						
not at all	**Reference**					
less than once a week	0.911046	0.149528	-0.57	0.57	0.660442	1.256741
at least once a week	1.01078	0.119192	0.09	0.928	0.8022	1.273593
almost every day	1.205041	0.13462	1.67	0.095	0.968079	1.500006
Number of living children						
0	**Reference**					
1—5	29.94955	30.37143	3.35	0.001	4.103916	218.5657
6+	28.87042	29.27273	3.32	0.001	3.957219	210.628
minutes to the nearest healthcare facility						
0-30	**Reference**					
31-60	0.938581	0.034016	-1.75	0.08	0.874224	1.007676
61+	1.007184	0.041556	0.17	0.862	0.928941	1.092016
_cons	0.007274	0.007384	-4.85	<0.001	0.000995	0.05319

Discussion

Findings show that only 33% used modern contraceptives in rural areas, and more than two-thirds (67%) of rural women did not use modern contraceptive methods in Tanzania. This modern contraceptive use in Tanzania is higher than in many countries, including Ghana (27.8%), Zambia (13.7%) and Ethiopia (18.3%) (Yeboah et al., 2024; Sserwanja et al., 2022; Mulugeta et al., 2023). This is because Tanzania has National policies that support the use of modern contraceptives. These policies include the Five-Year Costed Implementation Plan for Family Planning 2018-2022. The Tanzania Development Vision 2025 outlines the need for quality reproductive health services and a three-quarters reduction in infant and maternal mortality rates from their current levels. The National Five-Year Development Plan 2016/17-2020/21, with family planning as a component of public health interventions, recognises that continued rapid population growth could derail a potential demographic dividend. Despite the existence of these policies, the use of modern contraceptives in rural areas is still low, based on a number of factors explained in this study.

The current study found that women with primary or higher education had higher odds of using modern contraceptives compared to those with no education. These results are consistent with the research conducted by Negash et al. (2022), Adde et al. (2022), and Zeleke & Zemedu (2023), who found that women who had attended primary or secondary level of formal education were more likely to use modern contraceptives. This might be because women with higher levels of education typically have greater access to knowledge regarding reproductive health, including contraceptive use techniques and are more aware of the advantages of the numerous alternatives available.

Similarly, women whose husbands/partners had primary or secondary education had higher odds of using modern contraceptives. These results were also observed in the study conducted by Kawuki et al. (2022), Armah-Ansah et al. (2024), and Tesema et al. (2022). The authors found that in comparison to women whose husbands had no formal education, those whose husbands had finished at least basic school had a greater chance of using modern contraceptives.

According to the study, listening to radio broadcasts about family planning was linked to a greater likelihood of using modern contraceptives. These findings are similar to the study conducted in Sierra Leone and Tanzania, which compared young women who heard family planning messages on the radio to those who did not have 1.26 times greater odds of taking contemporary contraception (Sserwanja et al., 2022; Jato et al.,1999). The reasonable explanation is that many individuals, particularly those living in remote areas with limited access to healthcare institutions, are reached by radio and newspaper broadcasts. There's a higher likelihood of women seeking out contraceptive services if they read or hear about family planning.

Also, it was found that rich or middle-class people are more likely than poor people to use modern contraceptives, suggesting that income had an influencing role. The findings are consistent with research carried out by Budu et al. (2023), Blumenberg et al. (2023), Srivastava et al. (2023), Tampah-Naah et al. (2023), and Adebowale et al. (2014). They found that, when it came to the usage of contemporary contraceptives, the wealthiest women had greater chances than the poorest. This might be the result of wealthy people being able to pay the price of modern contraception. They have easier access to private medical facilities, where access to contraceptive treatments is widely available.

Additionally, the research revealed that women making joint decisions were more likely to use modern contraceptives, while those whose husband/partner or someone else made the decision had lower odds. This result is consistent with research from Adde et al. (2022), Mangimela-Mulundano et al. (2022), and Fantaye and Damtew (2024), who found that modern contraceptives are almost three times more likely to be used by women who made health decisions in collaboration with someone else than by those who made the decision alone. This

may be because women who actively participate in family planning decisions feel powerful and autonomous.

Finally, compared to women without children, those with one to five or six or more children had a greater likelihood of using modern contraception. This finding is consistent with studies conducted by Alo et al., (2020), Ukoji et al., (2022), and Ngome & Odimegwu, (2014). They found that with an increase in births, there was a considerable rise in the probability that women would use contraception of any kind. This might be a result of women's tendency to want to space out or reduce the number of children they have after giving birth.

Conclusion and Policy Implications

This study demonstrates the considerably low prevalence of modern contraceptive use among women of reproductive age in rural areas of Tanzania using national data from the Demographic and Health Survey and Malaria Indicator Survey. The factors associated with modern contraceptive use among women of reproductive age in rural areas of Tanzania included education, listening to radio broadcasts about family planning, income level, joint decisions at households and number of children. This evidence suggests ensuring that contraceptives are readily available in rural health facilities; this can be achieved by improving supply chains and providing mobile clinics to reach remote areas.

Also, there is a need to conduct sensitizations and education programs to change perceptions and misconceptions about contraceptives; this includes capacity building for local health workers to provide accurate information and counselling. Similarly, engaging men in modern contraceptive discussions enables a supportive environment for women using contraceptives. Lastly, policies should prioritize rural areas and integrate modern contraceptive use into broader health and development initiatives. Implementing these interventions can help increase the uptake of modern contraceptives among women in rural areas in Tanzania and elsewhere in developing countries.

References

Abeid, R. A., Sumari, E. I., Qin, C., Lyimo, A. A., & Luttaay, G. A. (2023). Uptake of modern contraceptive methods among women of reproductive age in Chake District-Pemba Tanzania: a descriptive crossectional study. *Contraception and Reproductive Medicine*, *8*(1), 35.

Adde, K. S., Ameyaw, E. K., Mottey, B. E., Akpeke, M., Amoah, R. M., Sulemana, N., & Dickson, K. S. (2022). Health decision-making capacity and modern contraceptive utilization among sexually active women: Evidence from the 2014–2015 Chad Demographic and Health Survey. Contraception and Reproductive Medicine, 7(1), 1-9.

Adebowale, S. A., Adedini, S. A., Ibisomi, L. D., & Palamuleni, M. E. (2014). Differential effect of wealth quintile on modern contraceptive use and fertility: evidence from Malawian women. BMC women's health, 14, 1-13.

Alo, O. D., Daini, B. O., Omisile, O. K., Ubah, E. J., Adelusi, O. E., & Idoko-Asuelimhen, O. (2020). Factors influencing the use of modern contraceptive in Nigeria: a multilevel logistic analysis using linked data from performance monitoring and accountability 2020. BMC Women's Health, 20(1), 1-9.

Armah-Ansah, E. K., Bawa, B., & Igonya, E. K. (2024). Prevalence and factors associated with intention to use contraceptives among women of reproductive age: a multilevel analysis of the 2018 Guinea demographic and health survey. BMC Pregnancy and Childbirth, 24(1), 8.

Beyene, K. M., Bekele, S. A., & Abu, M. K. (2023). Factors affecting utilization of modern contraceptive methods among women of reproductive age in Ethiopia. *Plos one*, *18*(11), e0294444.

Bishop, A. S., Nurius, P. S., Rousson, A. N., Bhattacharya, A., & Baumgarten, E. B. (2025). Social determinants of contraception use among rural adolescents: Implications for addressing disparities. *The Journal of Rural Health*, *41*(1), e12901. https://doi.org/10.1111/jrh.12901

Blumenberg, C., Hellwig, F., Ewerling, F., & Barros, A. J. (2020). Socio-demographic and economic inequalities in modern contraception in 11 low-and middle-income countries: an analysis of the PMA2020 surveys. Reproductive health, 17(1), 1-13.

Boah, M., Adokiya, M. N., & Hyzam, D. (2023). Prevalence and factors associated with the utilization of modern contraceptive methods among married women of childbearing age in Yemen: a secondary analysis of national survey data. *BMJ open*, *13*(6), e071936.

Budu, E., Dadzie, L. K., Salihu, T., Ahinkorah, B. O., Ameyaw, E. K., Aboagye, R. G., ... & Yaya, S. (2023). Socioeconomic inequalities in modern contraceptive use among women in Benin: a decomposition analysis. BMC women's health, 23(1), 444.

Budu, E., Okyere, J., Osei, M. D., Seidu, A. A., & Ahinkorah, B. O. (2023). Determinants of contraceptive continuation among women in sub-Saharan Africa. *BMC Women's Health*, *23*(1), 447.

Fantaye, F. T., & Damtew, S. A. (2024). Women decision making on use of modern family planning methods and associated factors, evidence from PMA Ethiopia. Plos one, 19(2), e0298516.

Hailegebreal, S., Dileba Kale, T., Gilano, G., Haile, Y., & Endale Simegn, A. (2023). Modern contraceptive use and associated factors among reproductive-age women in Ethiopia: multilevel analysis evidence from 2019 Ethiopia mini demographic and health survey. *The Journal of Maternal-Fetal & Neonatal Medicine*, *36*(2), 2234067.

Jato, M. N., Simbakalia, C., Tarasevich, J. M., Awasum, D. N., Kihinga, C. N., & Ngirwamungu, E. (1999). The impact of multimedia family planning promotion on the contraceptive behavior of women in Tanzania. International Family Planning Perspectives, 60-67.

Kawuki, J., Gatasi, G., Sserwanja, Q., Mukunya, D., & Musaba, M. W. (2022). Utilisation of modern contraceptives by sexually active adolescent girls in Rwanda: a nationwide cross-sectional study. BMC Women's Health, 22(1), 1-10.

Mangimela-Mulundano, A., Black, K. I., & Cheney, K. (2022). A cross-sectional study of women's autonomy and modern contraception use in Zambia. BMC Women's Health, 22(1), 550.

Mulugeta, S. S., Muluneh, M. W., Belay, A. T., Yalew, M. M., & Agegn, S. B. (2023). Reason and associated factors for nonuse of contraceptives among Ethiopian rural married women: a multilevel mixed effect analysis. *SAGE Open Nursing*, *9*, 23779608221150599.

Negash, W. D., Eshetu, H. B., & Asmamaw, D. B. (2022). Predictors of modern contraceptive use among reproductive age women in high fertility countries in sub-Saharan Africa: evidence from demographic and health surveys. BMC Women's Health, 22(1), 1-10.

Ngome, E., & Odimegwu, C. (2014). The social context of adolescent women's use of modern contraceptives in Zimbabwe: a multilevel analysis. Reproductive health, 11(1), 1-14.

Srivastava, S., Mohanty, P., Muhammad, T., & Kumar, M. (2023). Socio-economic inequalities in non-use of modern contraceptives among young and non-young married women in India. *BMC Public Health*, *23*(1), 797.

Sserwanja, Q., Musaba, M. W., Mutisya, L. M., & Mukunya, D. (2022). Rural-urban correlates of modern contraceptives utilization among adolescents in Zambia: a national cross-sectional survey. *BMC Women's Health*, *22*(1), 324.

Sserwanja, Q., Turimumahoro, P., Nuwabaine, L., Kamara, K., & Musaba, M. W. (2022). Association between exposure to family planning messages on different mass media channels and the utilization of modern contraceptives among young women in Sierra Leone:

insights from the 2019 Sierra Leone Demographic Health Survey. BMC Women's Health, 22(1), 376.

Tampah-Naah, A. M., Yendaw, E., & Sumankuuro, J. (2023). Residential status and household wealth disparities in modern contraceptives use among women in Ghana: a cross-sectional analysis. *BMC Women's Health*, *23*(1), 550.

Tesema, Z. T., Tesema, G. A., Boke, M. M., & Akalu, T. Y. (2022). Determinants of modern contraceptive utilization among married women in sub-Saharan Africa: multilevel analysis using recent demographic and health survey. BMC Women's Health, 22(1), 181.

Tessema, Z. T., Teshale, A. B., Tesema, G. A., Yeshaw, Y., & Worku, M. G. (2021). Pooled prevalence and determinants of modern contraceptive utilization in East Africa: A Multi-country Analysis of recent Demographic and Health Surveys. *PloS one*, *16*(3), e0247992.

Ukoji, V. U., Anele, P. O., & Imo, C. K. (2022). Assessing the relationship between knowledge and the actual use of contraceptives among childbearing women in South-South Nigeria: evidence from the 2018 Nigeria demographic and health survey. BMC Public Health, 22(1), 2225.

URT, (2022). Demographic and Health Survey and Malaria Indicator Survey. Key Indicators

Yeboah, I., Agyekum, M. W., Okyere, J., Mensah, R. O., Essiaw, M. N., Appiah, H., ... & Christian, A. K. (2023). Use of any contraceptive method among women in rural communities in the eastern region of Ghana: a cross-sectional study. *BMC Public Health*, *23*(1), 1925.

Zeleke, G. T., & Zemedu, T. G. (2023). Modern contraception utilization and associated factors among all women aged 15–49 in Ethiopia: evidence from the 2019 Ethiopian Mini Demographic and Health Survey. *BMC Women's Health*, *23*(1), 51.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.8

Comparative study on genital yeasts diversity isolated from rural and urban women with vaginitis attending antenatal and gynecology clinics in Southern Highland regions of Tanzania

Lucy A. Namkinga[1,2,3], Joseph D. Swilla[1], Clement N. Mweya[1], Rebecca Mokeha[2], Delfina D Mkenda[2] and Omary Salehe[3]*

[1]Mbeya College of Health and Allied Sciences, University of Dar es Salaam, P. O. Box 608, Mbeya, Tanzania, [2]Department of Obstetrics and Gynecology, Mbeya Zonal Referral Hospital, P.O. Box 419, Mbeya, Tanzania, [3] Department of Internal Medicine, Mbeya Zonal Referral Hospital, P.O. Box 419, Mbeya, Tanzania

Abstract

Background: Vaginal yeast infections are a common health concern for women worldwide. While *Candida albicans* remains the primary causative agent, the prevalence of non-albicans *Candida* species and other yeasts is increasing. This study aimed to compare the diversity of genital yeasts isolated from rural and urban women with vaginitis in the Southern Highlands regions of Tanzania and evaluate the impact of socio-economic and environmental factors on yeast diversity.

Methods: A cross-sectional study was conducted involving 800 women (400 urban, 400 rural) attending antenatal and gynecology clinics. Vaginal swabs were collected and analyzed using standard mycological techniques. Socio-demographic data and information on hygiene practices were collected through structured questionnaires. Chi-square tests and logistic regression were used for statistical analysis.

Results: Non-*albicans Candida* species were more prevalent in rural women (57%) compared to urban women (32%). *Candida albicans* was the predominant species in both urban (68%) and rural (40%) populations. Non-*Candida* yeasts, including *Rhodotorula mucilaginosa* (2%) and *Pichia kudriavzevii* (1%), were isolated only from rural women. The use of untreated water (OR: 2.3, 95% CI: 1.7-3.1, p<0.001) and drying clothes in bushes (OR: 3.1, 95% CI: 2.2-4.4, p<0.001) were significantly associated with the presence of non-*albicans* species.

Conclusion: This study revealed significant differences in genital yeast diversity between rural and urban women, likely influenced by environmental and socio-economic factors. These findings highlight the need for targeted interventions and further research to address the specific needs of different populations in managing vaginitis.

Keywords: *Candida* vaginitis, non-albicans *Candida*, rural-urban differences, hygiene practices, yeast diversity

* **Corresponding author:** Email odulajalucy@yahoo.com. Contact +255718687073

https://dx.doi.org/10.4314/thrb.v26i3.8

Introduction

Vaginal yeast infections are widespread, impacting millions of women globally, and are predominantly caused by *Candida* species. While *Candida albicans* remains the most common agent, other non-*albicans Candida* species are emerging, presenting new challenges in clinical treatment. Women with compromised immune systems, such as those who are pregnant, undergoing hormonal therapy, or using broad-spectrum antibiotics, are particularly vulnerable to yeast infections (Sobel, 2007; Sopian et al., 2016). These infections not only cause physical discomfort but can also impact reproductive health, especially if left untreated. Research shows a shifting pattern in yeast infections, with an increasing incidence of non-albicans *Candida* species, particularly in developing regions. This shift may be attributed to environmental and socio-economic factors, which vary significantly across rural and urban populations. The impact of these factors on yeast diversity and infection rates warrants further investigation, especially in resource-limited settings where access to healthcare is restricted (Moreira *et al*., 2021).

Candida species display a range of biological characteristics that contribute to their pathogenic potential, including biofilm formation and resistance to antifungal medications. Biofilm-forming species such as *Candida glabrata* and *Candida tropicalis* are particularly resistant to treatment, making infections more persistent and challenging to manage clinically (Gow et al., 2011; Hassan et al., 2021; Silva et al., 2017). The ability of *Candida* species to adapt to various environments within the human body allows them to establish infections with ease, especially in individuals with recurrent or chronic cases. In addition to *Candida albicans*, non-*albicans* species like *Candida krusei* and *Candida parapsilosis* are increasingly identified as pathogens in cases of vaginitis. These species often require alternative treatment strategies, underscoring the need for precise diagnosis. Understanding these species' unique characteristics is essential for effective clinical management, especially in rural areas where advanced diagnostic methods may be unavailable (Seneviratne *et al.*, 2008).

The prevalence and diversity of genital yeasts are influenced by socio-economic and environmental factors, which differ significantly between rural and urban settings. Women in rural areas often face limited access to healthcare, clean water, and sanitation facilities, all of which contribute to increased susceptibility to infections (Felix et al., 2017; Jenks et al., 2023; Muvunyi et al., 2024). In regions where untreated water is used for personal hygiene, there is a higher likelihood of encountering non-*albicans* species, which thrive in such environments. Furthermore, cultural practices, like drying clothes outdoors on bushes, may expose women to environmental pathogens. These conditions foster a diverse range of microbial exposures, potentially impacting the vaginal microbiota. In contrast, urban populations typically have better access to clean water and hygiene resources, which may account for the lower incidence of certain yeast species. This study investigates these differences in the Tanzanian context to provide insights into how environmental and socio-economic factors influence yeast diversity.

While yeast infections are a global health issue, there is a gap in understanding how rural versus urban conditions affect yeast diversity in specific regions, like the Southern Highlands of Tanzania. Limited local research has explored how socio-economic and environmental disparities impact the vaginal microbiota of women in this area, making this

study especially relevant. By comparing rural and urban populations, this research aims to elucidate the factors driving yeast diversity and prevalence, which can inform targeted health interventions. This study not only addresses the specific challenges faced by Tanzanian women but also contributes to the broader field of infectious disease epidemiology by highlighting the role of social determinants in shaping infection patterns. By focusing on a population that may be underserved in terms of healthcare access, this study underscores the need for policies and programs that address local risk factors for vaginal infections.

Materials and methods

Study Design and Setting

A cross-sectional study was conducted at antenatal and gynecology clinics in rural and urban areas of the Southern Highland regions of Tanzania. The study period spanned from January 2023 to December 2023.

Study Population

A total of 800 women diagnosed with vaginitis were enrolled in the study, with an equal distribution between rural (n=400) and urban (n=400) areas. The inclusion criteria were: Women aged 15-45 years, residents of the Southern Highland regions of Tanzania, presenting with symptoms of vaginal discharge and/or pruritis vulvae and willing to participate in the study. Women who had used antifungal medication within the past week were excluded from the study.

Sample Collection and Processing

High vaginal swabs were collected from all participants using sterile techniques. Samples were immediately placed in transport media and processed within 4 hours at the UDSM-Mbeya College of Health and Allied Sciences (UDSM-MCHAS), Department of Microbiology and Immunology.

Laboratory Analysis

Samples were processed using the following methods: Wet mount microscopy for the presence of yeast cells and Trichomonas vaginalis. Gram staining for preliminary identification. The culture on Sabouraud's dextrose agar (SDA) contained 0.005% chloramphenicol and 0.05% cycloheximide. Germ tube test for presumptive identification of *Candida albicans* CHROMagar Candida for species differentiation. Additional biochemical tests for definitive species identification

Data Collection

Participants were interviewed using a structured questionnaire to collect data on socio-demographic characteristics, hygiene practices, and medical history. Follow-up visits were conducted after two weeks for result communication and after seven days of treatment for symptomatic cases.

https://dx.doi.org/10.4314/thrb.v26i3.8

Data Analysis

Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the distribution of yeast species and socio-demographic characteristics. Chi-square tests were used to compare the prevalence of different yeast species between rural and urban populations. Logistic regression analysis was performed to evaluate the association between socio-economic and environmental factors and the presence of non-albicans *Candida* species. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the National Institute for Medical Research's Medical Research and Mbeya Zonal Referral Hospital with approval number SZEC-2439/RA/V-1/26. For participants under 18 years of age, assent was obtained along with parental/guardian consent.

Results

Yeast Species Distribution

The distribution of *Candida* and non-*Candida* yeast species revealed notable differences between urban and rural women. As shown in Table 1, *Candida albicans* was the most prevalent species in both urban (68%) and rural (40%) populations. However, rural women exhibited a significantly higher prevalence of non-*albicans* species (57%) compared to urban women (32%). Specific non-albicans species, such as *Candida tropicalis*, *Candida glabrata*, and *Candida parapsilosis*, were more commonly isolated in rural areas. Additionally, non-*Candida* yeasts like *Rhodotorula mucilaginosa* (2%) and *Pichia kudriavzevii* (1%) were exclusively identified in rural women, possibly linked to distinct environmental exposures. Chi-square tests confirmed that these differences were statistically significant ($p < 0.05$).

Table 1: Distribution of Fungal species between Urban and Rural women attending antenatal Clinics Southern Highlands Regions' Hospitals.

S/N	Fungal Isolate	**Urban Samples, n=400**		**Rural Samples, n=400**	
		Samples	%	Samples	%
1	*C. albicans*	272	68	160	40
2	*C. tropicalis*	40	10	52	13
3	*C. parapsilosis*	16	4	36	9
4	*C. glabrata*	32	8	44	11
5	*C. krusei*	8	2	24	6
6	*C. guilliermondii*	12	3	16	4
7	*C. kefyr*	4	1	12	3
8	*Rhodotorula mucilaginosa*	0	0	8	2
9	*Pichia kudriavzevii*	0	0	4	1
10	*C. famata*	8	2	12	3
11	*C. norvegensis*	4	1	16	4

https://dx.doi.org/10.4314/thrb.v26i3.8

12	*C. lusitaniae*	4	1	8	2
13	*C. incospicua*	0	0	4	1
14	*C. colliculosa*	0	0	4	1

Socio-demographic Characteristics

Table 2 summarizes the socio-demographic indicators associated with *Candida* vaginitis among participants, showing distinct disparities across groups. A higher proportion of rural women had lower educational levels (62.8% had no formal education or only primary education) and lower monthly income (80.4% earned ≤ 150,000 Tshs), compared to their urban counterparts. Logistic regression analysis demonstrated that lower education levels (OR: 1.8, 95% CI: 1.3-2.5, p=0.001) and lower income (OR: 1.6, 95% CI: 1.2-2.2, p=0.002) were associated with an increased prevalence of non-albicans species, underscoring the impact of socio-economic disparities on infection risks.

Table 2: Social-demographic indicators for women with *Candida* vaginitis which contribute to a *Candida* species diversity in Southern Highland Regions of Tanzania. (N=800)

S/N	Variable	N		%	
		Urban	Rural	Urban	Rural
1	Educational level: 1. No formal education	90	150	19.7	43.7
	2. Primary	287	165	62.8	48.1
	3. Secondary +	80	28	17.5	8.2
2	Age group: 1. 15-20	85	220	22.9	51.3
	2. 21-30	148	140	39.9	32.6
	3. 31-40	118	57	31.8	13.3
	4. ≥45	20	12	5.4	2.8
3	Marital status: 1. Single	228	214	61.6	49.8
	2. Married/ Cohabiting	66	144	17.8	33.5
	3. Divorced/ Widow	76	72	20.5	16.7
4	Occupation: 1. Not employed	80	270	22.5	60.7
	2. Entrepreneur	180	150	50.7	33.7
	3. Employed	95	25	26.8	5.6
5	Income (Tshs. per month): 1. ≤ 150,000	110	450	19.6	80.4
	2. ≥ 150,000	160	80	66.7	33.3
6	Age at first sex (yrs): 1. ≤20	225	380	37.2	62.8
	2. 21-24	95	60	61.3	38.7
	3. ≥25	25	15	62.5	37.5
7	Pregnancy status: 1. Not pregnant	40	16	71.4	28.6
	2. Pregnant	518	226	69.6	30.4
8	Prior antibiotic use within 7 days:1. Not used	104	402	20.6	79.4
	2. Used	196	98	66.7	33.3
9	Water used to bath:1. Treated (tap water)	307	105	74.5	25.5
	2. Untreated (river, lake, well, pond) water	93	295	24	76.0
10	Drying of clothes and underwear				
	1. On ropes	310	100	77.5	25
	2. On grass or tree shrubs	90	300	22.5	75

Environmental and Hygiene Factors

https://dx.doi.org/10.4314/thrb.v26i3.8

Environmental and hygiene practices varied markedly between rural and urban women. Notably, 76% of rural women used untreated water sources (such as rivers, lakes, and wells) for bathing or washing, compared to 25.5% of urban women ($p < 0.001$). Similarly, 75% of rural women dried their clothes on bushes or grass, while only 22.5% of urban women engaged in this practice ($p < 0.001$). Logistic regression analysis further confirmed that untreated water use was associated with a higher likelihood of non-albicans species (OR: 2.3, 95% CI: 1.7-3.1, $p < 0.001$), while outdoor drying of clothes correlated with the presence of non-*Candida* yeasts (OR: 3.1, 95% CI: 2.2-4.4, $p < 0.001$). These practices may contribute to the increased prevalence of diverse yeast species observed among rural women.

Association Between Factors and Yeast Diversity

Logistic regression analysis revealed that the use of untreated water was significantly associated with the presence of non-albicans *Candida* species (OR: 2.3, 95% CI: 1.7-3.1, $p<0.001$). Drying clothes in bushes was associated with increased odds of carrying non-*Candida* yeasts (OR: 3.1, 95% CI: 2.2-4.4, $p<0.001$). Lower education level (OR: 1.8, 95% CI: 1.3-2.5, $p=0.001$) and lower income (OR: 1.6, 95% CI: 1.2-2.2, $p=0.002$) were also associated with a higher prevalence of non-*albicans* species.

Discussion

The findings of this study provide valuable insights into the diversity of vaginal yeasts among rural and urban women in the Southern Highlands of Tanzania, adding to the growing literature on vaginal microbiota and infection risks. The study confirmed that *Candida* albicans remains the predominant species across both groups, aligning with global trends (Baud et al., 2023; Bayigga et al., 2018; Corsello et al., 2003). However, the higher prevalence of non-albicans species in rural populations highlights how environmental factors may shape microbiota composition. These results echo findings from studies in other low-resource settings, where non-*albicans Candida* species have been observed at elevated levels, reinforcing the importance of understanding local epidemiological patterns.

Socioeconomic and environmental factors emerged as significant influences on yeast diversity, with rural women facing greater exposure to potential risk factors. This aligns with other studies showing that low socioeconomic status, limited health infrastructure, and traditional hygiene practices can increase infection risks (Felix et al., 2017; Jenks et al., 2023; Muvunyi et al., 2024). Access to clean water, sanitation, and educational resources are key determinants of infection rates, suggesting that addressing these social determinants could help reduce infection prevalence. These findings underscore the need for public health interventions tailored to the specific challenges of rural communities.

The presence of non-*albicans* and non-*Candida* yeasts in rural women carries important clinical implications. Non-*albicans* species often require alternative treatment strategies due to higher antifungal resistance rates, posing challenges for healthcare providers, especially in low-resource settings (Deorukhkar et al., 2014; Seneviratne et al., 2008). As diagnostic resources may be limited in rural areas, there is a heightened need for point-of-care diagnostic tools that can aid in species-specific treatment decisions. This finding emphasizes the need for policy changes that increase healthcare access in rural regions to improve treatment efficacy and reduce recurrence rates.

These findings highlight the importance of addressing basic public health needs to reduce the burden of yeast infections. Infrastructure improvements, such as clean water access and proper sanitation facilities, would directly benefit rural communities by reducing exposure to infection-causing agents. Public health campaigns to promote hygiene awareness, especially around safe water use and proper drying of clothes, could help curb infection rates. This aligns with recommendations from other studies, suggesting that community-level interventions can effectively reduce infectious disease prevalence (Moreira *et al*., 2021).

This study has several limitations, including its cross-sectional design, which limits the ability to draw causal conclusions about the associations observed. Additionally, the reliance on self-reported hygiene practices introduces the possibility of recall bias. Another limitation is the study's geographical focus, as findings may not be generalizable to other regions with different environmental and socio-economic conditions. Future research could benefit from longitudinal studies to capture the dynamics of yeast colonization and infection over time. Expanding to other regions would provide a broader understanding of how regional factors influence yeast diversity and infection patterns, helping to inform national health policies and intervention programs..

Conclusion

This study provides valuable insights into the diversity of genital yeasts in different settings and highlights the importance of considering hygienic practices and socio-economic and environmental factors in managing vaginitis. The findings underscore the need for targeted interventions and further research to address the specific needs of different populations.

Based on these results, we recommend strengthening educational programs on hygiene practices in rural areas, with a focus on water treatment and proper drying of clothes; increasing access to healthcare and diagnostic services for early detection and management of vaginitis, particularly in rural areas; conducting further research to explore the impact of socio-economic factors on yeast infections and to investigate the pathogenic potential of non-*Candida* yeasts in vaginal infections; and developing and implementing guidelines for species-specific treatment of vaginal yeast infections, taking into account the local epidemiology. These measures could significantly improve the management of vaginitis and reduce the burden of yeast infections in both rural and urban populations..

Acknowledgments

The authors would like to thank the staff at the participating clinics for their assistance in patient recruitment and sample collection. We also acknowledge the support of the laboratory staff at UDSM-Mbeya College of Health and Allied Sciences for their technical assistance.

Author contributions

LAN, JDS, RM, and DM designed the study. LAN, RM, and DM conducted and contributed to data analysis. LAN, CNM and SO interpreted the data. LAN, JDS and CNM prepared the original manuscript. All co-authors contributed to subsequent revisions. All authors read and approved the final manuscript.

Funding
None

Conflict of interest
The authors declare that they have no financial and non-financial competing interests.

Availability of data and material
All data generated or analyzed during this study is included in this published article.

References

Baud, A., Hillion, K.-H., Plainvert, C., Tessier, V., Tazi, A., Mandelbrot, L., Poyart, C., & Kennedy, S. P. (2023). Microbial diversity in the vaginal microbiota and its link to pregnancy outcomes. *Scientific Reports*, *13*, 9061. https://doi.org/10.1038/s41598-023-36126-z

Bayigga, L., Kateete, D. P., Anderson, D. J., Sekikubo, M., & Nakanjako, D. (2018). Diversity of vaginal microbiota in sub-Saharan Africa and its effects on HIV transmission and prevention. *American Journal of Obstetrics and Gynecology*, *220*(2), 155. https://doi.org/10.1016/j.ajog.2018.10.014

Corsello, S., Spinillo, A., Osnengo, G., Penna, C., Guaschino, S., Beltrame, A., Blasi, N., & Festa, A. (2003). An epidemiological survey of vulvovaginal candidiasis in Italy. *European Journal of Obstetrics, Gynecology, and Reproductive Biology*, *110*(1), 66–72. https://doi.org/10.1016/s0301-2115(03)00096-4

Deorukhkar, S. C., Saini, S., & Mathew, S. (2014). Non-albicans Candida Infection: An Emerging Threat. *Interdisciplinary Perspectives on Infectious Diseases*, *2014*, 615958. https://doi.org/10.1155/2014/615958

Felix, T. C., Menezes, R. de P., Berardi, M. C., Röder, D. V. D. de B., & Pedroso, R. dos S. (2017). CANDIDA SPECIES IN THE GENITAL TRACT OF WOMEN ATTENDING A UNIVERSITY HOSPITAL FOR GYNECOLOGICAL INTERVENTIONS. *Brazilian Journal of Medicine and Human Health (Inactive / Archive Only)*, *5*(1), Article 1. https://doi.org/10.17267/2317-3386bjmhh.v5i1.1254

Gow, N. A., Veerdonk, F. L. van de, Brown, A. J., & Netea, M. G. (2011). Candida albicans morphogenesis and host defence: Discriminating invasion from colonization. *Nature Reviews. Microbiology*, *10*(2), 112. https://doi.org/10.1038/nrmicro2711

Hassan, Y., Chew, S. Y., & Than, L. T. L. (2021). Candida glabrata: Pathogenicity and Resistance Mechanisms for Adaptation and Survival. *Journal of Fungi*, *7*(8), 667. https://doi.org/10.3390/jof7080667

Jenks, J. D., Prattes, J., Wurster, S., Sprute, R., Seidel, D., Oliverio, M., Egger, M., Rio, C. D., Sati, H., Cornely, O. A., George R Thompson, 3rd, Kontoyiannis, D. P., & Hoenigl, M. (2023). Social determinants of health as drivers of fungal disease. *eClinicalMedicine*, *66*, 102325. https://doi.org/10.1016/j.eclinm.2023.102325

Moreira, D., Ruiz, L. S., Leite-Jr, D. P., Auler, M. E., Ramos, R. T. B., Costa, V. T., Lara, B. R., Gasparetto, A., Gandra, R. F., Melhem, M. S. C., & Paula, C. R. (2021). Difference Between the Profiles Presented by Yeasts that Colonize the Vaginal Mucosa or Cause Primary or Recurrent Candidiasis. *Mycopathologia*, *186*(3), 411–421. https://doi.org/10.1007/s11046-021-00556-y

Muvunyi, C. M., Ngabonziza, J. C. S., Florence, M., Mukagatare, I., Twagirumukiza, M., Ahmed, A., & Siddig, E. E. (2024). Diversity and Distribution of Fungal Infections in Rwanda: High Risk and Gaps in Knowledge, Policy, and Interventions. *Journal of Fungi*, *10*(9), Article 9. https://doi.org/10.3390/jof10090658

Seneviratne, C. J., Jin, L., & Samaranayake, L. P. (2008). Biofilm lifestyle of Candida: A mini review. *Oral Diseases*, *14*(7), 582–590. https://doi.org/10.1111/j.1601-0825.2007.01424.x

Silva, S., Rodrigues, C. F., Araújo, D., Rodrigues, M. E., & Henriques, M. (2017). Candida Species Biofilms' Antifungal Resistance. *Journal of Fungi*, *3*(1), 8. https://doi.org/10.3390/jof3010008

Sobel, J. D. (2007). Vulvovaginal candidosis. *Lancet (London, England)*, *369*(9577), 1961–1971. https://doi.org/10.1016/S0140-6736(07)60917-9

Sopian, I. L., Shahabudin, S., Ahmed, M. A., Lung, L. T. T., & Sandai, D. (2016). Yeast Infection and Diabetes Mellitus among Pregnant Mother in Malaysia. *The Malaysian Journal of Medical Sciences : MJMS*, *23*(1), 27.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

Ethnobotany and Antimicrobial Activity of the Selected Medicinal Plants Used for the Management of Microbial Infections in Pemba Island, Tanzania

Hassan Mohamed Faqih[1], Ramadhani S.O. Nondo[1], Joseph N. Otieno[1], Michael Qwarse[1], Samson Hilonga[1], Khamis Rashid Kheir[2], Mayassa Salum Ally[2], Boniphace Charles Mwita[1], Francis Machumi[1], Mariana John Shayo[1].*

[1]The Institute of Traditional Medicine, Muhimbili University of Health and Allied Sciences, P.O.BOX 65001 Dar es Salaam, Tanzania.[2]Zanzibar Health Research Institute, P.O.BOX 2636 Binguni-Zanzibar.

Abstract:
Introduction: Microbial infections are among the leading causes of mortality worldwide, claiming millions of lives each year. A significant portion of these deaths is attributed to the resistance of certain microbes to the existing antimicrobial agents. In contrast, local communities have long utilized medicinal plants to manage infections caused by microbes. However, many of these plants remain underexplored, with limited documentation and evaluation of their biological activities. This study aims to contribute to documenting and assessing the antimicrobial properties of medicinal plants traditionally used to treat microbial infections. The findings may serve as a foundation for further research to discover novel antimicrobial agents to combat bacterial and fungal infections.
Methodology: An ethnobotanical survey was conducted in Pemba Island, collecting data from 42 local informants through semi-structured interviews. Plant species with the highest fidelity levels were selected for the evaluation of antibacterial and antifungal activities using the disc diffusion and microdilution methods.
Results: A total of 117 plant species belonging to 48 families were reported for managing microbial-related conditions. Fever exhibited the highest informant consensus factor (ICF) of 0.76, indicating strong agreement on the plant species used for treating this condition. *Azadirachta indica* achieved the highest fidelity level (FL) of 100% for fever, highlighting the significant potential of this plant. Antimicrobial testing revealed activity against various bacteria, with inhibition zones ranging from 9.5 mm to 18 mm and minimum inhibitory concentrations (MICs) ranging from 0.625 mg/mL to 2.5 mg/mL for the selected active plant species.
Conclusion: The medicinal plants used by the Pemba community demonstrate considerable antimicrobial activity against human pathogens, including *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae*.
Keywords: Ethnobotany, Medicinal plants, Microbial infections, Antimicrobial, Pemba Island

Introduction

Diseases caused by microbes represent a severe public health problem globally, leading to a high loss of people's lives, mostly the poor (Ngezahayo *et al*., 2015). According to the World Health Organization (WHO), infectious diseases are the cause of about 5 million deaths annually and are among the top 10 diseases that kill most people in the world (WHO, 2020). The discovery of antimicrobial agents capable of slowing multiplication or killing microbes has saved the lives of many people affected by pathogenic microbes (Benitez *et al*., 2019; Chang *et al*., 2007; Ventola, 2015). However, this progress is negatively affected by the microbes' resistance to commercially available antimicrobial agents. (Horváth *et al*., 2016). Therefore, more research is needed to develop new active molecules against resistant pathogenic microbes. Medicinal plants act as natural sources of new compounds with curative value

*Corresponding author: *E-mail address*: hassan.faqih@yahoo.com

https://dx.doi.org/10.4314/thrb.v26i3.9

and can also be used in modern drug development (Mujeeb et al., 2014). This is supported by the fact that more than 60% of all modern drugs have their origins in natural sources, with plants being the most dominant source (Mathur & Hoskins, 2017).

The ethnobotanical information on the uses of medicinal plants in specific communities has been one of the means of identifying plants with potential therapeutic effects against human diseases. Literature reveals that the Unguja and Pemba Islands in Tanzania have about 800 traditional health practitioners (Solera-Deuchar et al., 2020) and the majority of them use medicinal plants in their practices (Revolutionary Government of Zanzibar, 2008; Biesen *et al.,* 2012).

Furthermore, local communities in Pemba Island traditionally use medicinal plants to manage microbial infections, but few ethnobotanical studies have been conducted to document this information. Previous studies show that only one ethnobotanical study was conducted in a small area around Ngezi Forest Reserve in Pemba Island, which reported ethnobotanical information on plants used to manage various diseases (Tsang, 2017). Ever since, no ethnobotanical study has been conducted to document more medicinal plants traditionally used to manage microbial infections in Pemba.

Therefore, this study aimed to document medicinal plant species used to manage conditions related to microbial infection in Pemba and evaluate the antibacterial and antifungal activity of extracts of selected plants against laboratory strains and clinical isolates of bacteria and fungi as a means of validating ethnobotanical information provided by traditional health practitioners in the communities.

Materials and Methods

Ethnobotanical survey

A survey was conducted over one month, from mid-April to mid-May 2021, in the Chake Chake, Micheweni, Wete, and Mkoani districts of Pemba Island, Tanzania (**Figure 1**). A total of forty-two (42) informants were recruited using a combination of purposive and snowball sampling techniques, as described by Bryman (2012). Purposive sampling was initially used to identify and select key informants who were either traditional health practitioners (THPs) or community leaders based on their expertise and experience in the use of medicinal plants. This approach ensured that the participants had relevant knowledge and experience on medicinal plants used for managing conditions related to microbial infections. Snowball sampling was then employed to expand the pool of informants by asking the initial participants to recommend other knowledgeable individuals within the community. This method was particularly useful in identifying additional traditional health practitioners and community leaders who participated in this study.

Thirty-six (36) out of 42 total informants were THPs, and six informants were community leaders, including local government leaders, religious leaders, and respected elders in the community. Eligibility criteria in this study were a THP or community leader residing in Pemba with experience in medicinal plants. The survey focused on medicinal plants used by the community to manage conditions related to microbial infections. In-depth interviews were conducted using guiding questionnaires to identify the plants used by these informants to manage microbial infections.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

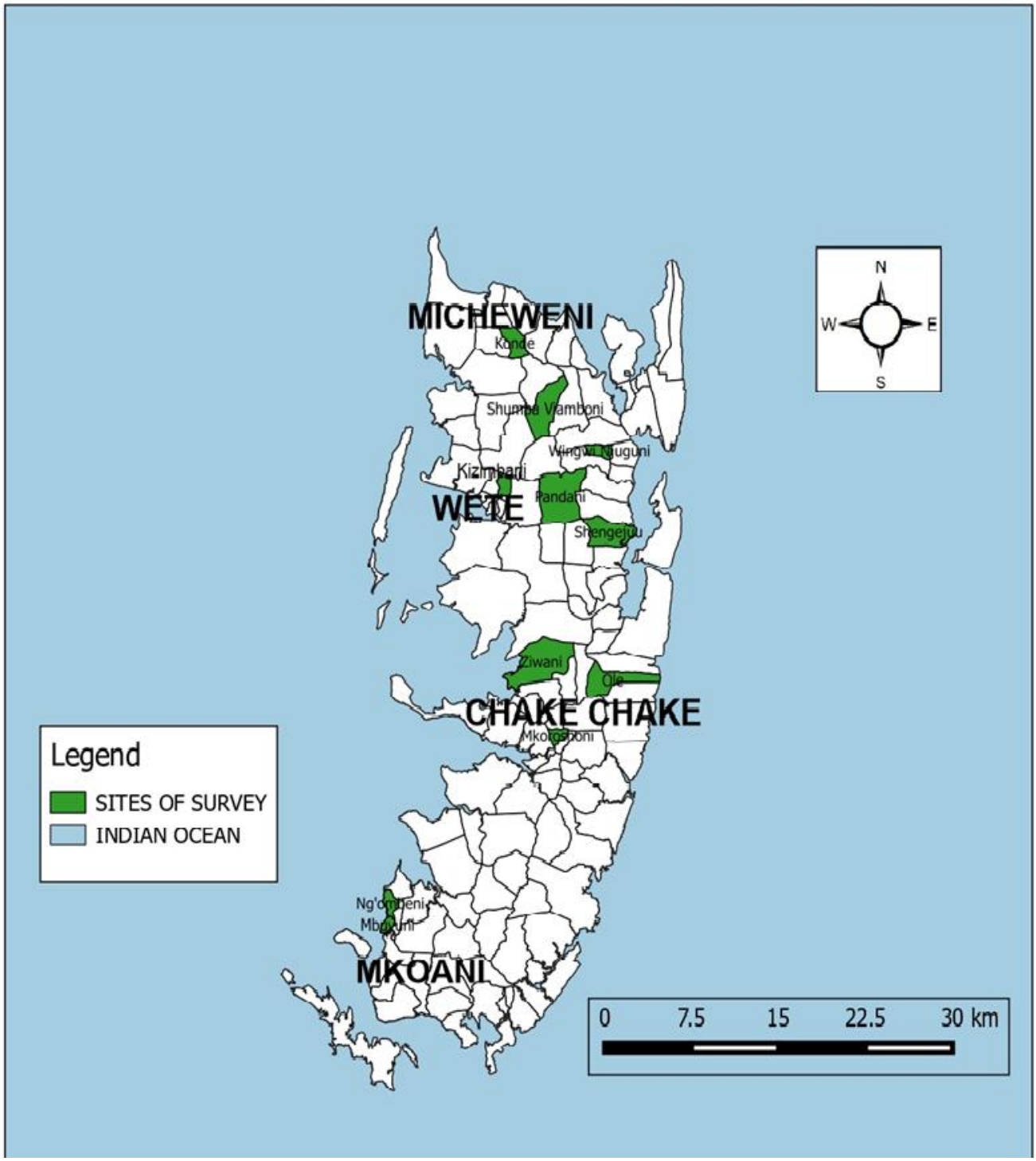


Figure 1: Map of Pemba Island, showing surveyed wards (shehia) in all Pemba districts

Recording and identification of medicinal plants

The medicinal plants mentioned by the informants were recorded using local and Swahili names. Preliminary identification of the botanical names was done in the field and later determined in the herbarium by a Botanist, Mr. Samson Hilonga from the Institute of Traditional Medicine (ITM) of the

https://dx.doi.org/10.4314/thrb.v26i3.9

Muhimbili University of Health and Allied Sciences (MUHAS). Voucher specimens were collected, assigned accession numbers, and deposited in the herbarium of the Institute of Traditional Medicine, MUHAS.

Selection and collection of plant materials

The selection of medicinal plant species for evaluation of antibacterial and antifungal activities was based on the fidelity level and a literature review (Gebreyes & Malesse, 2016). The already-known information for plants with high fidelity levels was searched from popular online databases, including NAPRALERT, Google Scholar, and PubMed. The plants with little or missing information on antimicrobial activity from the online search were considered for antimicrobial bioassay.

Preparation of plant materials and extraction

Dried powdered plant materials (150 g) were macerated in 1.0 L of 80% ethanol (20%/80% V/V water-ethanol) at room temperature for 48 hours. The extracts were then filtered by passing them through cotton wool, and the filtrates evaporated until the dry weight of each extract was obtained using the rotary evaporator (Büchi Labortechnik AG, CH-9230 Flawil, Switzerland) set at 40–50°C to optimize the extraction efficiency and ensure complete removal of the solvent within a reasonable timeframe. Further drying of the extracts was achieved by using a freeze-drying machine (GENEVAC LTD, Ipswich, England) and kept in a freezer at –20°C for antimicrobial bioassay.

Antimicrobial Bioassay

Microorganisms

Bacteria and fungi used in this study were obtained from the Department of Pharmaceutical Microbiology, School of Pharmacy, Muhimbili University of Health and Allied Science. The bacteria include *Staphylococcus aureus* (ATCC 25923), *Escherichia coli* (clinical isolates), *Klebsiella pneumonia* (ATCC 708903), *Salmonella typhi* (ATCC 8385), and *Pseudomonas aeruginosa* (ATCC 27853), and the fungi include *Candida albicans* (ATCC 90028) and unidentified dermatophytes (clinical isolates).

Determination of antimicrobial activity by the disc diffusion method

The qualitative assessment of antimicrobial activity was done by the disc diffusion method, as described by Dasgupta *et al*., 2012, with minor modifications. Dry extracts were dissolved in dimethyl sulfoxide (DMSO) to make a 500 mg/mL stock solution. The discs (Whatman No. 1, 6 mm size) were loaded with 10 µL of the stock solution to get 5 mg/disc, followed by air drying to remove the solvent. Tryptic Soy Agar (TSA) and Sabouraud Dextrose Agar (SDA) media were used to grow bacteria and fungi, respectively. The media were prepared according to the manufacturer's instructions. Using a sterile wire loop, a few colonies of bacteria and fungi from a sub-cultured plate were transferred into a vial containing sterile distilled water. The colonies were emulsified on the sides of the vial to make a suspension equivalent to McFarland 0.5 turbidity.

A pre-sterilized cotton swab was dipped into a vial containing the bacterial or fungal suspension, and the excess liquid was drained. The microorganisms were then spread evenly over the surface of the agar plate. Two test discs with plant extracts were placed on the plate containing the inoculum, and one standard disc (control positive) was placed at the centre of the plate. The plates were left in the hood chamber (safety cabinet) for about half an hour to allow the extract to diffuse into the media. The plates were kept in the incubator (at 37°C) for 24 hours. Gentamicin standard disc (10 µg/disc) and Clotrimazole standard disc (20 µg/disc) were used as the positive control drugs for antibacterial and antifungal tests, respectively. Antimicrobial activity was determined as the zone of inhibition around the test discs. The diameter of the inhibition zone was recorded in millimetres (mm), and the mean

https://dx.doi.org/10.4314/thrb.v26i3.9

value from two discs was determined and presented as mean plus or minus standard deviation (SD) (Dasgupta *et al.*, 2012; Koohsari *et al.*, 2015).

Determination of antimicrobial activity by the microdilution method

Quantitative assessment of antimicrobial activity was determined by a micro-titre dilution technique using 96-well micro-plates as described by Eloff (Eloff, 1998) with minor modifications. Active crude extracts (with an inhibition zone ≥ 7 mm) against at least one of the tested microbes in the qualitative analysis by the disc diffusion method were selected for the determination of minimum inhibitory concentrations (MICs). The MICs of the selected extracts were determined only against bacteria because all extracts were not active against fungi in the disc diffusion assay. The Tryptone soy broth (TSB) medium was prepared per the manufacturer's instructions. The 96-well plates were labeled accordingly by including the name of the organism, test extracts, negative control (DMSO), and positive control (gentamicin). The broth media were transferred into a clean and sterile petri dish. About 50 µL of broth was added into each of the wells of the 96-well plates using a multichannel micropipette. Test solutions were prepared by dissolving 10 mg of extract in 0.1 mL of DMSO and diluted with 0.9 mL of broth to make a 10 mg/mL concentration. After that, 50 µL of test solutions were added into the first well of each row of plates pre-loaded with 50 µL of broth media. The mixture was mixed well by multichannel micro-pipette, then 50 µL from the first row was taken and transferred to the second row and mixed, then the third row until the well in the 8th row was reached, where 50 µL was discarded, leaving only 50 µL.

The same procedure was repeated for the negative control (DMSO) and the positive control drug (gentamicin). The bacterial suspension was transferred into a clean and sterile petri dish, followed by thorough mixing using a multichannel micropipette with sterile tips. 50 µL of bacteria suspension was transferred into each well of 96-well plates containing test extract, negative control, or positive control to make 100 µL of the final volume. The final plant extract concentrations (mg/mL) per well were 2.5, 1.25, 0.625, 0.313, 0.156, 0.078, 0.039, and 0.0195. The highest concentration of the positive control drug was 125 µg/ml (0.125 mg/ml) in the first well. Each extract and positive control solution were tested in duplicate. The 96-well plates were incubated at 37°C for 24 hours. Two hours before reading the result, 20 µL of the indicator (0.2% para-iodonitrotetrazolium salt) was added to each well, followed by incubation for 30 minutes. Antibacterial activities were determined by observing colour changes. The presence of colour changes (pink or purple) indicated a lack of antimicrobial activity, while the absence of colour changes indicated antimicrobial activity. The minimum inhibitory concentration (MIC) was determined to be the lowest concentration in the well, where there was no colour change, and it was recorded in mg/mL.

Data analysis

A descriptive statistical method was used to summarize ethnobotanical data in frequencies and percentages using Microsoft Excel 2007. The quantitative ethnobotanical data were analyzed using the Informant Consensus Factor (ICF) and Fidelity Level (FL). The results of antimicrobial activity were summarized as mean ± SD inhibition zones (mm) and minimum inhibitory concentrations in mg/mL.

The Informant Consensus Factor (ICF)

Informant consensus factor (ICF) was used to search for agreement between the informants on the reported therapy for each group of diseases. ICF was determined using the formula:

$$ICF = \frac{Nur - Ns}{Nur - 1}$$

https://dx.doi.org/10.4314/thrb.v26i3.9

Whereby **Nur** is the number of use reports in each disease category, and **Ns** is the number of species used.

Fidelity level

Fidelity level (FL) is the percentage of informants who mentioned using certain plant species to treat a particular disease in the study area. The FL index was determined using the formula:

$$FL\ (\%) = \frac{Np}{N} \times 100$$

Whereby **Np** is the number of informants that use the plant species to treat a particular disease, and **N** is the number of informants that claim to use the plants as medicine to treat any given disease (Rehman *et al*., 2017).

Results

Socio-demographic Characteristics of Informants

Forty two (42) informants were interviewed: 73.8% were males and 26.2% were females. 57.1% of the informants were 50–69 years old, followed by 30-49 years old (35.7%). In addition, most informants had never attended formal school (52.4%) or had a primary or secondary school (42.9%) education. Only 4.8% had a college education. 71.4% of the participants had experience in traditional healing practice for 21–40 years, while 14.3% were in traditional healing practice for more than 40 years or less than 20 years.

Sources of Knowledge on medicinal plants

About 50% of the informants inherited healing knowledge from their elders, 31% through training from THPs, 12% after a long illness, and 7% from spiritual calls

The diversity of medicinal plants documented for managing microbial infections in Pemba

The study identified 117 plant species belonging to 103 genera and 48 plant families used in managing microbial-related infections, as shown in **Appendix 1.** The distribution of medicinal species in the respective families revealed that the plant family with the highest number of species was Fabaceae, which contributed fourteen species (11.97%), followed by the Lamiaceae, nine species (7.69%), and the Euphorbiaceae and Malvaceae families, 7 species (5.98%) each. The Asteraceae and Rutaceae families had 5 species (4.27%) each, and the remaining families had less than five species each (**Figure 2**).

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

Plant growth forms and parts of the plants used

The trees (35.9%) were the leading growth form (habit) mentioned by the informants, followed by shrubs

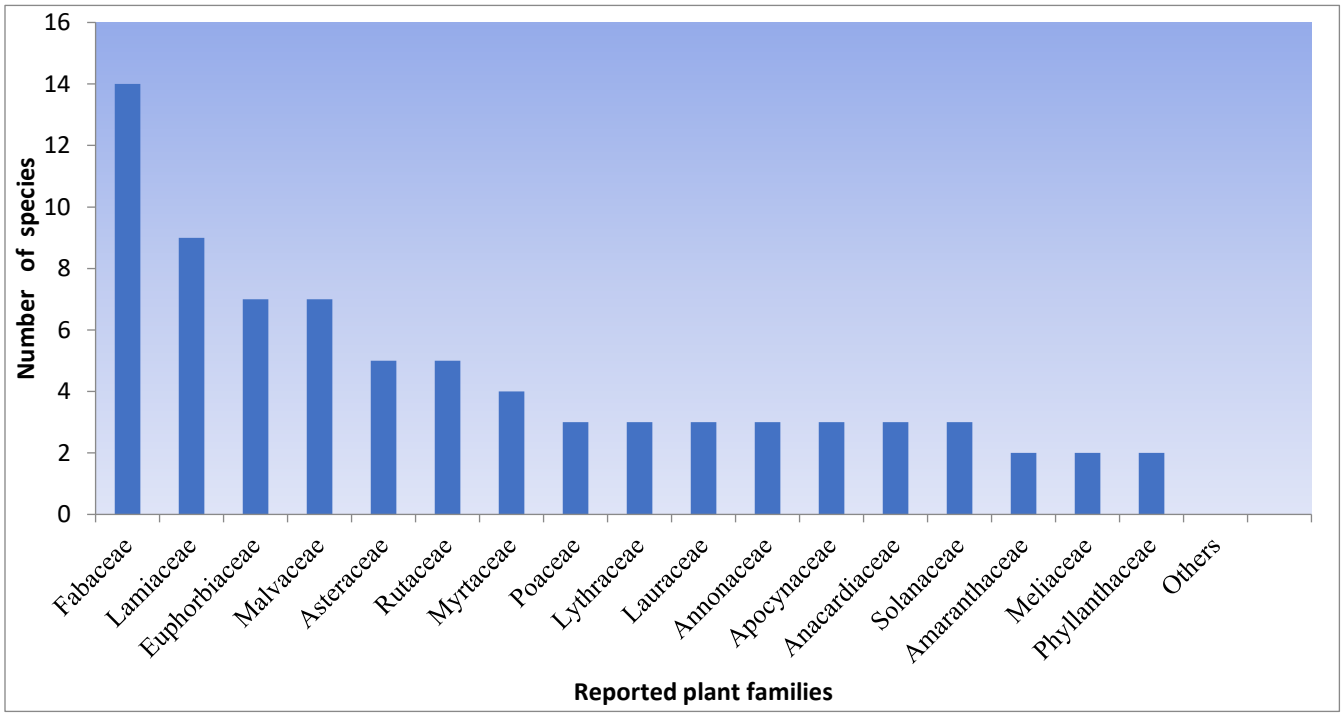


Figure 2: Plant families commonly used in the management of microbial infections in Pemba

(32.5%), herbs (18.8%), climbers (8.5%), grasses (2.6%), and creepers (1.7%) (**Figure 3**). Leaves were the most used plant parts, followed by roots, barks, whole plants, seeds, and fruits (**Figure 4**).

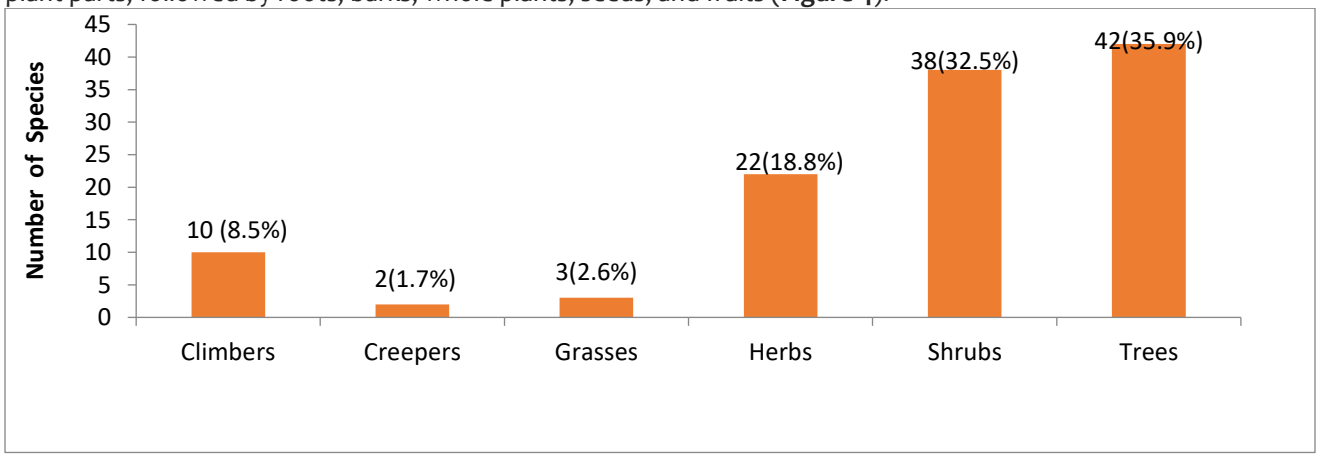


Figure 3: Plant growth forms

https://dx.doi.org/10.4314/thrb.v26i3.9

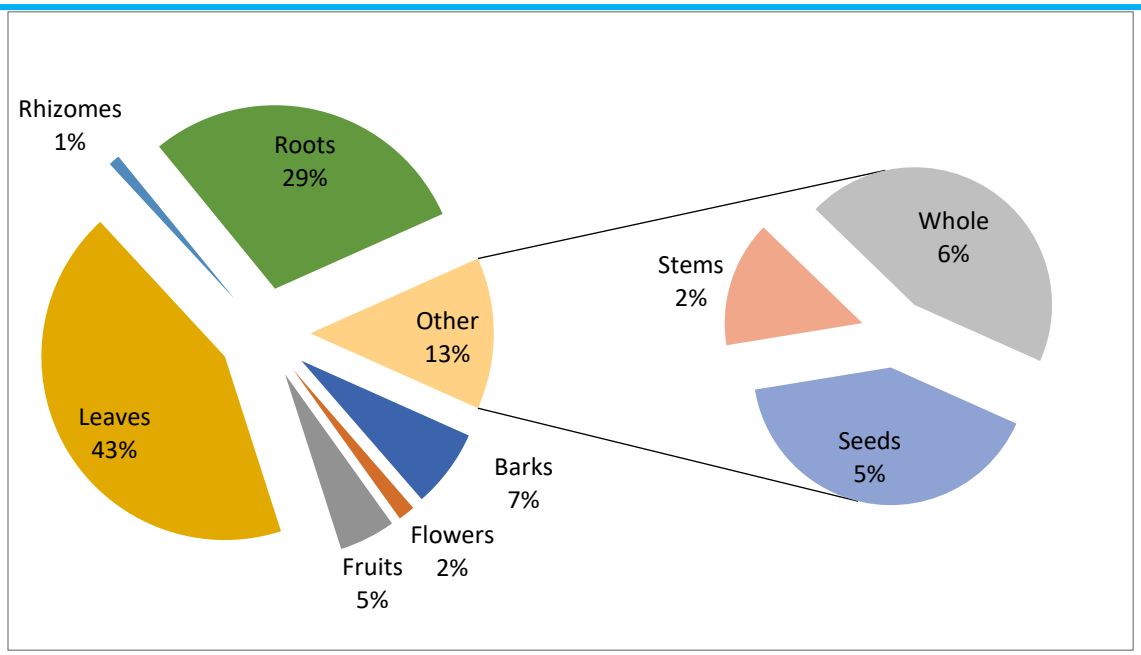


Figure 4: Parts of the plants used

Quantitative analysis of ethnobotanical data

Informant consensus factor values (ICF)

The primary diseases recorded in the study area were grouped into eleven (11) human disease categories. Eight (8) out of the 11 categories (72.73%) had ICF >0.5. The highest informant consensus factor value (0.76) was observed for the management of fever, while the lowest ICF value (0.32) was for the management of cuts and wounds (**Table 1**).

Table 1: Results of Informant Consensus Factor valued for 11 disease categories in Pemba

S/N	Diseases category	Number of plant species (Ns)	Number of use report (Nur)	Informant Consensus Factor (ICF)
1	Fever	22	90	0.76
2	Gastro-intestinal ailments	59	186	0.69
3	Pediatric ailments	14	39	0.66
4	Eyes infections	15	41	0.65
5	Skin infections	27	76	0.65
6	Oral and pharyngeal infections	22	57	0.63
7	Respiratory disorders	32	79	0.60
8	Ear infections	13	28	0.56
9	Genitourinary ailments	29	52	0.45
10	Boils and inflammations	6	10	0.44
11	Cuts and wounds	18	26	0.32

Fidelity levels of medicinal plants

The fidelity level (FL) of medicinal plant species stands for the relative therapeutic potential of medicinal plants against a given disease. The present study calculated the FL of the most frequently

https://dx.doi.org/10.4314/thrb.v26i3.9

mentioned medicinal plants with more than ten frequencies. The top twenty priority plants have been presented in Table **3.** *Azadirachta indica* scored a 100% fidelity level, while *Ocimum suave* scored the lowest fidelity level (45%

Table 2: Fidelity levels of the most preferred plants

S/N	Plant species	Major ailment	Np	N	Fidelity Level (FL)%
1	*Azadirachta indica*	Fever	34	34	100.00
2	*Canthium zanzibaricam*	Fever	31	33	93.94
3	*Vernonia hildebrandtii*	Cough	25	27	92.59
4	*Phyllanthus niruri*	Diarrhoea	35	38	92.11
5	*Plecrunthus barbatus*	Stomach pain	33	36	91.67
6	*Euphorbia hirta*	Stomach ulcers	31	35	88.57
7	*Uvaria acuminate*	Stomach complaints	23	27	85.19
8	*Hyptis suaveolens*	Fever	35	42	83.33
9	*Psiadia punctulata*	Stomach pain	23	29	79.31
10	*Solanu mincanum*	Diarrhoea	25	32	78.13
11	*Brillantaisia owariensis*	Stomach complaints	26	34	76.47
12	*Lawsonia inermis*	Skin infections	19	25	76.00
13	*Ethulia conyzoides*	Eyes infections	23	31	74.19
14	*Boerhavia diffusa*	Ear infections	22	30	73.33
15	*Ocimum canum*	Pediatric fever	21	29	72.41
16	*Cajanus cajan*	Eyes infections	29	42	69.05
17	*Agathisanthemum bojeri*	Skin infections	18	27	66.67
18	*Aloe sp.*	Ear infections	21	33	63.64
19	*Indigofera tinctoria*	Diarrhoea	24	38	63.16
20	*Ocimum suave*	Toothache	18	40	45.00

Key: Total informants (N_T) = 42**,** Np = Number of informants who mentioned the species used for a particular major ailment, N = Number of informants who mentioned the same species used for any ailment.

Plant materials for antimicrobial bioassay were collected from seven (7) plant species, among the top 20 species with the highest fidelity levels ranging from 45% to 100%. Apart from the fidelity level, these plants were selected based on the low information concerning antimicrobial activity in the literature: *Agathisanthemum bojeri* (flowers), *Brillantaisia owariensis* (leaves), *Canthium zanzibaricum* (leaves and roots), *Indigofera tinctoria* (roots), *Psiadia punctulata* (roots), *Uvaria acuminata* (leaves and roots), and *Vernonia hildebrandtii.*

Antimicrobial activity of selected medicinal plants

Inhibition zones of selected plant extracts

The results of the disc diffusion assay revealed that four extracts of seven plant species had antibacterial activity against at least one of the tested bacteria. It was also observed that no extract exhibited antifungal activity against fungi (*C. albicans)* or clinical isolate dermatophytes. The activity

https://dx.doi.org/10.4314/thrb.v26i3.9

was observed against Gram-positive (*S. aureus*) and Gram-negative (*E. coli and K. pneumoniae*) bacteria. Ethanolic leaf extracts of *C. zanzibaricum,* root extracts of *C. zanzibaricum,* root extracts of *U. acuminata,* and leaf extracts of *V. hildebrandtii* exhibited inhibition zones of 18 ± 0 mm, 9.5 ± 0.7 mm, 16.5 ± 0.7 mm, and 10.5±0.7 mm, respectively, against *S. aureus.* The *C. zanzibaricum* leaf extract was also active against *E. coli,* with a zone of inhibition of 10.7 ± 0.6 mm. Also, leaf extracts of *C. zanzibaricum* and *V. hildebrandtii* exhibited activity against *K. pneumoniae* with inhibition zones of 10.5 ± 0.71 mm and 11.5 ± 0.71 mm, respectively (**Table 3**).

Table 3: Antimicrobial activity of ethanolic extracts of selected medicinal plants

Botanical name (Plant part)	**Diameter of zone of inhibition (mm)**						
	S. aureus	*E. coli*	*K. pneumoniae*	*S. typhi*	*P. aeruginosa*	*C. albicans*	*Dermatophytes*
Canthium zanzibaricum (Leaves extract)	18 ± 0	10.7 ± 0.58	10.5±0.71	NA	NA	NA	NA
Canthium zanzibaricum (Roots extract)	9.5±0.7	NA	NA	NA	NA	NA	NA
Uvaria acuminate (Roots extract)	16.5±0.7	NA	NA	NA	NA	NA	NA
Vernonia hildebrandtii (Leaves extract)	10.5±0.7	NA	11.5±0.71	NA	NA	NA	NA
Agathisanthemum bojeri (Flowers extract)	NA	NA	NA	NA	NA	NA	NA
Brillantaisia owariensis (Leaves extract)	NA	NA	NA	NA	NA	NA	NA
Indigofera tinctoria (Roots extract)	NA	NA	NA	NA	NA	NA	NA
Psiadia punctulate (Roots extract)	NA	NA	NA	NA	NA	NA	NA
Positive control							
Gentamicin	22	22	21	20	20	-	-
Clotrimazole	-	-	-	-	-	24	23

KEY: NA = No activity. The zone of inhibition was expressed as mean ± standard deviation (SD) in mm. Values presented include disc size (6 mm)

The four plant extracts that exhibited inhibition zones (≥ 7mm) around the disc were considered active and included in the microdilution assay to determine their minimum inhibitory concentrations (MICs) against the sensitive bacteria strains. The extracts of *A. bojeri*, *B. owariensis*, *I. tinctoria,* and *P. punctulata* were inactive against any microbes tested.

Minimum Inhibitory Concentrations of the selected plant extracts against tested bacteria

Four extracts were tested against *S. aureus*, *E. coli*, *K. pneumoniae*, *S. typhi,* and *P. aeruginosa* bacteria. The root extract of *U. acuminata* showed the highest activity with a MIC value of 0.625 mg/mL against *S. aureus,* followed by leaf extracts of *C. zanzibaricum* and *V. hildebrandtii* with a MIC value of 2.5 mg/mL against *E. coli* and *K. pneumoniae* bacteria. The MIC value for the root extract of *C. zanzibaricum* was above 2.5 mg/mL against all five bacteria tested (**Table 4**).

https://dx.doi.org/10.4314/thrb.v26i3.9

Table 4: Minimum Inhibitory Concentration (MIC) of ethanolic extracts

Botanical name (Plant part)	Minimum Inhibitory Concentration (MIC) in mg/ml				
	S. aureus	*E. coli*	*K. pneumoniae*	*S. typhi*	*P. aeruginosa*
Canthium zanzibaricum (Leaves extract)	> 2.5	2.5	2.5	> 2.5	> 2.5
Canthium zanzibaricum (Roots extract)	> 2.5	> 2.5	> 2.5	> 2.5	> 2.5
Uvaria acuminata (Roots extract)	0.625	> 2.5	> 2.5	> 2.5	> 2.5
Vernonia hildebrantii (Leaves extract)	> 2.5	> 2.5	2.5	> 2.5	> 2.5
Positive control					
Gentamicin	0.03125	0.0625	0.01563	0.03125	0.00098

Discussion

Ethnobotanical information of the Medicinal Plants

Plant families, growth forms, and plant parts

This study reports ethnobotanical information and the antimicrobial activity of medicinal plants used to manage symptoms and diseases associated with microbial infections in Pemba Island, Zanzibar. The results showed that Fabaceae is a leading family with the most numerous species used traditionally in managing microbial infection conditions in Pemba Island. The finding is in agreement with a study done by Hilonga *et al.* (2019) on traded medicinal plants in Tanzania, where Fabaceae was reported as the dominant family in trade, accounting for about 24% of all 162 species (*Hilonga et al.*, 2019). Regarding the management of diseases related to antimicrobial infections, this finding differs from an observation reported in a similar study done in Mauritius. In that study, the family Zingiberaceae was documented as the leading source of medicinal plants used for the management of infectious diseases (Nunkoo & Mahomoodally, 2012).

The Fabaceae family contributed the highest percentage over the other families in the current study, possibly because it is one of the large family groups with more than 1900 species, which generates a high diversity of secondary metabolites. As nitrogen-fixing plants, Fabaceae generate more nitrogen-containing secondary metabolites than other families, acting as a good source of therapeutic ingredients (Reddy, 2017; Wink, 2013).

In this study, trees are dominant over shrubs and other growth forms. Trees, being long-living perennial plants have a higher chance of accumulating medicinal secondary metabolites as compared to other growth forms, provided that good harvesting practices are observed (Lanner, 2002). These findings, however, differ from other ethnopharmacological studies conducted in other corners of the world, such as Pakistan (Bano *et al*., 2014), Ethiopia (Gebreyes & Malessse, 2016), and Uganda (Tugume & Nyakoojo, 2019), where herbs were the most reported plant growth forms.

The leaves have the highest number of mentions among the plant parts used in herbal remedies in the current study. The use of leaves in herbal preparation is a conservation-friendly practice because it assures the long existence of particular plant species. These findings correlate with

https://dx.doi.org/10.4314/thrb.v26i3.9

the previous studies conducted in Uganda (Tugume & Nyakoojo, 2019), Cameroon (Tcheghebe *et al*., 2016), and Algeria (Boutabia *et al*., 2020), where the informants mentioned the leaves as the most used plant parts for medicinal uses.

Informant Consensus Factor (ICF) and Fidelity Level (FL)

Most of the ICF values have been observed to be near one. This indicates the general strong agreement among the informants in the use of reported medicinal plants against particular diseases since the maximum ICF value is usually one (Andrade-Cetto & Heinrich, 2011). The fever category scored the highest ICF value, indicating strong agreement among informants over using particular plant species to manage the fever. This suggests that the mentioned plants for fever are potential sources of research materials for herbal formulations for fever cases.

Azadirachta indica was presented with the highest fidelity level (100%) for the management of fever in this study, implying that *A. indica* and other native plant species with high fidelity levels could have therapeutic potential against the given significant ailment (fever); hence, more scientific work could start with such plant species for confirmation. The literature supports these findings, where an extract of *A. indica* was confirmed to possess antifungal, antibacterial, and antimalaria activities (Subapriya & Nagini, 2005). These findings concur with the previous study done in Bangladesh, where *A. indica* scored the highest fidelity level (100%) (Hossain & Rahman, 2018).

Antimicrobial activity

The antimicrobial study has shown that extracts of *C. zanzibaricum*, *V. hildebrandtii*, and *U. acuminata* have antibacterial activity against at least one of the following bacteria: *S. aureus*, *E. coli*, and *K. pneumoniae*. The findings concerning *C. zanzibaricum* relate to the findings of another Canthium species in India, known as *Canthium coromandelicum*, which exhibited antimicrobial activity against *S. aureus*, *E. coli*, and *K. pneumoniae* (Chinnaiyan *et al*., 2013) .

Both ethanolic root and leaf extracts of *U. acuminata* were tested for antimicrobial activity in this study, however, activity was observed for the root extract only. The activity of the ethanolic root extract of *U. acuminata* against *S. aureus* correlates with the findings of dichloromethane (DCM) root extracts of *U. acuminata* reported in a previous study conducted in Tanzania (Munissi, 2019). This suggests that the compounds with antibacterial activity produced by *U. acuminata* are of medium polarity, which can be extracted by intermediate polar solvents like dichloromethane and aqueous ethanol used in the two studies. It was further reported that uvaretin and diuvaretin compounds were isolated from DCM root extracts of *U. acuminata*, and these compounds were active against *S. aureus* bacteria (Munissi, 2019).

Furthermore, *K. pneumoniae* bacteria was susceptible to the leaf extracts of *C. zanzibaricum and V. hildebrandtii*. The information on the susceptibility of *K. pneumoniae* towards Canthium sp differs from the results of a previous similar study conducted in India, where *K. pneumoniae* was reported to be not susceptible toward related Canthium species called *Canthium parviflorum* (Priya *et al*., 2009). *K. pneumoniae* susceptibility to Vernonia sp. is in line with the study conducted in Uganda, where *K. pneumoniae* was reported to be susceptible to the related plant species *Vernonia amygdalina* (Joel *et al*., 2016). This shows that species of the same genera may have similar or different biological activity depending on the present phyto-ingredients and their concentrations.

The leaf extract of *C. zanzibaricum* demonstrated antibacterial activity against *E. coli.* This result can be linked with ethnobotanical information reported by informants who claimed to use *C. zanzibaricum* leaves for managing urinary tract infections (UTI) and diarrhoea, which are associated with *E. coli* infection (Tharwat *et al.,* 2019). The inhibitory activity shown by the crude leaf extract of *C. zanzibaricum* is in line with the inhibitory activities exhibited by the compounds isolated from the

https://dx.doi.org/10.4314/thrb.v26i3.9

related species, *C. horridum,* against *E. coli* (Yang et *al*., 2010). The related species of the same genera may have related active metabolites, hence producing similar biological activities (Wink, 2013).

Conclusion

The use of medicinal plant species on Pemba Island is common among the local community. *Canthium zanzibaricum, Uvaria acuminata*, and *Vernonia hildebrandtii* were proven scientifically to possess antibacterial activities against *S. aureus*, *E. coli*, and *K. pneumoniae*. To the best of our knowledge, this study is the first to report the antibacterial activity of *C. zanzibaricum*. This opens further research on the other biological activities of *C. zanzibaricum.* Medicinal use of the documented plant species provides baseline data for further research on safety evaluation and pharmacological studies for anti-microbial drug development.

Conflict of Interests

The authors declare that they have no competing interests in the publication of this manuscript.

Acknowledgements

The authors would like to acknowledge the An-Nahl Trust for financial support. Most sincere gratitude also goes to informants from Pemba Island who voluntarily shared their knowledge on the use of medicinal plants with us.

Ethical approval

The ethical clearance for this study was given by the MUHAS Ethical Review Committee (Ref.No. DA/282/298/01.C/MUHAS-REC-03-2021-539) and the Zanzibar Health Research Ethical Committee (Ref. No. ZAHREC/04/ST/APRIL/2021/39). The informants' informed consents were obtained before the beginning of the interview.

References

Andrade-Cetto, A. and Heinrich, M. (2011), "From the field into the lab: Useful approaches to selecting species based on local knowledge", *Frontiers in Pharmacology*, 2 (20), doi: 10.3389/fphar.2011.00020.

Bano, A., Ahmad, M., Hadda, T., Saboor, A., Sultana, S., Zafar M., Khan, M.P.Z., Arshad, M. & Ashraf M. (2014), "Quantitative ethnomedicinal study of plants used in the skardu valley at high altitude of Karakoram-Himalayan range, Pakistan", *Journal of Ethnobiology and Ethnomedicine*, 10(1), 1–17, doi: 10.1186/1746-4269-10-43.

Benitez, L., and Carver, P. (2019), "Adverse Effects Associated with Long-Term Administration of Azole Antifungal Agents", *Drugs*, 79(8), 833–853, doi: 10.1007/s40265-019-01127-8.

Biesen, C.M., Dilger, H. & Nienstedt, T. (2012), "Bridging gaps in health care and healing: Traditional medicine and the biomedical health care sector in Zanzibar'", *Freie Universität Berlin: Institute of Social and Cultural Anthropology.* doi: 10.13140/2.1.3070.8162.

Boutabia, L., Telailia, S. & Menaa, M. (2020), "Traditional therapeutic uses of *Marrubium vulgare* L. By local populations in the Haddada region (Souk Ahras, Algeria)", *Ethnobotany Research and Applications*, 19, 1-11, doi: 10.32859/ERA.19.44.1-11.

Bryman, A. (2012), "Sociology for Pharmacists: Social Research Methods", *Oxford University Press*, Fourth edition, p. 418.

Chang, C.H., Young-Xu, Y., Kurth, T., Orav, J. E. & Chan, A. K. (2007), "The Safety of Oral Antifungal Treatments for Superficial Dermatophytosis and Onychomy Chinnaiyan cosis: A Meta-analysis", *American Journal of Medicine*, 120(9), 791–798. doi: 10.1016/j.amjmed.2007.03.021.

Chinnaiyan, S.K, Subramanian, M.R, Kumar, S.V, Chandu, A.N. & Deivasigamani, K. (2013), "Antimicrobial and anti-HIV activity of extracts of *Canthium coromandelicum* (Burm.f.) Alston leaves", *Journal of Pharmacy Research*,7(7), 588-594, doi: 10.1016/j.jopr.2013.06.026.

Dasgupta, N., Ranjan, S., Saha, P., Jain, R., Malhotra, S. & Saleh, M. (2012), "Antibacterial activity of leaf extract of Mexican marigold (Tagetes erecta) against different gram-positive and gram-negative bacterial strains", *Journal of Pharmacy Research*, 5(8), 4201–4203.

Eloff, J. N. (1998), "A sensitive and quick microplate method to determine the minimal inhibitory concentration of plant extracts for bacteria", *Planta Medica*, 64(8), 711–713. doi: 10.1055/s-2006-957563.

Gebreyes, T. and Melesse, M. (2016), "Determination of informant consensus factor and fidelity level of ethnomedicinal plants used in Misha Woreda, Hadiya Zone, Southern Ethiopia", *International Journal of Biodiversity and Conservation*, 8(12), 351–364, doi: 10.5897/ijbc2016.1020.

Hilonga S., Otieno J.N., Ghorbani A., Pereus D., Kocyan A. & de Boer H. (2019), "Trade of wild-harvested medicinal plant species in local markets of Tanzania and its implications for conservation", *South African Journal of Botany*, 122, 214-224, doi: 10.1016/j.sajb.2018.08.012.

Horváth, G., Bencsik, T., Ács, K. & Kocsis, B. (2016), "Sensitivity of ESBL-Producing Gram-Negative Bacteria to Essential Oils, Plant Extracts, and Their Isolated Compounds", *Antibiotic Resistance: Mechanisms and New Antimicrobial Approaches*, p. 239-269, doi: 10.1016/B978-0-12-803642-6.00012-5.

Hossain, S.M., and Rahman, M. (2018), "Ethnobotanical uses and informant consensus factor of medicinal plants in Barisal District, Bangladesh", *Bangladesh Journal of Plant Taxonomy*,25(2),241–255. doi: 10.3329/bjpt.v25i2.39530.

Joel, W., Jacob, S. & Esther, K. (2016), "Indigenous knowledge and antibacterial activity of selected herbs used locally to treat common cold in Central Uganda", *Journal of Medicinal Plants Research*, 10(31),520–528. doi: 10.5897/jmpr2016.6181.

Koohsari, H., Ghaemi, E.A., Sheshpoli, M.S., Jahedi, M., Zahiri, M. (2015), "The investigation of antibacterial activity of selected native plants from North of Iran." *Journal of medicine and life*, 8(2),38–42.

Lanner, R. (2002), "Why do trees live so long", *Ageing Research Reviews,* 1(4),653-671. doi: 10.1016/S1568-1637(02)00025-9.

Mathur,S., and Hoskins, C. (2017), "Drug development: Lessons from nature (Review)", *Biomedical Reports*, 6(6), 612-614. doi.org/10.3892/br.2017.909.

Mujeeb, F., Bajpai, P. & Pathak, N. (2014), "Phytochemical evaluation, antimicrobial activity, and determination of bioactive components from leaves of *aegle marmelos*", *BioMed Research International*, 2014(497606), 11 pages. doi: 10.1155/2014/497606.

Munissi, J. (2019), "Cytotoxic and Antimicrobial Activities of the Constituents of Ten Plant Species from Tanzania", *Tanzania Journal of Science*, 45(1), 44–52.

Ngezahayo, J., Havyarimana, F., Hari, L., Stévigny, C. & Duez, P. (2015), "Medicinal plants used by Burundian traditional healers for the treatment of microbial diseases", *Journal of Ethnopharmacology*, 173, 338–351. doi: 10.1016/j.jep.2015.07.028.

Nunkoo, D.H. and Mahomoodally, M.F. (2012)," Ethnopharmacological survey of native remedies commonly used against infectious diseases in the tropical island of Mauritius", *Journal of Ethnopharmacology,* 143(2), 548–64. doi.10.1016/j.jep.2012.07.013

Priya, P. S., Sasikumar, J. M. and Gowsigan, G. (2009), "Antibacterial activity of methanol extract of *Ruta chalapensis* (L), *Quercus infectoria* (Oliver) and *Canthium parviflorum* (Lam)", *Ancient Science of Life*, 29(2), 28–31.

Reddy, J. (2017), "Important Medicinal Plant Families and Plant Based Drugs: A Review." *5th International Conference on Civil, Architecture, Environment and Waste Management At: Singapore,* doi: 10.17758/eap.ae0317304.

Rehman, M. N., Ahmad, M., Sultana, S., Zafar M. & Edwards, S. (2017), "Relative popularity level of medicinal plants in Talagang, Punjab Province, Pakistan", *Revista Brasileira de Farmacognosia*, 27(6), 751–775. doi: 10.1016/j.bjp.2017.09.004.

Revolutionary Government of Zanzibar (2008), "Zanzibar Traditional and Alternative Medicine Policy"Available at:https://www.afro.who.int/sites/default/files/2017-05/Zanzibar-traditional-and-alternative-medicine-policy-2008_0.pdf

Solera-Deuchar, L., Mussa, M. I., Ali, S., Haji, H. J. & McGovern, P. (2020), "Establishing views of traditional healers and biomedical practitioners on collaboration in mental health care in Zanzibar: A qualitative pilot study", *International Journal of Mental Health Systems*, 14(1), 1–11. doi: 10.1186/s13033-020-0336-1.

Subapriya, R. and Nagini, S. (2005), "Medicinal properties of neem leaves: A review", *Current Medicinal Chemistry - Anti-Cancer Agents*, 5(2),149–156. doi: 10.2174/1568011053174828.

Tcheghebe, O., Tatong, F., Seukep, A., Kamga J. & Justin, N. (2016), "Ethnobotanical survey of medicinal plants used for malaria therapy in western Cameroon", *Journal of Medicinal Plants Studies*, 4(3), 248-258.

Tharwat, N., El-Sherif, R., Elnagdy, S., Marzaban, R. & Amer, S. (2019), "Virulent Escherichia coli strains among Egyptian patients with acute diarrhoea versus urinary tract infection, and their antibiotic susceptibility", *Arab Journal of Gastroenterology*,20(2),74–80. doi: 10.1016/J.AJG.2019.01.003.

Tsang, T. (2017), "An Ethnobotanical Examination of Traditional Medicine in Ngezi Forest Reserve", *Independent Study Project (ISP)* Collection.2705. https://digitalcollections.sit.edu/isp_collection.

Tugume, P. and Nyakoojo, C. (2019), "Ethno-pharmacological survey of herbal remedies used in the treatment of paediatric diseases in Buhunga parish, Rukungiri District, Uganda", *BMC Complementary and Alternative Medicine*, 19(1), 353. doi: 10.1186/s12906-019-2763-6.

Ventola, C. L. (2015), "The Antibiotic Resistance Crisis Part 1: Causes and Threats", *Pharmacy and Therapeutics: a peer-reviewed journal for managed cure and hospital formulary management*, 40(4), 277–283.

Wink, M. (2013), "Evolution of secondary metabolites in legumes (Fabaceae)", *South African Journal of Botany*, 89, 164-175. doi: 10.1016/j.sajb.2013.06.006.

World Health Organization (WHO) (2020), "The top ten causes of death" (18June,2021), Available at:https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death.

Yang, B., Chen, G., Song, X., Chen, Z. & Wang, J. (2010), "Chemical Constituents and Antimicrobial Activities of *Canthium horridum*", *Natural Product Communications*, 5(6), 913-914, doi:10.1177/1934578X1000500620.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

Appendix 1: Medicinal plants used to manage infectious diseases in Pemba, Zanzibar

Botanical name (Family)	Voucher number	Vernacular name (swahili)	Growth form (Habit)	Wild, Cultivated or both	Part used	Symptom/Disease managed	Preparation
Abrus precatorius L. (**Fabaceae**)	HMF005	Mpirikichi/ Macho ya fufu/Macho ya kunguu	Climber	Wild	L	Cough	Decoction
Acacia auriculiformis A.Cunn. ex Benth. (**Fabaceae**).	HMF012	Mkeshia	Tree	Cultivated	R, B	Stomach complaints	Decoction
Achyranthes aspera L. (**Amaranthaceae**)	HMF026	Mshikie hanye/Mlelea mwana	Herb	Wild	R	Candidiasis	Decoction
Adansonia digitata L. (**Malvaceae**)	Not collected	Mbuyu	Tree	Wild	L	Eyes infections	Crushed to get juice
Agathisanthemum bojeri Klotzsch (**Rubiaceae**)	HMF35	Msinga pwepwe/Mvuma nyuki	Herb	Wild	R	Cough	Decoction
				Wild	F_L	Ringworms	Fresh flowers rubbed on the skin
Allium sativum L. (**Amaryllidaceae**)	Not collected	Kitunguu thawmu	Herb	Cultivated	B_u	Bloody diarrhoea	Chewing
Aloe pembana L.E Newton (**Asphodelaceae**)	Collected as seedling	Mzimakilio/Mualovera	Herb	Wild	L	Ear infections	The leaves are heated and squeezed to get hot liquid drops
Ammophila arenaria (L.) Link (**Poaceae**)	HMF047	Nyasi	Herb	Wild	W	Cough	Decoction with sea salt crystals
Anacardium occidentale L. (**Anacardiaceae**)	HMF068	Mkorosho	Tree	Cultivated	B	Toothache and gum bleeding	Decoction

https://dx.doi.org/10.4314/thrb.v26i3.9

Ananas comosus L. Merr (**Bromeliaceae**)	Not collected	Mnanasi	Herb	Cultivated	F	Urinary tract infections	Decoction of pineapple peels
Annona muricata L. (**Annonaceae**)	HMF001	Mstafeli	Tree	Cultivated	L	Skin infections	Grounded with the guava leaves to get juice
Annona squamosa L. (**Annonaceae**)	HMF040	Mtopetope	Tree	Both	B	Headache	The barks are crushed with lime to get juice
Azadirachta indica A. Juss. (***Meliaceae***)	HMF100	Mwarubaini/Msirikali	Tree	Both	L	Candidiasis, fever, Stomachache	Decoction
Boerhavia diffusa L. (**Nyctaginaceae**)	HMF088	Muataata	Herb	Wild	W	Stomach ulcers	Decoction
Brillantaisia owariensis P.Beauv. (Acanthaceae)	HMF002	Mpresha	Herb	Both	L	Stomach complaints	Decoction
Caesalpinia bonducella L. (**Fabaceae**)	HMF013	Msoo	Shrub	Wild	R	Stomach complaints, Urinary tract infections (UTI)	Decoction
Cajanus cajan (L.) Millsp. (**Fabaceae**)	HMF052	Mbaazi	Shrub	Cultivated	L	Eyes infections, Cough	Crushed, then squeezed to get juice.
Canthium zanzibaricum Hiern (**Rubiaceae**)	HMF018	Mpendapendapo/Mnyung'unya	Shrub	Wild	L	Fever, urinary tract infections (UTI), Diarrhoea, Skin infections	Decoction
					R	Stomach complaints	Decoction

https://dx.doi.org/10.4314/thrb.v26i3.9

					F	Skin infections	Dried, powdered and mixed with coconut oil
Capsicum sp. (**Solanaceae**)	Not collected	Mpilipili	Shrub	Cultivated	F	Chronic open wounds	Grounded to have a chili paste
Carica papaya L. (**Caricaceae**)	HMF015	Mpapai	Tree	Cultivated	L	Fever	Decoction mixed with lemon slices
					S	Fever	One teaspoon is dried and powdered with one glass of warm water.
Cassia sieberiana DC. (**Fabaceae**)	HMF007	Mchapia tumbili	Tree	Wild	R	Stomach complaints	Decoction
Cassytha filiformis L. (**Lauraceae**)	HMF016	Mtandakanga	Climber	Wild	S_t	Skin infections	Crushed to get the paste
Casuarina equisetifolia L. (**Casuarinaceae**)	HMF032	Mvinje	Tree	Cultivated	L	Stomach gas	Decoction mixed with the leaves of sanamaki and mnanaa
Catharanthus roseus (L.) G.Don (Apocynaceae)	HMF048	Mbustani	Herb	Both	W	Fever, stomach complaints	Decoction
Cinnamomum verum J. Presl. (Lauraceaea)	HMF101	Mdalasini	Tree	Both	B	Stomach pain	Decoction
Citrus aurantifolia (Christm.) Swingle. (**Rutaceae**)	HMF067	Mdimu wa kikali/ mdimu mkali	Tree	Cultivated	R	Febrile seizures	Dried, powdered and mixed with

https://dx.doi.org/10.4314/thrb.v26i3.9

							mpacha powder
Citrus limon (L.) Burm. F (**Rutaceae**)	HMF065	Mlimao	Tree	Cultivated	R	Stomach pain	Decoction mixed with young coconut water.
Citrus sinensis (L.) Osbeck (**Rutaceae**)	HMF099	Mchungwa	Tree	Cultivated	F_L	Skin infections	Fresh flowers rubbed on the skin.
Clerodendrum sp. (**Lamiaceae**)	HMF019	Mpepe	Shrub	Cultivated	R	Persistent headache	Decoction with two dried matured coconut milk to get the oil mixture.
Cocos nucifera L. (**Arecaceae**)	Not collected	Mnazi	Tree	Cultivated	F	Mouth ulcers	The water of young coconut is mixed with honey and powder of henna leaves
Commiphora africana (A.Rich.) Engl. (**Burseraceae**)	HMF055	Mwambamji	Shrub	Wild	R	Stomach pain, diarrhoea	Decoction
Corchorus sp .(**Malvaceae**)	HMF071	Kombotumwa	Herb	Wild	L	Wounds	Grounded fresh leaves
Coriandrum sativum L. (**Apiaceae**)	Not collected	Giligilani	Herb	Cultivated	S	Mouth ulcers, stomach complaints	Chewing
Cucumis melo L. (**Cucurbitaceae**)	HMF010	Mtango mwitu	Climber	Wild	L	Skin infections	The juice of crushed fresh leaves is mixed with coconut oil

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

Curcuma longa L. (**Zingiberaceae**)	Not colleccted	Manjano	Herb	Cultivated	R_h	Tonsillitis, Dry Cough, Chest pain	Dried or fresh materials are crushed with ginger and then mixed with honey.
Cymbopogon citratus (DC.) Stapf (Poaceae)	HMF107	Mchaichai	Herb	Cultivated	L	Urinary tract infections	Infusion
Cyphostemma adenocaule (A.Rich.) Wild & R.B.Drumm (**Vitaceae**)	HMF105	Mkichi	Climber	Wild	L	Cough	The leaves are crushed and squeezed to get juice.
Datura metel L. (**Solanaceae**)	HMF023	Mnaraha	Shrub	Wild	R	Diarrhoea, cough	Decoction
Deinbollia borbonica Scheff. (**Sapindaceae)**	Not collected	Mbuyu mwaka	Tree	Wild	R	Common cold	Decoction with ginger.
Dichostachys cinerea (L.) Wight & Arn. (**Fabaceae**)	HMF011	Mvunja shoka	Shrub	Wild	R	Stomach complaints	Decoction
Dissotis rotundifolia (Sm.) Triana (**Melastomataceae**)	HMF006	Mchanja uziwa	Herb	Wild	W	Cough	Decoction
Dysphania ambrosioides (L.) Mosyakin & Clemants (**Amaranthaceae**)	HMF057	Mtarifeni	Herb	Both	L	Stomach pain	Decoction
Eleusine indica (L.) Gaertn. (**Poaceae**)	HMF104	Kishinde	Herb	Wild	W	Pediatric fever	Decoction
Ethulia conyzoides L.f. (**Asteraceae**)	HMF009	Mbangi wazimu	Herb	Wild	L	Eyes and ears infections	The leaves are ground and squeezed to get drops of juice.
Eucalyptus sp. (**Myrtaceae**).	HMF022	Mkaratusi	Tree	Cultivated	L	Toothache	Dry powdered material used with toothbrush

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

Euclea racemosa L. (**Ebenaceae**)	HMF102	Mdaa	Shrub	Wild	R	Urinary Tract Infections	Decoction
Euphorbia hirta L. (**Euphorbiaceae**)	HMF110	Kiozesha nyama	Herb	Wild	R	Syphilis, Gonorrhoea	Root decoction
					W	Stomach ulcers	Decoction
Ficus exasperata Vahl (**Moraceae**)	HMF086	Msasa	Tree	Both	L	Cough	Decoction
Ficus glumosa Delile (**Moraceae**)	HMF034	Mjenga ua	Tree	Both	L / R	Skin infections	Dried, powdered and mixed with coconut oil
Ficus sur Forssk (**Moraceae**)	HMF041	Mkuyu	Tree	Wild	L	Dry cough	Decoction mixed with lemon juice and honey.
Flacortia indica (Burm.f.) Merr. (**Salicaceae**)	HMF039	Mchongoma	Tree	Wild	R	Urinary tract infections, stomach pain	Decoction
Flueggea virosa (Roxb. ex Wild) Royle (**Phyllanthaceaea**)	HMF069	Mkwamba	Shrub	Wild	L & R	Stomach complaints, Urinary tract infections	Root decoction mixed with juice of crushed fresh leaves
Gonatopus boivinii Decne. (**Araceae**)	HMF059	Mnazi wa nyoka/Kiti cha nyoka	Herb	Wild	S_t	Ear infections	Stem is heated for 7 to 10 minutes
Gossypium hirsutum L. (**Malvaceae**)	HMF027	Mpamba	Shrub	Both	L	Headache	Ground with the stems of mbono.
Harungana madagascariensis Lam. ex Poir.(**Hypericaceae**)	HMF080	Mngoningini/ Mdamudamu	Tree	Wild	B	Skin infections	Cooked with coconut oil
Hibiscus diversifolius Jacq. (**Malvaceae**)	HMF089	Mpapurapumbu	Shrub	Wild	R	Urinary tract infections	Decoction

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

Hoslundia opposita Vahl (**Lamiaceae**)	HMF111	Mlamanja/Mlachore	Shrub	Wild	L	Pediatric fever	The leaves are ground with water
Hyptis suaveolens (L.) Poit. (**Lamiaceae**)	HMF008	Mkua usiku	Shrub	Wild	R&L	Urinary Tract Infections, Typhoid fever	Decoction
Indigofea tinctoria L. (**Fabaceae**)	HMF091	Mwino	Shrub	Wild	R	Stomach pain and diarrhoea	Decoction /infusion
Jatropha curcas L. (**Euphorbiaceae**)	HMF051	Mbono kaburi	Tree	Wild	R	Gonorrhoea	Roots are cut into 11 finger-sized pieces and boiled with the coconut milk.
Lannea schweinfurthii (Engl.) Engl. (**Anacardiaceae**)	HMF028	Muumbu/Mnyumbu	Tree	Wild	B	Chronic wounds	Dried and powdered
Lantana camara L. (**Verbenaceae**)	HMF046	Haung'ong'wa	Shrub	Wild	L	Pediatric fever	Decoction
Lawsonia inermis L. (**Lythraceae**)	HMF108	Mhina	Shrub	Both	L	Skin infections, candidiasis	Decoction
Leonotis nepetifolia (L.) R.Br. (**Lamiaceae**)	HMF058	Mkuu wa usiku halisi	Shrub	Wild	L	Fever	Decoction
Lippia javanica (Burm.f.) Spreng (**Verbenaceae**)	HMF045	Mpambawake/mwinga jini	Shrub	Both	L	Fever, cough, febrile seizure, stomach pain	Decoction
Macaranga peltata (Roxb.) *Müll.Arg.* (**Euphorbiaceae**)	HMF033	Msinduzi	Tree	Wild	R, B	Skin infections	Decoction
Mangifera indica L. (**Anacardiaceae**)	HMF074	Mwembe dodo	Tree	Cultivated	B	Toothache	Decoction

https://dx.doi.org/10.4314/thrb.v26i3.9

Manihot esculenta Crantz (**Euphorbiaceae**)	HMF093	Mhogo	Shrub	Cultivated	R	Wounds	Root tuber is burnt to ashes.
Markhamia zanzibarica (Bojer ex DC.) K.Schum. (**Bignoniaceaea**)	HMF079	Mtalawanda	Tree	Wild	R	Stomach complaints	Decoction
Mentha sp. (**Lamiaceae**)	Not collected	Mnanaa	Herb	Cultivated	L	Stomach gas	Decoction with mvinje and sanamaki leaves
Mimosa pudica L. (**Fabaceae**)	HMF021	Kifauongo	Shrub	Wild	L	Cough, stomach ulcers	Ground, mixed with honey.
Moringa oleifera Lam. (**Moringaceae**)	HMF031	Mronge/Mnuka uvundo	Tree	Both	R	Gonorrhoea	Root bark are powdered and mixed in water of two young coconuts.
Mucuna gigantea (Willd.) DC. (**Fabaceae**)	HMF082	Upupu	Climber	Wild	L	Gonorrhoea	Ground and powder soaked in medium matured coconut water, then mixture filtered to get juice.
Murraya Koenigii (L.) Spreng. (**Rutaceae**)	HMF020	Mvuje	Tree	Cultivated	L	Fever, gas in the stomach, vomiting	Decoction
Musa sp (**Musaceae**)	Not collected	Mgomba	Herb	Cultivated	T	Tuberculosis	The inner tube of the trunk is

https://dx.doi.org/10.4314/thrb.v26i3.9

							squeezed to get its juice.
Myristica fragrans Houtt. (**Myristicaseae**)	Not collected	Mkungumanga	Tree	Both	S	Ear infections	Powder is mixed with coconut oil and covered in a piece of cloth and then squeezed drop wise to infected ear.
Ocimum canum Sims (**Lamiaceae**)	HMF003	Kivumbasi	Herb	Wild	L/W	Fever, common cold	The fresh leaves are ground in water.
Ocimum basilicum L. (**Lamiaceae**)	HMF076	Mrehani	Herb	Cultivated	L	Tonsillitis	They are dried, powdered and mixed with black pepper.
Ocimum suave Willd. (**Lamiaceae**)	HMF053	Mtule	Shrub	Both	L	Toothache, gum bleeding.	Fresh leaves are ground to get the paste
Paederia foetida L. (**Rubiaceae**)	Not collected	Mmavimavi	Climber	Wild	L	Diarrhoea	Decoction
Parinari curatellifolia Planch. ex Benth. (**Chrysobalanaceae**)	HMF044	Mbura	Tree	Wild	R	Urinary tract infections, Toothache	Decoction
Passiflora edulis Sims (**Passifloraceae**)	HMF024	Mpesheni	Climber	Cultivated	L	Stomach pain	Decoction
Pemphis acidula J.R.Forst. (**Lythraceae**)	HMF056	Mjoma	Shrub	Wild	L	Common cold	Decoction
Persea americana Mill. (**Lauraceae**)	HMF038	Mparachichi	Tree	Cultivated	S	Skin infections	Dried, powdered and

https://dx.doi.org/10.4314/thrb.v26i3.9

							mixed with rose water
Phyllanthus niruri L. (**Phyllanthaceae**)	HMF098	Mzalia nyuma	Herb	Wild	R	Stomach pain, diarrhoea, bloody diarrhea	Decoction
Piper nigrum L. (**Piperaceae**)	HMF073	Pilipili manga	Climber	Both	S	Tonsillitis	Powdered and mixed with the powder of dried leaves of mrehani..
Plecrunthus barbatus Andrews (**Lamiaceae**)	HMF070	Mpatakuva	Shrub	Both	L	Fever, stomach complaints, Urinary tract infections, candidiasis	Decoction
Pouteria campechiana (Kunth) Baehni (**Sapotaceae**)	HMF106	Mzaituni	Tree	Cultivated	L	Eyes infections	Leaves are crushed to get juice.
Psiadia punctulata (DC.) Vatke (**Asteraceae**)	HMF015	Mwezi upande	Shrub	Wild	L	Chronic skin rashes	The fresh leaves are ground and mixed with coconut milk
					R	Stomach pain	Decoction
Psidiam guajava L. (**Myrtaceae**)	HMF087	Mpera	Tree	Cultivated	L	Common cold, respiratory system infections	Mixed with the leaves of kivumbasi and mkarafuu to make decoction.

https://dx.doi.org/10.4314/thrb.v26i3.9

Punica granatum L. (**Lythraceae**)	HMF025	Mkomamanga	Shrub	Cultivated	F	Wounds	Fruit peels are dried and powdered
Rauvolfia mombasiana Stapf (**Apocynaceae**)	HMF097	Ramba nkurambe/Muongochaa	Tree	Wild	R	Stomach complaints Fever	Pieces of root are soaked in cup of water for 10 to 15 minutes
Ricinus communis L. (**Euphorbiaceae**)	HMF062	Mbono/Mbarika	Shrub	Wild	L & R	Gonorrhoea	Leaves and roots are boiled together with 2 to 3 litres of water (Decoction)
Saba comorensis (Bojer) Pichon (**Apocynaceae**)	HMF036	Mbungo	Climber	Wild	F	Mouth ulcers and sore throats	Seeds are mixed with ashes of firewood/charcoal.
Senna alexandria Mill. (**Fabaceae**)	Not collected	Sanamaki	Shrub	Both	L	Gas in the stomach	Mixed with with leaves of mvinje and mnanaa to make decoction
Senna obtusifolia (L.) H.S.Irwin. & Barneby. (**Fabaceae**)	HMF095	Mkundenyika jike	Shrub	Wild	L	Open wounds	Fresh or dried leaves are ground
Senna occidentalis (L.) Link. (**Fabaceae**)	HMF109	Mkundenyika/Mkundenyika dume	Shrub	Wild	L & R	Pediatric fever	Roots are boiled for drinking and leaves are ground with water for bathing.
Sida acuta Burm.f. (**Malvaceae**)	HMF030	Mfyagio/Mlambuzi	Shrub	Wild	L	Boils and inflammation	Leaves are ground to get paste

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.9

Sida cordifolia L. (**Malvaceae**)	HMF017	Muopoa habari	Shrub	Wild	R	Diarrhoea, stomach pain	Decoction
Solanum incanum L. (**Solanaceae**)	HMF061	Mtunguja	Shrub	Wild	W	Skin rashes	Whole plant is cut into pieces and ground with water
Sonchus schweinfurthii Oliv.&Hiern (**Asteraceae**)	HMF037	Mchunga	Herb	Wild	R	Stomach pain	Decoction
Sonneratia alba Sm. (**Lythraceae**)	HMF042	Mtonga	Tree	Wild	S	Skin infections	Powdered dried seeds is mixed with coconut oil
Suregada zanzibarensis Baill. (**Euphorbiaceae**)	HMF043	Mdimu mwitu	Shrub	Wild	R	Stomach pain and diarrhoea	Decoction
Syzgium cumini (L.) Skeels. (**Myrtaceae**)	HMF049	Mzambarau	Tree	Wild	B	Bloody diarrhoea	Decoction
Syzygium aromaticum (L.) Merr. & L.M.Perry [c] (**Myrtaceae**)	HMF050	Mkarafuu	Tree	Cultivated	F_L	Diarrhoea and Vomiting	Decoction
Tacca leontopetaloides (L.) Kuntze (**Taccaceae**)	HMF054	Uwanga	Herb	Wild	R	Tonsillitis, mouth ulcers	Root The powder is mixed with honey
Tamarindus indica L. (**Fabaceae**)	HMF081	Mkwaju	Tree	Both	L	Cough, diarrhoea	L are ground to have juice
Terminalia catappa L. (**Combretaceae**)	HMF060	Mkungu	Tree	Wild	B	Pneumonia	Decoction
Tragia furialis Bojer (**Euphorbiaceae**)	HMF096	Uweni	Climber	Wild	L	Tits inflammation	Fresh leaves are ground and applied on the inflamed tits.

https://dx.doi.org/10.4314/thrb.v26i3.9

Triumfetta rhomboidea Jacq. (**Malvaceae**)	HMF083	Muopoa habari mweusi	Shrub	Wild	W	Candidiasis	Decoction
Uvaria acuminata Oliv. (**Annonaceae**)	HMF092	Mchofuo	Shrub	Wild	R	Chronic wounds (donda ndugu)	Driedoot bark powder.
					R & L	Stomach complaints	Decoction
Vernonia noveboracensis (L.) Michx. (**Asteraceae**)	HMF084	Mnyunywe	Shrub	Wild	L	Pediatric fever, fever, febrile seizure	Dried leaves are burnt to produce herbal smoke
Vernonia hildebrandtii Vatke (**Asteraceae**)	HMF090	Mpacha	Shrubs	Wild	L	Candidiasis, diarrhoea, Cough	Decoction
Xylocarpus granatum J.König (**Meliaceae**)	HMF085	Mtonga	Tree	Wild	S	Skin infections	Dried powdered material mixed with coconut oil and applied to affected part
Zanthoxylum holtzianum L. (**Rutaceae**)	HMF112	Mjafari	Shrub	Wild	R	Stomach pain	Roots are boiled with ubani (arabic gum) (Decoction)

https://dx.doi.org/10.4314/thrb.v26i3.9

Zingiber officinale Roscoe. (**Zingiberaceae**)	Not collected	Tangawizi	Herb	Cultivated	R_h	Sore throat, Dry Cough, Chest pain	Ground with tumeric (manjano) to get mixed powder if dried or paste if undried, the obtained mixture is added to honey.
Ziziphus mauritiana Lam. (**Rhamnaceae**)	HMF063	Mkunazi	Tree	Cultivated	L	Stomach complaints, loss of appetite	L are ground and squeezed to get juice.
Unidentified	Not collected	Mjeshi	Tree	Wild	R	Common cold, headache	Powder is covered in a piece of cloth and nasal inhaled occasionally.
Unidentified	Not collected	Mnungu	Tree	Wild		Stomach ailments	Decoction

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.10

Examining sociodemographic factors affecting male involvement in family planning services: a study of married men in Musanze district

Emmanuel Ndahiro Manirafasha[12*], *Clemence Nishimwe* [3]

[1]Center for Nursing and Midwifery, University of Global Health Equity, Kigali, Rwanda, [2]Ministry of Health of Rwanda, Associate Nursing Program, [3] Nursing, College of Health Sciences, Mount Kenya University, Kigali, Rwanda

Abstract

Background: Male involvement in family planning (FP) services utilization is crucial for promoting reproductive health, reducing unintended pregnancies, and fostering more equitable and healthy relationships between partners. This study aims to identify the Sociodemographic factors associated with male involvement in FP services utilization in Musanze district, Northern Rwanda.

Methods: A quantitative-method cross-sectional study was conducted with 397 married men in Musanze District. Participants were chosen through simple random sampling, and data were gathered using pre-tested, interview-administered questionnaires. Multivariable logistic regression analysis was utilized to identify sociodemographic factors associated with male involvement in FP services.

Results: The overall male involvement in FP services was low, at 36.7%. It was found that male involvement in FP services was significantly predicted by age (OR=6.199, 95% CI: 1.727-22.251), education level (OR=0.331, 95% CI: 0.147-0.745), and employment status (OR=2, 95% CI: 1.24-3.224).

Conclusion: In general, the level of male involvement in FP services utilization in the Musanze district was low. Based on these findings, the study suggests integrating men into existing FP services to enhance utilization and sustainability.

Keywords: Male involvement; Family Planning Services; Sociodemographic Factors; Married Men; Musanze District

Introduction

Family planning (FP) refers to making informed decisions about the number and timing of children a family desires to have, as well as the methods and practices used to achieve those goals. The primary objective of FP is to promote reproductive health, prevent unintended pregnancies, and improve the overall well-being of individuals and families (UNFPA, 2022). Family planning services have long been recognized as a worldwide crucial aspect of public health programs. They improve maternal and child health, reduce unintended pregnancies, and enhance overall reproductive health outcomes. While these services primarily target women, male involvement in FP is increasingly acknowledged as a critical factor in its success and effectiveness (Titiyos et al., 2023). Globally, in 2019, 1.1 billion women of reproductive age (15-49 years) intended to utilize FP methods. However, 190 million women had an unmet need for FP, with higher rates observed in Sub-Saharan Africa (SSA) than in other regions (Kraft et al., 2022). Despite significant progress, many women worldwide desire to avoid pregnancies, but they and their partners do not use contraception. Several factors contribute to this unmet need, including inadequate service quality, limited method

* **Corresponding Author:** Emmanuel Ndahiro Manirafasha: **Email:** emmyndahiro14@gmail.com

options, fear of partner opposition, and concerns about side effects and health issues (Manortey & Missah, 2020). It is important to address male involvement in FP in this context.

Male involvement in FP extends beyond the promotion of condom use and vasectomies as male contraceptive methods. It encompasses the active support provided by men to their partners in contraception, their advocacy for FP within their social circles, and their efforts to shape policy environments that foster the development of programs aimed at male involvement (Mulatu et al., 2022). Numerous studies have indicated that the acceptance and continuity of FP services tend to be more successful for women when men actively participate (Tamiso et al., 2016).

Traditionally, FP programs have primarily focused on women. However, it is essential to recognize that men are also significant decision-makers when it comes to sexual activity and determining the desired number of children within African communities. Their involvement in FP is vital for the acceptance and continuation of contraceptive methods (Fedrick, Mkingule, Mtae, & Emmanuel, 2019). The participation of men in FP services can enhance women's utilization of FP and improve maternal outcomes. Consequently, this can potentially prevent an estimated 830 maternal deaths in sub-Saharan Africa daily (Nkwonta & Messias, 2019). The lack of male involvement in FP is a contributing factor to low contraceptive usage and a high unmet need for FP in Africa. Men actively participating in FP can potentially reduce maternal mortality by 32% and child mortality by 10% (Wondim et al., 2020).

Despite establishing family planning (FP) policy initiatives, male participation in FP services remains low across most sub-Saharan African countries. A study conducted in Ethiopia found that only 12.5% of men engage in FP services. This low male involvement includes insufficient knowledge of FP methods, fear of side effects, a desire for more children, and cultural or religious prohibitions (Wondim et al., 2020). Furthermore, according to Francis (2020), Tanzania reported that only 17.5% of males are involved in FP. The factors contributing to low male involvement include concerns about side effects from FP use, inadequate availability of FP commodities, and a limited number of clinics (Fedrick, Mkingule, Mtae, & Emmanuel, 2019).

In contrast, Butto (2015) reported that only 6% of males in Kenya were using FP methods despite interventions from national and non-governmental organizations. However, continuous education and reorientating FP services to enhance their accessibility for men have been identified as key strategies for increasing male involvement in FP services (Butto & Mburu, 2015). A study conducted in Ghana found that only 48% of men are involved in utilizing FP services, even though men endorse most FP methods employed by their partners (Kwawukume et al., 2022). Similarly, a study carried out in Ethiopia discovered an alarmingly low prevalence of male involvement in family planning, cumulating to 39.66%. This lack of participation can be attributed to factors like limited contraceptive options for men, insufficient understanding and favorable attitudes towards family planning, and educational background (Kassa et al., 2022).

A study conducted in Uganda concluded that ignorance, excessive alcohol consumption, and poverty represent the primary obstacles to male involvement in reproductive health services, including family planning. Additionally, negative attitudes among healthcare professionals toward men, coupled with the lack of services explicitly designed for men, discourage their engagement (Bagenda et al., 2021). The same study conducted by Muheirwe (2019) in Uganda revealed a low level of male participation in maternal and child health care. A majority of men, approximately 68%, cited a lack of awareness and the influence of social-cultural values as barriers to their involvement in these services. They expressed disinterest due to a limited understanding of the importance of their participation in maternal and child health care (Muheirwe & Nuhu, 2019).

Strengthening male participation in FP services and addressing reproductive health issues are crucial public health initiatives. These efforts play a key role in achieving Sustainable Development Goal 3 (SDG 3), which focuses on reducing maternal mortality and improving overall health outcomes. Another study conducted in Uganda found that when men are actively involved in FP services, women are more likely to be motivated to accept, use, and continue using FP methods. The study also revealed that 34.0% of women experienced insufficient partner

involvement in FP, 80.6% believed that discussing FP with their partner positively impacts their contraceptive use, and 93.5% thought that men play a significant role in FP (Wambete et al., 2022). As a result, men must be consistently included in FP services.

The government of Rwanda considers FP a crucial aspect of development and vital for reducing maternal mortality and poverty. Over the past decade, there has been a notable increase in government funding for FP, including efforts in monitoring and evaluation. According to a study by Ndayishimiye, 54.6% of women in Rwanda use modern contraceptives, while 12.6% rely on traditional methods. Among non-contraceptive users, who make up 17.9%, socio-cultural factors such as cultural beliefs, religious prohibitions, fear of side effects, lack of knowledge, and traditional beliefs are predominant reasons. Additionally, 5.1% of non-users cited opposition from their husbands, fearing that using contraceptive methods without their husband's approval could result in divorce or violence (Ndayishimiye, 2022).

According to the Rwanda Demographic and Health Survey (RDHS, 2019-2020), the contraceptive prevalence rate among currently married women in Rwanda is 64%, up from 47% in 2005 (NISR, 2006). The survey also indicates that married women (58%) use contemporary contraceptives more than sexually active unmarried women (48%). The total fertility rate (TFR) is 4.1 children per woman, with rural women having a higher rate of 4.3 compared to urban women at 3.4 (NISR, 2020).

The RDHS for 2014-2015 documented a decline in the TFR from 6.1 births per woman in 2005 to 4.6 in 2010 and 4.2 in 2014-2015, attributed to increased contraceptive use over the past decade (National Institute of Statistics of Rwanda et al., 2016). Currently, 58% of married women use modern contraceptive methods, while 6% use traditional methods. In contrast, 50% of sexually active unmarried women use contraception, with 48% opting for contemporary methods and 2% using traditional methods. Contraceptive use is higher in rural areas (65%) compared to urban areas (61%). Despite these advancements, contraceptive discontinuation after one year is 30%, and the unmet need for family planning stands at 14%. The most frequently cited reasons for discontinuation include fear of side effects, desire to become pregnant, and insufficient male involvement in family planning (NISR, 2020).

A low male involvement in Maternal and Child Health (MCH) services, including FP, is a case in the Musanze district. According to Karamage, in 2016, the level of male involvement in MCH services was still low, as most of them thought that it was a woman's affair. In addition, men did not accompany their partners in MCH services, including FP services, due to fear of facing friends and relatives, behaviors of staff at health facilities, long waiting times, unavailability of physical space to accommodate men, and low level of education stated as barriers to male involvement in MCH services (Karamage, 2016). Failure to involve men in utilizing FP services can have serious consequences in a society such as Rwanda. Even if women are motivated to use FP methods, the lack of involvement and opposition from husbands contributes to a high rate of unmet needs, low contraceptive use, and discontinuation of the FP method (Ndayishimiye, 2022).

However, access to FP services for men is limited due to various sociodemographic factors that are not well-identified. Therefore, this study aims to identify the Sociodemographic factors associated with male involvement in FP services utilization in Musanze district, Northern Rwanda.

Methods

Study design and setting

A cross-sectional study was conducted from August to December 2023 in Musanze District, located in northern Rwanda. Musanze is one of the five districts in the Northern Province and is bordered by Uganda to the north, Gakenke District to the south, Burera District to the east, and Nyabihu District to the west. According to the Fifth Rwanda Population and Housing Census (2022), Musanze District has a population of 476,522, 227,340 males and 249,182 females, with a population density of 1,154 people per square kilometer. The district encompasses urban and rural areas, with 234,258 residents living in urban areas and 242,264 in rural areas. Covering an area of 530 square

kilometers, Musanze District is divided into 15 sectors, 68 cells, and 432 villages. The estimated population of men aged 21 years and older is 74,801 (NISR), 2023). The district was selected for the study due to its lower contraceptive prevalence rate, which ranks third in the Northern Province at 70%. Specifically, only 66% of the population uses modern family planning methods, while 4% use traditional methods. Additionally, the total fertility rate in the district is 3.5 children per woman (NISR, 2020).

Population and Eligibility Criteria

This study focused on married men aged 21 and older who had female partners of reproductive age and resided in the Musanze District. This demographic was chosen because men in this age group are generally in committed relationships and more likely to be involved in sexual and reproductive activities, making them a suitable population for gathering information on family planning (FP). Participants were recruited during weekly community meetings held every Tuesday in the district. To be included in the study, participants had to provide voluntary consent, be married men aged 21 or older with a partner within the reproductive age range of 15-49 years, and reside in Musanze District. Exclusion criteria included refusal to participate, inability to communicate or hear, reported infertility, or having a partner outside the reproductive age range.

Sample size determination

The sample size was determined using the Yamane formula for population (Yamane, 1967).

$$n = \frac{N}{1+N.(e)^2}$$

According to the National Institute of Statistics of Rwanda, Musanze district profile (NISR, 2023). The estimated population of males aged 21 and above was 74,801 (NISR), 2023). Since the study population (N) is 74801**,** by using a 95% confidence interval and sampling error of 0.05, the calculation becomes,

n= 74801/1+74801(0.05)^2=397

Where by

N: study population **n:** sample size **e:** sampling error

Therefore, the sample size in this study becomes 397

Sampling procedure

Three out of the 15 sectors in Musanze District, Northern Province, were purposively selected for the study based on the researcher's availability, geographical location, and financial resources. One of these sectors was urban, while the other two were rural, each with distinct socio-demographic characteristics. The study included 397 men aged 21 or older who met the criteria. Participants were selected using simple random sampling, a probability technique that ensures everyone in the population had an equal chance of being chosen. This approach provided a representative sample, facilitating reliable conclusions and statistical inferences. Each married man was assigned a unique identifier (ID) number during data collection. The statistical software R, equipped with a random number generator, was used to select numbers within the range of the total study participants. This process ensured equal opportunity for inclusion in the sample. The randomly generated numbers were matched with the assigned unique identifiers, and those corresponding to the selected numbers were included in the sample**.**

Study variables and measurements

The primary outcome variable is male involvement in FP services utilization (high or low involvement). The predictor variables are sociodemographic-related aspects such as men's age, education level, religion, occupation, marital status, and the number of living children. Level of Male involvement in FP was computed from the following six "Yes" or "No" questions: men's use of FP methods, accompanying partner to FP facility, discussing with a partner on FP issues,

approving partner's use of FP, providing support to partner to access FP services, and encouraging the use of FP to partner. Based on the summative score of the question designed to determine male involvement through spousal communication and approval, men with scores 0-3 were considered as having low participation in FP and 4-6 as high involvement. This scoring level was derived from researchers (Manortey & Missah, 2020; Wondim et al., 2020).

Data collection procedure

A questionnaire adopted from previous research (Amuzie et al., 2022; Fedrick, Mkingule, Mtae, & Kigadye, 2019) was used to collect data from respondents. The questionnaire was primarily in English and also translated into Kinyarwanda. It included both closed and semi-closed questions designed to achieve two main objectives: (1) to assess the current level of male involvement in FP services utilization in Musanze District, Northern Rwanda, and (2) to identify the Sociodemographic factors associated with male involvement in family planning services utilization in Musanze district, Northern Rwanda. The questionnaire's sections provided quantifiable data to evaluate male participation in FP services and to investigate the Sociodemographic factors associated with male involvement in family planning services.

Reliability of the Instruments of the Study

The reliability of an instrument refers to its ability to consistently produce the same results when used multiple times in the same situation (Taherdoost, 2016). This means that the measurements of similar individuals under the same conditions should be consistent in the research. To ensure reliability, researchers conduct a pre-test by distributing 10% of the questionnaires to target respondents. This pre-test identifies and removes any ambiguities or unnecessary items from the questionnaire.

Validity of the Instruments of the Study

Validity refers to how accurately a research instrument measures what it is intended to measure (Taherdoost, 2016). Researchers gather feedback from academicians and supervisors to review the instrument, addressing potential confusion and aligning it with research objectives to ensure validity. A pilot study in the Kinigi sector, similar to the selected respondent sectors, tested sampling feasibility, tool suitability, and survey question clarity. Adjustments based on the pilot study enhanced the methodology. Respondents from the pilot study were excluded from the primary investigation.

Data analysis

The analysis was performed using Stata software version 18. Descriptive statistics using frequency tables were used for categorical data, while mean and standard deviation were used to summarize numerical data. Multivariable logistic regression analysis was applied to identify sociodemographic factors associated with male involvement in family planning. Odds ratios with 95% confidence intervals were reported, and a p-value less than 0.05 was considered statistically significant.

Ethical consideration

The study adhered to the principles outlined in the Declaration of Mount Kenya University. Initially, ethical approval was obtained from Mount Kenya University's ethical review committee (Reference number: MKU 04/PGS&R/0927/2023). After getting permission to collect data from the Musanze district administration and local leaders, the detailed objectives of the study were communicated to all participants, and written informed consent was obtained from each individual. All data collected from respondents were treated confidentially, with no names recorded on the questionnaire, and stored securely with password protection on a computer.

Results

Demographic Characteristics of Respondents

The study's respondents had an average age of 38.1 years (SD=7.8). The largest group was aged 32-42 (44.84%), followed by 27.5% in the 43-53 range. Additionally, 24% were aged 21-31, and 3.8% were 54-64. In terms of education, 46% had secondary education, 30% had primary education, 12% attended university, and 11% had no formal education. Religiously, 47% were Catholic, 26% belonged to other Christian denominations, 20.6% were Adventist, and 6.05% were Muslim. Regarding marital status, 57% were in informal marriages, and 42.5% were legally married. In employment, 51.4% were employed, and 48.6% were unemployed. Most respondents (93.4%) had 0-5 children, while 6.5% had 6-10. Detailed sociodemographic data is in Table 1.

Table 1: Sociodemographic characteristics of the respondents

Variables	Frequency (n=397)	Percent (%)
Age group		
21-31	95	23.93
32-42	178	44.84
43-53	109	27.46
54-64	15	3.78
Education		
No education	44	11.08
Primary	122	30.73
Secondary	183	46.10
University	48	12.09
Religion		
Other	103	25.94
Catholic	188	47.36
Adventist	82	20.65
Muslim	24	6.05
Marital status		
Married illegally	228	57.43
Married legally	169	42.57
Employment status		
Employed	193	48.61
unemployed	204	51.39
Number of living children		
0-5	371	93.45
6-10	26	6.55

Level of Male Involvement in FP Services Utilization

Results in Table 2 show that male involvement in FP services utilization in Musanze District was 36.70%, indicating that male involvement in FP is relatively low.

Male involvement	Freq.	Percent
Low	251	63.22
High	146	36.78

Total	397	100.00

Table 2: level of male involvement in FP services utilization

Sociodemographic factors associated with male involvement in family planning services utilization

Table 3 describes a bivariate analysis of the sociodemographic characteristics of respondents and male involvement in FP.

Variables	Male Involvement in Family Planning		Chi-square	P-value
	Low	High		
Age group				
21-31	77	18		
32-42	105	73	17.46	0.0006
43-53	61	48		
54-64	8	7		
Education				
No education	24	20	12.94	0.0048
Primary	87	35		
Secondary	119	64		
University	21	27		
Religion				
Other	63	40	8.90	0.0306
Catholic	116	72		
Adventist	50	32		
Muslim	22	2		
Marital status				
Married illegally	157	94	7.32	0.0068
Married legally	71	75		
Employment status				
Employed	136	115	8.47	0.0036
unemployed	57	89		
Number of living children				
0-5	231	20	2.25	0.1340
6-10	140	6		

Key: Statistically significant difference means (P<0.005)
Source: Primary Data, 2024

Analysis of socio-demographic factors influencing male involvement in family planning (FP) services reveals key trends. Men aged 32-42 are the most involved, while younger men (21-31) show less engagement. Higher education levels are linked to greater participation, with those having secondary education most engaged. Catholics are more involved than Muslims. Men in informal marriages are more likely to participate than those in formal marriages. Employed men are also more likely to engage in FP services compared to unemployed men. However, the number of children does not significantly affect FP involvement. These findings suggest that interventions should target younger men, those with lower education, and specific religious or marital groups to boost male participation in family planning.

Multivariable analysis

The most substantial contributing factor to male involvement in family planning (FP) is the age group, with an odds ratio (OR) of 6.199. This indicates that respondents in the 54-64 age group are six times more likely to have high involvement in FP than those in the 21-31 age group (OR=6.199, 95% CI: 1.727-22.251). Furthermore, employment status has a positive association with male involvement in FP. Employed respondents were twice as likely to exhibit higher involvement in FP

than unemployed individuals (OR=2, 95% CI: 1.24-3.224). Lastly, education level has shown a significant statistical association with male involvement in FP (OR=0.331, 95% CI: 0.147-0.745). To summarize, age, employment status, and education are sociodemographic factors contributing to an increased probability of male involvement in FP services in the Musanze district (Table 4).

Table 4: Multivariable analysis of sociodemographic factors associated with male involvement in FP

Variable	Male involvement		P-value	Odds Ratio	Sig
	Low f (%)	High f (%)		AOR (95% CI)	
Age group (years)					
21-31	77(81%)	18(19%)		Ref	
32-42	105(58.99%)	73(41.1%)	<0.001	3.134(1.656-5.934)	***
43-53	61(55.99%)	48(44%)	<0.001	5.201(2.553-10.599)	***
54-64	8(53.33%)	7(46.67%)	0.005	6.199(1.727-22.251)	**
Education					
No education	24(9.56 %)	20(13.7 %)		Ref	
Primary	87(34.66%)	35(23.97 %)	0.008	0.331(0.147-0.745)	*
Secondary	111(47.4 %)	64(43.8 %)	0.075	0.495(0.229-1.072)	
University	21 (8.37 %)	27(18.4 %)	0.894	0.937(0.362-2.426)	
Religion					
Other	63 (25.1%)	40(27.4%)		Ref	
Catholic	116(46.2%)	72(49.32%)	0.711	0.902(0.522-1.558)	
Adventist	50(19.9%)	32(21.92%)	0.996	1.002(0.514-1.953)	
Muslim	22(8.76%)	2(1.37%)	0.086	0.226(0.041-1.237)	
Marital status					
Married illegally	157(62.55%)	71(48.63%)		Ref	
Married legally	94(37.45%)	75(51.37%)	0.565	1.148(0.716-1.841)	
Employment status					
Employed	115(45.18%)	89(60.96%)	0.004	2(1.24-3.224)	**
Unemployed	136(54.18%)	57(39.04%)		Ref	
Number of living children					
0-5	231(92.0%)	140(95.89%)		Ref	
6-10	20 (7.97%)	6(4.11%)	0.11	0.42(0.145-1.217)	

Significance: *** p<0.001, ** p=0.01, * p<0.05. Ref: Reference

Discussion

Current level of male involvement in FP services utilization

The findings indicated that male involvement in FP in Musanze district is low (36.78%). This finding is consistent with previous studies conducted in Ethiopia, where a similar percentage (39.9%) of low level of male involvement in FP services utilization was observed (Kassa et al., 2022) and Bangladesh (40%) (Bishwajit et al., 2017) indicating a comparable level of male involvement in FP. However, it contrasts sharply with the more recent surveys reporting lower rates, such as 17.5% in Tanzania (Fedrick, Mkingule, Mtae, & Emmanuel, 2019); 12.5% in Ethiopia (Wondim et al., 2020); 17% in the Democratic Republic of Congo (MacQuarrie1 et al., 2015) and 8% in Indonesia (Utomo et al., 2021). In Indonesia, there is a widely held belief that FP is mainly women's responsibility. The focus of national FP programs on women further reinforces this perception. Furthermore, the significant differences in the use of FP services throughout these countries are partly explained by factors such as place of residence, region, and socioeconomic status. Another potential factor contributing to these differences could be the variations in population characteristics and sample sizes.

Sociodemographic Factors Associated with male Involvement in FP services utilization

The study revealed that respondents had an average age of 38.1 years (SD ± 7.8). It highlighted that sociodemographic characteristics significantly influence male involvement in FP services in Musanze District. Men aged 54-64 demonstrated notably higher involvement in FP than other age

groups. Moreover, education level was significantly associated with FP engagement, with higher education correlating with greater participation. Employment status also played a crucial role, as employed men were more likely to participate actively in FP services than their unemployed counterparts.

The study demonstrated that the level of education significantly influences male involvement in FP, with findings aligning well with a study conducted in Mozambique. Specifically, the study found that the higher educational status of husbands was positively associated with increased male involvement in FP, with a p-value of < 0.0048. Educated men are likelier to have better family planning knowledge, encouraging participation. This observation is consistent with research by Agadjaniana et al. (2017), which also reported a significant association between educational level and FP utilization (Agadjanian, 2015).

A study conducted in Nigeria in 2016 also reported that education level influences male involvement in reproductive health care services. It found that men with secondary education or higher were more likely to engage in reproductive health services compared to those with no formal education. Educated men generally possessed more excellent knowledge of contraception, which contributed to increased involvement in family planning and reproductive health (Ani et al., 2016).

It was observed that age is strongly associated with male involvement in family planning (FP). The study found that as men age, their participation in FP increases. This finding contrasts with a survey conducted in Kenya, which reported that male participation in FP decreased with age. In Kenya, the highest levels of involvement were among men aged 20-24 years, while older men showed the lowest levels of participation (Ameso Ruth, 2019). Another study revealed that many men in their mid-30s require FP services. The study reported that 40% of men aged 35-39 had a high awareness of reproductive health compared to other age groups, and the majority of men (80%) aged 35-44 expressed no desire to have children in the future (Casey et al., 2016).

Similarly, employment status significantly correlates with male family planning (FP) involvement. Employed men had twice the odds of participating in FP compared to their unemployed counterparts (OR=2, 95% CI: 1.24-3.224). This association between occupation and FP utilization is consistent with findings from Ling (2017), which also reported a significant link between employment status and FP use (Bougangue & Ling, 2017).

Several studies have highlighted a correlation between men's employment status and family planning (FP) engagement. For instance, a study conducted in India found that 54.5% of male professionals were receptive to contraception. In contrast, contraceptive use among women varied significantly by socioeconomic status, with 78.1% of women from higher social classes using contraceptives, compared to only 29.2% among women from lower social classes. This disparity underscores the notion that improved socioeconomic status is associated with higher utilization of contraceptives (Vijayasree, 2017). This study also aligns with the survey conducted in Nigeria, which identified employment status as one of the factors influencing male involvement in FP. Furthermore, it found that men whose spouses are employed are more likely to participate in FP services compared to those whose spouses are unemployed (Amuzie et al., 2022).

Limitations of the study

This study aimed to document the current male involvement level in FP and identify potential sociodemographic factors affecting their participation in FP within Musanze District, Northern Rwanda. Despite its contribution, the study's limitation lies in its focus on one district, limiting generalizability. Future research recommendations should include nationwide studies.

Conclusion

From the present study, it can be concluded that male involvement in FP services utilization in the Musanze district was low (36.7%). Men's age predicted male involvement in FP services utilization in the Musanze district, level of education and employment status. It is, therefore, essential to

organize educational campaigns on the awareness of FP services and address factors like age, education, and employment status. Developing strategies to improve them is crucial for promoting FP utilization and improving maternal health.

Authors' Contributions

This work was carried out in collaboration between all authors. ENM and CN participated in conceiving the study and developing data collection tools. ENM carried out data collection and designed the manuscript. CN participated in the data analysis and manuscript draft. All authors read and approved the final manuscript.

Funding

There is no funding to report.

Conflicts of Interest

All authors declare no conflict of interest.

References

Agadjanian, V. (2015). Bridging user and provider perspectives: Family planning access and utilization in rural Mozambique. *International Journal of Gynecology & Obstetrics*, *130*(S3). https://doi.org/10.1016/j.ijgo.2015.03.019

Ameso Ruth, A. (2019). *Nyango, A. R. (2019). Male involvement in contraceptive uptake among urban Somali Refugees in Nairobi County, Kenya (Issue April). - Google Search*.

Amuzie, C. I., Nwamoh, U. N., Ukegbu, A., Umeokonkwo, C. D., Azuogu, B. N., Agbo, U. O., & Balogun, M. S. (2022). Determinants of male involvement in family planning services in Abia State, Southeast Nigeria. *Contraception and Reproductive Medicine*, *7*(1), 15. https://doi.org/10.1186/s40834-022-00182-z

Ani, F., Abiodun, O., Sotunsa, J., Faturoti, O., Imaralu, J., & Olaleye, A. (2016). Demographic factors related to male involvement in reproductive health care services in Nigeria. *The European Journal of Contraception & Reproductive Health Care*, *21*(1), 57–67. https://doi.org/10.3109/13625187.2015.1036856

Bagenda, F., Batwala, V., Orach, C. G., Nabiwemba, E., & Atuyambe, L. (2021). Benefits of and Barriers to Male Involvement in Maternal Health Care in Ibanda District, Southwestern, Uganda. *Open Journal of Preventive Medicine*, *11*(12), 411–424. https://doi.org/10.4236/ojpm.2021.1112032

Bishwajit, G., Tang, S., Yaya, S., Ide, S., Fu, H., Wang, M., He, Z., Da, F., & Feng, Z. (2017). Factors associated with male involvement in reproductive care in Bangladesh. *BMC Public Health*, *17*(1), 3. https://doi.org/10.1186/s12889-016-3915-y

Bougangue, B., & Ling, H. K. (2017). Male involvement in maternal healthcare through Community Health Planning and Services: The views of the men in rural Ghana. *BMC Public Health*, *17*(1), 693. https://doi.org/10.1186/s12889-017-4680-2

Butto, D., & Mburu, S. (2015). Factors Associated with Male Involvement in Family Planning in West Pokot County, Kenya. *Universal Journal of Public Health*, *3*(4), 160–168. https://doi.org/10.13189/ujph.2015.030404

Casey, F. E., Sonenstein, F. L., Astone, N. M., Pleck, J. H., Dariotis, J. K., & Marcell, A. V. (2016). Family Planning and Preconception Health Among Men in Their Mid-30s: Developing Indicators and Describing Need. *American Journal of Men's Health*, *10*(1), 59–67. https://doi.org/10.1177/1557988314556670

Fedrick, F., Mkingule, L., Mtae, H., & Emmanuel, P. (2019). *Factors Influencing Male Involvement in the Utilization of Family Planning in Chato District, Geita Region Tanzania*. 121–139.

Fedrick, F., Mkingule, L., Mtae, H., & Kigadye, E. (2019). *Services Related Barriers for Male Involvement in Utilization of Family Planning in Chato District Tanzania*. *26*.

Karamage, E. (2016). *Men Engagement in Maternal and Child Health Care services in Musanze district.*

Kassa, B. G., Tenaw, L. A., Ayele, A. D., & Tiruneh, G. A. (2022a). Prevalence and determinants of the involvement of married men in family planning services in Ethiopia: A systematic review and meta-analysis. *Women's Health*, *18*, 174550572210990. https://doi.org/10.1177/17455057221099083

Kassa, B. G., Tenaw, L. A., Ayele, A. D., & Tiruneh, G. A. (2022b). *Prevalence and determinants of the involvement of married men in family planning services in Ethiopia: A systematic review and meta-analysis*. https://doi.org/10.1177/17455057221099083

Kraft, J. M., Serbanescu, F., Schmitz, M. M., Mwanshemele, Y., Ruiz C., A. G., Maro, G., & Chaote, P. (2022). Factors Associated with Contraceptive Use in Sub-Saharan Africa. *Journal of Women's Health*, *31*(3), 447–457. https://doi.org/10.1089/jwh.2020.8984

Kwawukume, S. A. K., Laar, A. S., & Abdulai, T. (2022). Assessment of men's involvement in family planning services use and associated factors in rural Ghana. *Archives of Public Health = Archives Belges De Sante Publique*, *80*(1), 63. https://doi.org/10.1186/s13690-022-00822-5

MacQuarrie1, K. L. D., Edmeades2, J., Steinhaus2, M., & Head3, S. K. (2015). Men and Contraception: Trends in Attitudes and Use. *DHS Analytical Studies No. 49*, *September*, 1–118.

Manortey, S., & Missah, K. (2020). Determinants of Male Involvement in Family Planning Services: A Case Study in the Tema Metropolis, Ghana. *OALib*, *07*(01), 1–21. https://doi.org/10.4236/oalib.1106043

Muheirwe, F., & Nuhu, S. (2019). Men's participation in maternal and child health care in Western Uganda: Perspectives from the community. *BMC Public Health*, *19*(1), 1048. https://doi.org/10.1186/s12889-019-7371-3

Mulatu, T., Sintayehu, Y., Dessie, Y., & Dheresa, M. (2022). Male involvement in family planning use and associated factors among married men in rural Eastern Ethiopia. *SAGE Open Medicine*, *10*, 205031212210941. https://doi.org/10.1177/20503121221094178

National Institute of Statistics of Rwanda, Rwanda, & DHS Program (Eds.). (2016). *Rwanda Demographic and Health Survey, 2014-15: Final report*. National Institute of Statistics of Rwanda, Ministry of Finance and Economic Planning : Ministry of Health ; The DHS Program, ICF International.

Ndayishimiye, C. (2022). Women's Perceptions and Attitudes toward Family Planning and Its Barriers in Poor Rural Settings: Advancing Rwanda's Family Planning Policy. In Dr. S. Donmez (Ed.), *New Horizons in Medicine and Medical Research Vol. 7* (pp. 1–11). Book Publisher International (a part of SCIENCEDOMAIN International). https://doi.org/10.9734/bpi/nhmmr/v7/2131A

NISR. (2006). *RWANDA DEMOGRAPHIC AND HEALTH SURVEY 20005-2006—Google Search*. ww.nisr.rw

NISR. (2020). *National Institute of Statistics of Rwanda, Rwanda Demographic and Health Survey 2019-20 Key Indicators Report*. https://www.statistics.gov.rw/publication/demographic-and-health-survey-20192020-key-indicators

(NISR), N. I. of S. of R. (2023). *National Institute of Statistics of Rwanda (NISR); The Fifth Rwanda Population and Housing Census, District Profile: Musanze, September 2023*. *September 2023*, 1–132.

Nkwonta & Messias. (2019). Male Participation in Reproductive Health Interventions in Sub-Saharan Africa: A Scoping Review. *International Perspectives on Sexual and Reproductive Health*, *45*, 71. https://doi.org/10.1363/45e8119

Taherdoost, H. (2016). Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3205040

Tamiso, A., Tassew, A., Bekele, H., Zemede, Z., & Dulla, A. (2016). Barriers to Males Involvement in Family Planning Services in Arba Minch Town, Southern Ethiopia: Qualitative Case Study. *International Journal of Public Health Science (IJPHS)*, *5*(1), 46. https://doi.org/10.11591/ijphs.v5i1.4762

Titiyos, A., Mehretie, Y., Alemayehu, Y. K., Ejigu, Y., Yitbarek, K., Abraham, Z., O'Connell, K. A., & Kassaw, J. (2023). Family planning integration in Ethiopia's primary health care system: A qualitative study on opportunities, challenges, and best practices. *Reproductive Health*, *20*(1), 176. https://doi.org/10.1186/s12978-023-01709-6

UNFPA. (2022). UNFPA Strategy for Family Planning, 2022-2030: Expanding Choices – Ensuring Rights in a Diverse and Changing World. *Laser Focus World*, *39*(11), 60.

Utomo, B., Hariyanti, H., Prasetyo, S., Magnani, R., & Rahayu, S. (2021). Contraceptive Use Dropout-adjusted Unmet Need for Family Planning. *F1000Research*, *10*, 780. https://doi.org/10.12688/f1000research.54823.1

Vijayasree, L. (2017). A study on the influence of education and occupation on family planning practices in rural Shamirpet, R.R. District, T.S., India. *International Journal of Bioassays*, *6*(11), 5525. https://doi.org/10.21746/ijbio.2017.6.11.1

Wambete, S. N., Baru, A., Serwaa, D., Dzantor, E. K., Poku-Agyemang, E., Kukeba, M. W., & Olayemi, O. O. (2022). *The attitude of reproductive age women towards male involvement in family planning; a community-based cross-sectional study in Nakawa Division, Kampala, Uganda*. https://doi.org/10.1101/2022.07.14.22277630

Wondim, G., Degu, G., Teka, Y., & Diress, G. (2020a). Male Involvement in Family Planning Utilization and Associated Factors in Womberma District, Northern Ethiopia: Community-Based Cross-Sectional Study. *Open Access Journal of Contraception*, *Volume 11*, 197–207. https://doi.org/10.2147/oajc.s287159

Wondim, G., Degu, G., Teka, Y., & Diress, G. (2020b). Male Involvement in Family Planning Utilization and Associated Factors in Womberma District, Northern Ethiopia: Community-Based Cross-Sectional Study. *Open Access Journal of Contraception*, *Volume 11*, 197–207. https://doi.org/10.2147/OAJC.S287159

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.11

Effectiveness of knowledge sources in acquiring mental health knowledge among adults in Tanzania

Fransiska Josephat Mruma[*], *Emmanuel Mkhai, Mohammed Kassim*

Information Studies, University of Dar es Salaam

Abstract

Background: Mental health knowledge plays a crucial role in individuals' decision-making processes regarding their mental health. Therefore, it is important that the sources of this knowledge function effectively to ensure that this resource is readily available.

Objectives: This study aims to investigate the effectiveness of mental health knowledge sources, particularly those used by adults in two selected cities in Tanzania. Specifically, the study seeks to identify the sources from which adults acquire mental health knowledge and examine the effectiveness of these sources.

Methods: This study employed a cross-sectional descriptive research design. Data were collected using questionnaires, focus group discussions, and interviews. Thematic analysis was used to analyze qualitative data, while descriptive statistics were applied to the quantitative data using IBM SPSS version 25.

Results: Adults acquire mental health knowledge from various sources, with radio and informal sources such as family, friends, and relatives being the most commonly used. The findings further indicate that although radio is the most frequently used source, it is ineffective in providing mental health knowledge because it does not consistently deliver the information in appropriate quantities or regularly.

Conclusion: Relying on informal and largely ineffective sources, such as friends and family, presents a challenge. Formal knowledge sources are essential to enhance the delivery of accurate and relevant mental health information.

Keywords: knowledge sources, mental health, knowledge, adults, Tanzania.

Introduction

Mental health is the state of well-being in which an individual realizes his/ her abilities, such as the ability to: cope with life challenges, work productively, and contribute to their community. This makes mental health an integral part of the overall health of human beings (WHO, 2004). More specifically, mental health is a crucial part of our wellbeing because without it, there is no health (WHO, 2017). The value of mental health is noticeable at individual, community, and wider society levels (Kousoulis, 2019; Srivastava et al., 2018). One of the values of this component of human health is its ability to help people to cope with the stress of life because when mental health is stable, other aspects of life function optimally (Lamasigi et al., 2021).

However, despite the availability of knowledge on the importance of this health, mental health problems continue to be a great challenge for global health systems. This is evident in the number of people that are reportedly affected by this problem. Available data show that more than 1 billion people have been reported to have mental health problems globally (World Health Organization [WH], 2021). In Africa, particularly in Tanzania, more than seven (7) million people have been reported to have different mental health problems (Ministry of Health [MoH], 2023). Although they can affect

[*] **Corresponding Author:** Fransiska Josephat Mruma; Email: fmruma1988@gmail.com

anyone, various scholars (e.g. MoH, 2022; Kyumana, 2022; Mwambingu et al., 2019; Daniel et al., 2018; Kutcher, 2017) have reported that mental health problems are more prevalent among adults who live in cities. In addition to this, another interesting or concerning pattern associated with this problem is its rapid increase, which has been recorded in recent years (See MoH, 2023).

The prevalence of this problem appears to have compelled Tanzania to join the ongoing efforts (initiatives and strategies) to fight it. For example, through its ministry of health, the government of Tanzania has demonstrated its commitment to reducing mental health problems. One sign of this commitment was the government's decision to join the race to reduce mental health problems as part of the achievement of global Sustainable Development Goals (SDGs), particularly goal 3 (targets number 4 and 5) which aims to reduce deaths caused by non-communicable diseases by improving mental health and general wellbeing. As part of the efforts to meet these two targets, Tanzania has initiated various mental health literacy programs that aim to enhance people's understanding and awareness of mental health problems by 2030 (United Nation [UN], 2021).

Tanzania has also made various other efforts. These include the development of the Mental Health Guidelines of 2003, which are a key component of the Tanzania National Health Policy; the adoption of the Comprehensive Global Mental Health Action Plan (CMHAP) 2013-2020; and the amendment of the Mental Health Act in 2008. These efforts have partly been made to emphasize the need to ensure that people dealing with mental health problems have access to quality health services, increase their knowledge and that their rights are protected (WHO, 2010; Kyumana, 2022).

However, despite the just-mentioned efforts, mental health problems continue to be prevalent in the country (e.g. Kyumana, 2022; Mwambingu et al., 2019; Daniel et al., 2018). This state has been attributed to various factors, including a lack of ability to determine the credibility of mental health knowledge sources among communities (WHO, 2019; Knuk et al.., 2018; Seedat et al., 2013).

The knowledge sources used by adults play a great role in the quality and quantity of knowledge that this population group possesses. This is because what people consume, in terms of knowledge determines their ability to handle the problems that face them (Razak, 2020). Conversely put, the sources of mental health knowledge that people use determine how they handle mental health problems. As such, adults that interact with relevant and credible mental health knowledge sources are more likely to be more knowledgeable about the problem, empowered to handle it, and capable of understanding the importance of mental health to their society.

Despite the availability of studies conducted in Tanzania on mental health knowledge, such as those by Kyumana (2022), Mwambingu et al. (2019), Daniel et al. (2018), and Kutcher (2017), the sources used by adults to obtain this knowledge generally remain unknown. Therefore, although the rising prevalence of mental health problems has been linked to lack of knowledge, which has been linked to people's interaction with poor knowledge sources, little can be done to correct the situation unless more research is carried out on the subject.

It is against this background that this study was carried out to investigate the knowledge sources used by adults to acquire mental health knowledge in Tanzania. Specifically, the study aimed to identify the types of sources from which adults acquire mental health knowledge and examine their effectiveness. Doing so was considered important in the establishment of strategies to enhance the accessibility of mental health knowledge in Tanzania and beyond.

Literature Review

A well-informed adult is better positioned to deal with mental health problems when they occur (Dhawan & Kaushik, 2019). Such adults are capable of remaining mentally healthy or avoid mental health problems (WHO, 2019). As stated in the previous section, this is what makes mental health knowledge an important facet of the efforts made against mental health problems. However, as also

pointed out in the introduction section, for this knowledge to have an effect, it has to be relevant and comprehensive.

This knowledge can be acquired from various sources. These can fall under the following categories: traditional (e.g., radio, televisions, newspapers, and magazines), informal (e.g., faith healers, friends and relatives), or digital media (e.g., social media platforms like Facebook, WhatsApp, instagram, thread and Telegram) (Brennen et al., 2020; Masele & Daud, 2022). Overall, the usefulness of the knowledge obtained from either of these sources is determined by their credibility, availability, accuracy, and timelines (Rudoliph et al., 2019). Therefore, for adults to maintain their mental health or prevent mental health problems, they have to be able to identify and examine these sources, which exist in many types, as revealed by various scholars (e.g. Alduraywish et al., 2020; Endward, 2019).

Researchers (Brennen, 2020; Garcia et al., 2018) have reported that mass media sources, such as newspapers, television, and radio, have a high impact on mental health because they reach large numbers of people within a short time. In developing regions like Africa, it has been reported that most adults who live in urban areas have access to radio and televisions but lack time to listen to or watch them because of their complicated livelihood routines (Christina et al., 2014; Srivastava, 2018). In the same vein, Berkie and Anbesaw (2021) noted that about 50% of the population that lived in Dessie, Ethiopia, used newspapers and magazines as their predominant sources of mental health knowledge.

In efforts to acquire mental health knowledge, people also interact with online social media platforms such as Instagram, Facebook, WhatsApp, X, Threads and Telegram (Sun et al., 2020). Beck et al. (2014) reported that about 80% of young adults use online health knowledge and consider it reliable. Such a feeling was also shared by different researchers, such as Naslund and Bartel (2016), and Christina et al. (2014), who have reported that people with mental health problems use online information to add knowledge and gain hope. From the mental health knowledge obtained from online sources, people may gain insight into important health care decisions, which could reduce mental health challenges (Garcia et al., 2018).

However, while online sources have the potential of playing a very important role in the fight against mental health problems, especially among adults, problems such as unreliable and slow connections, unreliable power supply, and high internet connection costs limit their influence (Benedict et al., 2017). In the same vein, Sun et al. (2021) add that although people spend more time surfing the internet, it is difficult to get mental health knowledge from internet sources than it is to receive knowledge from their surroundings.

Furthermore, people get mental health knowledge from nurses and other medical practitioners who operate psychosocial programs (Kohort et al., 2018; Newsome &Gladding, 2018). However, these professionals are not available in the right amounts in Africa, and Tanzania, in particular, need to fight mental health issues. More specifically, Tanzania has one mental health professional per 200,000 people (Oliver, 2020). According to Ambikile and Iseselo (2017), this patient-professional imbalance has led mental health workers to believe that their field is being prioritized by responsible health stakeholders.

Effectiveness of Knowledge Sources

The effectiveness of knowledge sources determines the quantity and quality of the knowledge adults can acquire from them (Choudhury et al., 2016). In some cases, the effectiveness of these sources determines their usage rates. For instance, social media knowledge sources have been reported to be less used by the majority of the adults in Saud Arabia than expected (Alduraywish et al., 2020). Untrustworthiness and ineffectiveness are the main reasons that have been connected to this limited use. These reasons have been reported to motivate knowledge seekers to avoid acquiring mental health knowledge from these sources. However, more than half of the population of the

United States uses social media to obtain health knowledge and considers it an effective source (Clarke et al., 2016; Sun et al., 2022). In the same vein, other scholars (Benedict et al., 2017; Garcia et al., 2018) have reported that social media is considered an effective mental health knowledge source, particularly among young adults. However, the media has also been termed as ineffective by those who believe that young adults use too much time interacting with social media platforms even when there is no mental health knowledge.

Besides social media, radio, and television, people (i.e. adults) use print media to acquire mental health knowledge. Newspapers, books, booklets, brochures and magazines are the print media that are commonly used to acquire mental health knowledge (Choudhury et al., 2016). However, these sources are beneficial to communities that have the capability and passion to read. This suggests that these sources are unlikely to benefit the majority of African communities because of the prevalence of poor reading culture among them (Otache, 2020; Wema, 2018).

Materials and Methods

This study applied a cross-sectional descriptive research design along a mixed method approach to investigate the sources used by adults to acquire mental health knowledge. The study was conducted in two cities, namely Dar es Salaam and Dodoma. The study's population comprised adults that were met on these cities' streets and healthcare providers (i.e. psychiatrists and nurses) from Mirembe National Mental Hospital.

The convenience sampling technique was used to select 361 adults who were involved in the study. To get these participants, simple random sampling was used to select representative wards from those in the two cities that hosted the study. To select key informants (psychiatrist and nurses) that were interviewed, the study used purposive sampling. Data collection used questionnaires, interviews, and focus group discussions. The questionnaires were administered by the researcher due to the nature of the livelihood activities of the adults in the two cities.

Adults in city areas are too busy since most of them are business-centered. A total of four focus group discussion (FGD) sessions (two in each city) were held with selected adults. Thematic analysis was used to analyze qualitative data, while descriptive statistics were generated from quantitative data with the aid of the IBM Statistical Product and Services Solution (SPSS) program, version 25. The results of the analyses have been presented in the form of quotations and tables in the next section.

Results

Demographic Characteristics

Demographic characteristics provide background information about the respondents of a study. To obtain these characteristics, the adults who participated in this study were asked to indicate their gender, age, marital status, education, and income levels. Tables 1 summarize the demographic characteristics of the respondents.

Table 1: Distribution of Respondents by their Demographic Characteristics

Category	Frequency	Percentage
Gender		
Male	208	57.6
Female	153	42.4
Age		
18-25	96	26.6
26-33	116	32.1
34-41	62	17.2
42- 49	40	11.1
50- 57	31	8.6
58-65	9	2.5
Marital Status		
Married	184	51
Single	131	36.3
Divorce	12	3.3
Widow/widower	14	3.9
Separated	9	2.5
Cohabitated	11	3
Education		
Never attend to formal education	12	3.3
Primary	127	35.2
Secondary	126	34.9
Certificate	19	5.3
Diploma	34	9.4
Degree	41	11.4
Masters	2	0.6
Income		
Below 50,000	53	14.7
51,000-150,000	109	30.2
151, 000-250,000	67	18.6
251000- 350,000	44	12.2
351000 – 450,000	36	10
Above 450,000	52	14.4

Overall, 361 adults participated in this study. According to the data in Table 1, significant percentages (57.6) of these respondents were males while a moderate percentage (42.4%) of them were females. Moreover, the results show that more than half (58.7%) of the respondents were young adults, while only 11.1% were 50 or more years old. According to the findings, more than half (51%) of the respondents were married, while 36.3% of them were single. The results also show that there were respondents

who were widows/widowers (3.9%), divorced (3.3%), separated (2.5%), and those who cohabitated (3%). On another note, over one-third of the respondents had primary education (35.2%) and secondary education (34.9%). The study further indicates that the majority of its respondents had low incomes.

Types of sources of mental health knowledge

One of the key targets of this study was to establish the types of knowledge sources that adults used to obtain mental health knowledge in the study area. The study targeted this information because understanding the sources used to acquire mental health knowledge helps in determining the availability, accuracy and credibility of the knowledge of the source. For this reason, respondents were asked to indicate the sources from which they acquired mental health knowledge. A summary of what has been found on this is presented in Table 2:

Table 2: Sources used by Adults to Acquire Mental Health Knowledge

Sources	Frequency	Percentage
Friends	229	63.4
Family and Relatives	258	71.8
Psychiatrists	83	23
Religion Leaders	149	41.3
Radio	292	80.9
Television	150	41.6
Mental health Conferences	66	18.3
Seminars and Trainings	99	27.4
Social media	172	47.6
Nurses	102	28.3
Newspapers	129	35.7
Books	108	29.9
Leaflets/brochures	73	20.2
Ward/ street leaders	91	25.2
Magazines	79	21.9

Based on the views of the respondents of this study, various knowledge sources are used to acquire mental health knowledge. However, the results in Table 2 indicate that the majority (80.9%) of adults in the study area acquire mental health knowledge from the radio. The other sources that many adults use are family and relatives (71.8%) and friends (63.4%). The results also indicate that moderate percentages of the adults used social media(47.6%), Television (41.6%), religious leaders (41.3%), and Newspapers (35.7%) as mental health knowledge sources. The sources that were least cited by the adults were books (29.9%), nurses (28.3%), seminars and trainings (27.4%), ward/ street leaders (25.2%), psychiatrists (23%), magazines (21.9%), leaflets/ brochures (20.2%), and mental health conferences (18.3%).

The findings in Table 2 are similar to those that emerged from the analysis of the data collected during focus group discussions and interview sessions. For example, during FGDs, one respondent narrated that:

> *"I usually use the radio when I need to get knowledge on a particular issue concerning health. I usually listen to radio Clouds FM (e.g., the Afyackeck program), which is aired on Tuesdays from 9: 00 am to 10:00 am. This program provides knowledge concerning health in general. So if you are lucky, it happens one day you hear them talking about mental health" (Female, aged 30, diploma holder).*

Another FGD participant was quoted saying:

> *"As we are talking about radio, I heard this even though I don't remember when, but I heard it once. As you know our working environment and the nature of activities, it is easy to listen to radio while sitting here waiting for customers. This is due to fact that, there is a portable radio that I can carry anywhere, but again, I have mobile phones, even if it is not smart phone, I can listen to radio in any type of phone regardless of its type" (Male, aged 31, secondary education).*

This was also confirmed by one of the key informants during an interview session at Mirembe National Mental Hospital. The interviewee said:

> *"Last week, I had sessions on Clouds Media (i.e. Clouds Television and Clouds FM radio) concerning mental health. I was there to educate the society on mental health problems, particularly schizophrenia and depression. Society must understand these mental health problems because they are growing as days are going on. Therefore, when we get a chance, we go to the media to provide knowledge" (Male, 40, PhD holder, psychiatrist).*

These narrations imply that adults acquired mental health knowledge through radio. According to the participants of this study, the explanation of the high usage of radio as a source of mental health knowledge appears to lie in the busy schedules of the adults in the study area. The portability and ubiquitous nature of radio means that people can receive mental health knowledge while engaged in their daily activities. These two characteristics that place radio in the most convenient media category for the surveyed population have been partly attributed, by the participants of this study, to the integration of the media into mobile phones.

Since people carry their mobile phones around, they now also carry and listen to their radio while on the move or performing their daily duties, thereby enhancing their chances of getting mental health knowledge. However, these findings have also indicated that most radio programs provide general health knowledge while mental health is given limited attention. As a result, the participants of this study considered their encounters with mental health knowledge radio programs as accidental. This was confirmed by one of the psychiatrists who were interviewed in this study, who indicated that whenever they get a media opportunity, they take it.

Although radio was the most mentioned knowledge source in this study, the participants of this study appear to rely largely on informal sources for mental health knowledge. These sources were family, relatives and friends. To confirm this, one respondent narrated this during a focus group discussion session:

> *I got mental health knowledge from my family. We also have a family member who has mental health problems. He is a very dangerous person. We never allow him to go outside. So, it is my family who always told me about mental health issues. I have never heard this from any other sources (Female, aged 30, primary education).*

This narration confirms that some adults rely on their families, relatives, and friends for mental health knowledge. According to the data obtained from participants, these sources are important to the surveyed population because they are considered as available. However, the findings of this study also

indicate that this population's reliance on these sources is driven by their lack of knowledge about the availability of formal sources of this knowledge.

According to the findings of this study, nearly half (47.6%) of the adults that took part in this study said that they relied on social media for mental health knowledge. Similar findings were came out of the analysis of the study's qualitative data of this. For example, one of the respondents had this to share during a focus group discussion:

> *I acquire mental health knowledge from social media, particularly Instagram. You know what…, The world has changed to a digital form, and everything is on social media. I usually use my Instagram account to obtain mental health knowledge. I followed different accounts on Instagram which know those mental health issues. For stance, I followed this account called Mental Health Tanzania. Even though it has no vast knowledge, I got some mental health knowledge from that account, and the knowledge is easy to retrieve (Male, aged 24, Degree holder).*

In support of this, another respondent added:

> *Of course, social media have mental health knowledge to some extent. However, note that these are mostly preferred by young adults and those who have a high level of education. This is because it is difficult for older adults to engage with social media like Twitter (X) and Instagram for the sake of acquiring mental health knowledge only. Why? Because they are busy with their work schedules. Besides, they don't have smartphones. Let alone having smartphones, others are not familiar with social media accounts that have mental health knowledge (Male, aged 30, master's holder).*

These findings indicate that social media are preferred by those adults who have high level of education and those in possession of a smartphone. Generally, the study shows that young adults are the ones who are most interested in social media as a mental health knowledge source.

To generate more insights for this study, a cross tabulation of respondents' level of education and the mental health knowledge sources used was performed. The same was done for the variables of age and mental health knowledge sources. The results of these actions are presented in Table 3 and Table 4:

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.11

Table 3: Relationship between Education Level and the Usage of Social Media Sources

		Education level								Chi-Square Tests
Variable		Never attend to formal education	Primary	Secondary	Certificate	Diploma	Bachelor Degree	Masters	Total	Asymp. Sig. (2-sided)
Use of Social media	Yes	3(25%)	38(30%)	62(49%)	11(58%)	23(68%)	33(80%)	2(100%)	172	p*Value=0.000*
	No	9(75%)	89(70%)	64(50%)	8(42%)	11(32%)	8(20%)	0(0%)	189	
Total		12(100%)	127(100%)	126(100%)	19(100%)	34(100%)	41(100%)	2(100%)	361	

Table 4: Relationship between Age of Respondents and the Usage of Social Media Sources

Variables		Respondents Age							Total	**Chi-Square Tests**
		18-25	26-33	34-41	42- 49	50- 57	58-65	Above 65		Asymp. Sig. (2-sided)
Use of Social media	Yes	61(16.8%)	61(16.8%)	32(8.8%)	11(3%)	7(2%)	0(0%)	0(0%)	172(47.6%)	
	No	35(9.7%)	55(15%)	30(8.3%)	29(8%)	24(6.6%)	9(2%)	7(2%)	189(52.4%)	p*Value=0.000*

As the results in Table 3 reveal, all (100%) of the respondents who had master's degrees used social media as a source of mental health knowledge. These were followed by those with bachelor's degree (80%), certificate (58%), and diploma (68%). Moreover, approximately half (49%) of the respondents who had a secondary education said that they used social media to acquire mental health knowledge.

Regarding age, the results in Table 4 reveal a significant variation in age and the use of social media sources (see *p* value =.000). For example, the results disclose that a significant percent (18.6%) of the respondents aged 42 to 65 years or above had not used social media to acquire mental health knowledge. This percentage is huge when compared to the 5% of the same age group that admitted to having used the media to acquire mental health knowledge. Likewise, this finding also show that 42.4% of adults aged between 18 and 41 years used social media to acquire mental health knowledge. This percentage is bigger than the 33% of this age group that said they did not use social media for this purpose.

Perceived Effectiveness of the Sources

Another target of this study was to examine the effectiveness of the sources used adults to acquire mental health knowledge in Tanzania. To achieve this target, the study required its respondents to rate the effectiveness of their mental health knowledge sources by using the following Likert scales (1. = Not at all effective, 2. = Slightly effective, 3. = Moderately effective, 4. = Very effective, 5. = Extremely effective). What the study has found on this subject has been summarized in Table 5:

Table 5: Effectiveness of the Sources Used to Acquire Mental Health Knowledge

Sources	Not effective at all	Slightly effective	Moderately effective	Very effective	Extremely effective
Radio	52(14.4%)	205(57%)	54(15%)	30(8.3%)	20(5.5%)
Television	207(57.3%)	80(22.2%)	44(12.2%)	30(8.3%)	0(0%)
NGOs mental health Specialist workers	63(17.5%)	98(27.1%)	75(20.8%)	59(16.3%)	66(18.3%)
Religious institutions	151(42%)	136(36.6%)	25(6.9%)	29(8.1%)	20(5.5%)
Newspapers and Magazines	284(78.7%)	54(15%)	20(5.5%)	3(0.8%)	0(0%)
Social media	220(61%)	69(19.1%)	40(11%)	20(5.5%)	12(3.3%)
Websites	265(73.4%)	40(11.1%)	24(6.6%)	20(5.5%)	12(3.3%)
Health workers	88(24%)	214(59.3%)	33(9.1%)	26(7%)	0(0%)
Training and seminars	211(58.4%)	72(19.9%)	30(8.3%)	28(7.8%)	20(5.5%)
Counselling services centers	204(56.5%)	76(21.1%)	31(8.6%)	21(5.8%)	29(8.1%)
Brochures	254(70.4)	67(18.6%)	40(11.1%)	0(0%)	0(0%)
Ward leaders	263(73%)	46(12.7%)	30(8.3%)	12(3.3%)	10(2.8%)

The results achieved on this subject (see Table 5) indicate that respondents have rated the various sources they used to acquire mental health knowledge as not effective. More specifically, the majority of the respondents reported that newspapers and magazines (78.9%), websites (73.4%), ward leaders (73%), brochures (70.4%), and social media (61%) are not effective at all in facilitating the acquisition of mental health knowledge. Besides, more than half of the respondents reported that sources such as televisions (57.3%), training and seminars (58.4%), and counseling service centers (56.5%) are also not effective at all.

Furthermore, the study shows that FGDs presented various views on the effectiveness of the sources used by adults to acquire mental health knowledge. For example, speaking on this subject, one FGD participant shared this:

The sources that are needed to provide mental health knowledge in a real sense are not effective. This is because they don't provide enough knowledge concerning mental health. Besides, health care workers, particularly psychiatrists and nurses, try their level best to provide mental health knowledge to adults, but this happens only when you go to the hospital looking for help or when you have a patient with mental health problems. This is because they are also few. On this, sometimes it becomes too late to correct the mental state of the person taken to hospital (Male, aged 38, diploma holder).

While this participant confirms this study's quantitative findings on the effectiveness of mental health sources, this quotation also indicates that some or a few sources are effective. More specifically, this quotation highlights the source of healthcare workers' ineffectiveness, which is their presence in small numbers and their focus on dealing with patients taken to their service centers. According to this participant, this is a reactive approach that creates room for some mental health issues to get to irreversible stages. This challenge was confirmed during interviews. For instance, one of the psychiatrists who were interviewed said:

Even though we are few, we try our level best to provide mental health knowledge to adults. The problem of mental health now is very high. Imagine here we have 500+ patients with mental illness, let alone who have mental health problems. And I tell you, many people who have mental health problems are in streets, they have mental health problems and not mental illness. So when they reach the mental illness stage, they come to the hospital. So we provide mental health knowledge when we have ample time since we also need to deal with patients who come to the hospital. (Male, aged 38, Master's degree holder, Psychiatrist)

This response confirms that healthcare workers' ineffectiveness in providing mental health knowledge to adults is mainly due to their insufficiency. This appears to compel them to work with those whose problems have advanced to illnesses instead of meeting the knowledge needs of the many that are dealing with many that have mental health problems. This approach leaves a lot of people not knowledgeable about their problems.

The qualitative findings have also indicated that the approach taken by some knowledge providers makes them ineffective. For example, one FGDs participant spoke about the knowledge sources as follows:

> I don't know how to say it, but what I know and see is that most of the sources particularly televisions or social media, report events that have already happened rather than providing mental health knowledge to adults. It is normal to hear from different channels that a certain person tried to kill himself or a certain person threw himself on the ground and died. That is usually what was reported by media (Female, aged 30, degree holder).

Another respondent added the following during FGDs on the effectiveness of radio, newspapers and televisions:

> *Most of the radio and televisions report the bad scenarios caused by mental health problems rather than providing mental health knowledge which can be acquired by adults. For example, that bad scenario is like reporting that somebody was harmed by a person who is thought to have mental health problems. Moreover, it is normal to hear radio playing music especially amapiano rather than providing mental health knowledge to adults (Female, aged 30, degree holder).*

Similarly, other respondents highlighted knowledge sources' failure to provide mental health knowledge as follows:

> *It is challenging when you need to acquire mental health knowledge because the knowledge found in various sources is not related to mental health. Most of the health knowledge found in our sources is knowledge for HIV/AIDS or Tuberculosis, it is rare to find mental health knowledge in those sources. This affects some adults and others despair because the mental health knowledge is hard to find compared to other health knowledge as mentioned earlier (Female, aged 30, diploma holder).*

According to these quotations, knowledge sources have put less emphasis on providing metal health knowledge, and when they do, the contents of their knowledge is not educative. Based on these quotations, it can be noted that the participants feel that the approach taken by knowledge sources only amplifies their fears about mental health problems instead of equipping them with the capacity to respond. In addition, the participants appear to feel that mental health problems are not prioritized by health knowledge providers. This is noticeable in the last respondents' quotation that indicates that it is easy to get knowledge on other diseases than it is for mental health problems.

Discussion

This study has investigated the sources used by adults to acquire mental health knowledge in Tanzania. One of the key findings of this study is that the majority of adults use radio to acquire mental health knowledge. This finding corroborates those reported in a study by Ikpeama et al. (2024), which revealed that radio has been used as a credible source of mental health knowledge, particularly in South-East Nigeria due to its vast coverage of the subject (including causes, symptoms, and treatment of mental problems). Despite being used by the majority of adults in the study area to acquire mental health knowledge, radio has been criticized for providing general mental health knowledge.

Lack of specifity in the mental health knowledge provided through radio was also reported by Julia and Nabushawo (2021). However, this researcher also noted that although most adults living in urban areas can access knowledge from radio, fears of wasting time due to this source's limited provision of this knowledge deters its use. This finding also aligns this study with the current one because both of them have found that although radio is the most used source of mental health knowledge, knowledge seekers find it less useful due to the limited knowledge it provides on the subject.

The study has also found that adults still rely on informal knowledge sources to meet their mental health knowledge. Sources such as family, friends and relatives are considered relevant and trustworthy by most adults in the study area. However, these people's reliance on these sources is unlikely to substantially improve their mental health knowledge. This argument follows an observation made by Sun et al. (2020), who reported that informal sources of knowledge usually lack accuracy hence they cannot be trusted.

Additionally, social media platforms such as Instagram and Twitter are used as a source of mental health knowledge by most of this study's respondents. This demonstrates the role played, in mental health knowledge dissemination, by the advancements made in the sector of digital technologies. However, the findings have also shown that young adults and people with high levels of education are the ones that mainly use these sources. These users have noted that the ease of access to these sources and their usefulness are the factors that promote their use. These findings concur with those reported in a study that was carried out in Uganda by Kilumuro et al. (2022). These researchers observed that most adults acquired health knowledge from social media sources. In terms of the relationship between age and the use of social media to acquire mental health information, the current study corroborates findings reported by Chen and Wang's (2021) study. According to these

researchers, although social media seem to be valuable sources of health knowledge, they are usually not preferred like traditional sources such as radio and televisions by adults. Unlike the current study that has found that young adults prefer these media because they find them reliable, other researchers (see for example, Koehler & Rose, 2020; Luca et al., 2022) argue that although they are health knowledge avenues, particularly for young adults, social media negatively affect mental health if constantly used or misused. On this, Bandara and Hettiwaththege (2023) opine that without proper guidelines for acquiring mental health knowledge on social media, adults may experience anxiety, anti-social behavior, depression, and emotion suppression. This is possible because some social media accounts report mental illness incidents instead of sharing knowledge about the problem.

Although it has been found that the adults involved in this study use various sources to acquire mental health knowledge, which appears to suggest a good knowledge environment, the findings of this study do not support this assumption. According to these findings, the mental health knowledge sources these adults use are generally ineffective. More specifically, radio, television, newspapers, magazines, and social media have been found ineffective by this study. For example, instead of providing mental health knowledge, radio and television have been noted to report mental health problem incidents.

Similarly, Julia and Lumala (2020) revealed that the predominant mental health stories in different Kenyan media were on people who are suffering from acute mental illness instead of focusing on the whole spectrum of mental health. The current study has also found that another sign of the ineffectiveness of these sources (especially radio, television, and social media) is their lack of mental health knowledge dissemination schedules, which leaves knowledge seekers unaware of when the knowledge is going to be provided. In addition to this, these sources have been found to prioritize other health problems (e.g. HIV/AIDS, Cancer, heart diseases, and tuberculosis) and neglect mental health problems.

This tendency was also observed by Julia and Nabushawo (2021), and Nyakundi (2015), who argue that mental health knowledge remains an insignificant target for various knowledge sources. However, this state appears to be prominent in some places and absent in others. For instance, Morgan et al. (2018) reported that in Australia, various media play a significant role in shaping public perceptions and understanding of mental health issues.

Furthermore, this study has found that healthcare workers are the other knowledge source used by adults in the study area to acquire of mental health knowledge, but to a lesser extent. The findings in this study are similar to those by Kohort et al. (2018) and Newsome and Gladding (2018) who also found nurses and other medical practitioners as the sources that people used to acquire mental health knowledge, especially through psychosocial programs. However, due to their limited numbers, these sources are unable to effectively provide this knowledge. Insuffiencieny of healthcare workers is a problem that various other researchers (e.g. Ambikile & Iseselo, 2017; Oliver, 2020) have documented. Since these professionals remain insufficient while the number of people with mental health problems grows, other sources of mental health knowledge will stay in demand despite their reported weaknesses

Conclusion

It is apparent from the findings of this study that adults use different knowledge sources to equip themselves with mental health knowledge. However, the fact that most of the sources the adults use are found ineffective and mostly informal (e.g. friends and family) is a cause for concern. This is due to the questionable reliability of informal knowledge sources, which creates the likelihood of escalating the situation because wrong mental health knowledge can have severe implications on the problem. It is, therefore, incumbent upon the authorities responsible, such as the Ministry of Health and other

mental health stakeholders to ensure that proper sources of mental health knowledge are available to communities to enhance the provision of accurate and relevant mental health knowledge. It is also essential that such knowledge be provided frequently to the public to ensure that people always have access to such important knowledge. Since this study's findings demonstrate the usage of social media platforms to access mental health knowledge by most of the study's participants, these platforms should be effectively managed to avoid dissemination of misinformation regarding mental health.

.

References

Ambikile, J. & Iseselo, M. (2017). Mental health care and delivery system at Temeke hospital in DaresSalaam, Tanzania. *Biomedcentral Psychiatry*, *17* (109), 1-13. https://doi.org/10.1186/s12888-017-1271-9.

Alduraywish,S., Alltamimi, L., Aldhuwayhi, R., Alzamil, L., Alzeghayer, L., Alsaleh, F., Aldakheel, F., & Tharkar S. (2020). Sources of health knowledge information and their impacts on medical knowledge perception among Saudi Arabian population: Cross-sectional study. http://doi.org/10.2196/14414.

Bandara, K & Hettiwaththege, C. (2023). The Impact of Social Media on Student Mental Health and Learning – A Mini Review: *International Journal of Research Publication and Reviews, 4* (7), 303-321.

Beck,F.,Richard,J.,Than,V.,Montagni,I., Parizot,I., &Renahy,E(2014). Use of the Internet as a health information resources among French young adults: Results from a nationally representatives survey. *Journal of Medical Internet Search,* 16(5), e128.

Berkie, M & Anbesaw, T. (2021). Knowledge, attitude, and associated factors towards mental illness among residents of Dessie town, northeast, Ethiopia, a cross-sectional study; http://doi.org/10.1186/s12888-021-03609-0

Brennen, J.S., Simon, F.M., Howard, P.N. and Nielsen, R.K. (2020), "Types, sources, and claims of COVID-19 misinformation", Doctoral dissertation, University of Oxford.

Chen, J. & Wang, Y. (2021). Social media use for healthy purposes: systematic review. *Journal of Medical Internet Research, 23* (5)1-14.

Choudhury, S., Arora T., Alebbi, S., Ahmed, L., Aden, A., Omar, O.(2016). How Do Qataris Source Health Information?. Journal of Medical Internet Research, 11(11), 1-17.

Christina, C., Stan, K., Yifeng, W., & Alan, M. (2014). Using digital and social media metrics to develop mental health approaches for youth. *Adolescent Psychiatry, 4* (2), 116-121.

Clarke, M., Moore, J., Steege, L., Koopman, R., Belden, J., Canfield, S. (2016). Health information needs, sources, and barriers of primary care patients to achieve patient-centered care: A literature review. *Health Informatics Journal,* 22(4), 992-1016.

Daniel, M., Njau, B., Mtuya, C., Okelo, E., & Mushi,D.(2018). Perceptions of mental disoders and help-seeking behavior for mental health care within masai community of Northen Tanzania: An exploratory qualitative study. *East Africa Research Health Journal*, 2(2), 103-116.

Dhawan,S. &Kaushik,S. (2019). Mental health awareness amongst school students across Delhi: A pilot study. *Indian Journal of Health and Well-being, 10* (10), 382-387.

Garcia,A., Krep,G.,& Wright,K.(2018). Perceptions about disseminating health information among mommy bloggers: quantitative study. *International Journal of medical Research Protocal,* 7(4), 116-130. https://doi 10.2196/resprot.7764 .

Ikpeama C. J., Anaba, N., Kalu, C. (2024). Influence of radio programme News on mental health communication amongst residents of south-East Nigeria. *British Journal of Mass Communication and Media Research, 4* (1), 12-24.

Javed, A.,Lee, C., Zakaria, H., Buenaventura, R., Duailbi, K., Ng, B., Ramy, H.,Saha, G.,Arifeen, S., Elorza, P., & Ratnasingham, P. (2021). Reducing the stigma of mental health disoders with a focus on low and middle income countries. *Asian Journal of Psychiatry*, 58(2), 132-146. https://doi.org/10.1016/j.ajp.2021.102601

Julia, K. & Nabushawo, J. (2021). Kenyas media representation of mental health and the role of stigma communication. *African Journal of Media and Communication, 1* (1), 137-161

Kilumuro, K., Kaggwa, M., Kintu, T., Nakand,R., Muwanga, R., Muganzi, D., Pius, A., A yesiga, I., Najiuma, J. & Ashaba, S. (2022). Knowledge, attitude and perceptions of medical students towards mental health in a university in Uganda. *BMC Medical Education,* 22 (1), 1-9. https://doi 10.1186/s12909-022-03774-0

Kousoulis, A. (2019). *Prevention and Mental health: Understanding the evidence so that we can address the greatest health challenges of our times.* https://www.mentalhealth.org.uk/sites/default/files/2022-06/MHF-Prevention-report-2019.pdf

Kohort, B., Asher,L., Fazel, M.,Jordan, M., Mutamba, B., Pedersen, G., Singla,D., & Patel,V.(2018). The role of communities in mental health care in low and middle income countries:Ametareview of components and competencies. *International Journal of Environment Research and Public Health,*15(6),1279.doi: 10.3390/ijerph15061279

Koehler, N. & Rose, P. (2020). The impact of social media on mental health: a mixed-methods research of service providers' awareness. Electronic Theses). Calfonia state University

Knuk, M., Wladis, A., Mbembati, N., Ndao,S., Hsia, R., & Galukande, M. (2018). Human resources and funding constrains for essential surgery in districts hospitals in Africa: A restrospective cross sectional survey. doi: 10.1371/journal.pmed.1002543

Kyumana, V. (2022).Awareness of mental health challenges and its implications for job performance among library staffs at the workplace: A qualitative study. *University of Dar es salaam Library Journal,* 16(2), *89-104*. https://journals.udsm.ac.tz/index.php/lj/article/view/4519/3946.

Lamasigi. A., Rahmanissa, S., Lovita,I., Putra,N.(2021). Counseling on mental health awareness of children of the national. *Journal Ilmiah Indonesia,6* (2), 1350-1360

Luca, B., Levy, R., Makarin, A. (2022). Social media and mental health. Working Paper, No. 9723, Center for Economic Studies and ifo Institute(CESifo), Munich.

Masele J.& Daud, E. (2022). Sources of information and the influence of misinformation on COVID-19 vaccine uptake hesitancy among frontline workers in Tanzania: evidence from Dar es Salaam Dodoma. *Global Knowledge, Memory and Communication, 73* (6), 701-719.

Morgan,A. & Moris,L. (2016). Assessing health knowledge and beliefs about diabetes among African American college students using health beliefs model. *Journal of Nursing Education Practice, 6* (6), 17-24

Morgan, A.J., Jorm, A.F., & Reavley, N.J. (2018). Beliefs of Australian health professionals about the helpfulness of interventions for mental disorders: differences between professions and change over time. *Australian & New Zealand Journal of Psychiatry,* 52(4), 347-355. https://doi.org/10.1177/0004867417729436

Mwambingu, P., Andrea, D., & Katomero, J. (2019). Using mobile phones in improving mental health service delivery in Tanzania: a feasibility study at Mirembe national mental health hospistal in Dododma. *Journal of Global Health Science, 1*(1),1-8, DOI: 10.35500/jghs.2019.1.e6

Newsome, D. & Gladding, S. (2018). *Clinical mental health counseling in community and agency settings*. Merrill.

Nuslund, A., &Betrels,S.(2016). The future of mental health care:peer to peer support and social media.*Epidemiology and Psychiatric Sciences,*25(2),113-122. DOI: 10.1017/S2045796015001067

Nyakundi, A. (2015). The impact of communication campaigns on mental health behavior among secondary school students in Nairobi County. [Doctoral thesis]. Jomo Kenyatta University of Agriculture and Technology.

Oliver,G. (2020). *Mental health situation in Dares salaam and potential interventions*.The Cambrige initiative working paper series. https://www.cambridgedevelopment.org/uploads/1/0/2/4/102410442/the_mental_health_situation_in_dar_es_salaam_and_potential_interventions.pdf

Otache,T.(2020). Poor reading culture in Nigeria: The way forward. *African Journal of Social Science and Humanities Research, 3* (4), 25-37

Razak, T. (2020). A qualitative study understanding how mental health is viewed among South African middle-adults muslin males (Masters Thesis). South Africa University

Rudoliph, J., Berg, R., & Marlenga, B. (2019). Who and how: Exploring the preferred senders and channels of mental health information for Wisconsin farmers. *International Journal of Environmental Research and Public Health, 16* (20), 1-9. doi: 10.3390/ijerph16203836

Seedat, M., Niekerk, A., Sufla, S., Ratele, K. (2013). Mental health care in Africa" discusses the scarcity of mental health information and resources in Africa, leading to inadequate access to knowledge and services. *South Africa Journal of psychology, 44* (2), 121-133.

Sun, T., Tang,Q., Liu, D., Zhau, L., Wang, F., Xie, H. (2021). Mental health literacy about depression among rural left behind children in china: A comparative and cross- sectional study. *Journal of mental health, 30* (2), 263-276.

Sun, Y., Yu, J., Chiu, L. & Hsu,T.(2022). Can online health information sources really improve patient satisfaction? Front. *Journal of Public Health, 10* (2), 1-14.

Srivastava, K., Chaundary,S., Bhat,P., & Mujawas, S. (2018). Media and Mental health. *Industry Psychiatry Journal,*27(1),1-5.

Tesfaye, Y., Birhanu, Z., Agenagnew, L., Anand, S., Yitbarek, K., Ahmed, G., Gutnet, M., & Tucho, G. (2022). Knowledge and attitude of health extension workers regarding mental health problems in Jim zone, Ethiopia: a cross sectional study. doi:10.1136/ bmjopen-2020-048381.

Wema, E. (2018). Investigating reading culture among students in higher learning institutions in Tanzania. *University of Dar es Salaam Library Journal, 13* (1),4-19

United Nation (UN), (2021). *The sustainable development goals report (2021).*

World Health Organization (WHO 2021). *Comprehensive mental health action plan 2013-2030*

World Health Organization (WHO), (2020). *Mental health in Africa: A briefing for the all-party parliamentary group for Africa.*

World Health Organization (WHO), (2019). *World health organization country cooperation strategy 2016-2021.*

World Health Organization (WHO), (2017). *Depression and other mental disorder. Global health estimates.*https://apps.who.int/iris/bitstream/handle/10665/254610/WHO-MSD-MER-2017.2-eng.pdf.

World Health Organization (WHO), (2014). *Social determinants of mental health.*

World Health Organization (WHO), (2010). *Mental Health Atlas: Country Profiles. Tanzania.*

World Health Organization (WHO), (2004).*Mental health financing. Mental health policy and service guidance package*. Geneva.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.12

Exploring the drivers of unprescribed antibiotics dispensing in community drug outlets in Dodoma Region, Central Tanzania: a cross-sectional study

Richard James Mabilika[1] and Emmanuel George Mang'ombe[1]*
[1]Department of Pharmacy and Pharmaceutical Sciences, School of Medicine and Dentistry, University of Dodoma, Dodoma – Tanzania

Abstract
Background: Community drug outlets have primarily been associated with the unregulated sale of antibiotics, accelerating the development and spread of antibiotic resistance.
Broad objective: This study aimed to determine the drivers and trends of unprescribed antibiotic dispensing in community drug outlets in Central Tanzania.
Methodology: This was a cross-sectional study in which 643 drug purchases were recorded in Chamba District Council (rural) and Dodoma City Council (urban) from March to June 2021. Data was collected using KoBo Collect software and analyzed by R statistical software using antibiotic dispensing as an outcome variable. Multivariate analyses were performed to determine the independent effect of variables on antibiotic dispensing.
Results: Of the 643 drug purchases recorded, 84.14 % (541/643) were in Dodoma City Council (urban), 50.3 % (324/643) were made by female clients, while only 24.88% (160/643) purchased antibiotics. Most antibiotics (75%; 120/160) were purchased and dispensed without prescriptions. Accredited Drug Dispensing Outlets (ADDO) and community pharmacies were the two types of drug stores visited in this study. Most antibiotics (86.3%; 138/160) were dispensed in ADDO beyond jurisdiction. Amoxicillin, ampicillin and cloxacillin fixed drug combination, azithromycin, Ciprofloxacin and doxycycline accounted for over 70% of the antibiotics dispensed. Compared to other diseases complaints, the odds of antibiotic dispensing for runny nose decreased by 11% (aOR=0.89;95%CI:0.81-0.98; p=0.024) and increased by 1.29 (aOR=1.29;95%CI:1.18-1.41; p<0.001), 1.31 (aOR=1.31;95%CI:1.11-1.54; p=0.001), 1.18 (aOR=1.18;95%CI:1.08-1.30; p<0.001) and 2 (aOR=2.01;95%CI: 1.75-2.31; p<0.001) times for cough, sore throat, fever and urinary tract complains respectively.
Conclusion: There are high levels of unprescribed antibiotic dispensing by accredited drug dispensers in ADDO. The majority of the antibiotics dispensed were well beyond those stipulated in the allowable ADDO medicines dispensing list. Upper respiratory and urinary tract infection symptoms accounted for most of the antibiotic dispensing in these settings.
Recommendations: Tailored community antibiotic stewardship campaigns among drug dispensers and the community at large, as well as more stringent law enforcement mechanisms, are inevitable in mitigating the overuse and/or misuse of antibiotics in community drug outlets.
Keywords: Antibiotic, dispensing, community, drug outlet, Dodoma, Tanzania

Introduction

Antibiotic resistance develops from changes in bacteria's genetic makeup (WHO, 2021); it is attained following contact between an antibiotic and a bacterial cell and can be transferred between bacteria cells by either vertical or horizontal gene transfers (WHO, 2020). Infections caused by antibiotic-resistant pathogens are complicated and, at times, impossible to treat, requiring the use of novel antibiotics that are not easily accessible and affordable (WHO, 2014). It is anticipated that the global mortality rate from drug-resistant infections will rise to 10 million deaths by 2050 (Jim O'Neill, 2014); 90% of these will occur in Africa and Asia

* Corresponding Author: ricmabilika@gmail.com, +255743368281

(WHO, 2016). The misuse and/or overuse of antibiotics in the human and animal health sectors has accelerated widespread antibiotic resistance (Ventola, 2015; WHO, 2020).

Unlike in low-income countries where antibiotics are consumed mostly for human health (Friedrich MJ, 2018), high- and middle-income countries primarily use antibiotics in agricultural production (Van Boeckel et al., 2015). Up to 80% of the antibiotics produced in the United States of America and Brazil are used in animal farms (Van Boeckel et al., 2015). As is the case in many developing countries, the overall consumption of antibiotics in Tanzania is predicted to continue rising (Sangeda et al., 2021) for reasons such as the unregulated sale of antibiotics in community drug shops, high prevalence of infectious diseases (Friedrich MJ, 2018), limited access to appropriate antibiotics, and poor diagnostic tools (Friedrich MJ, 2018; Mbwasi et al., 2020; Sangeda et al., 2021).

In Tanzania, antibiotics can be legally bought in community pharmacies (drug outlets run under a pharmacist superintendent) in the urban areas and Accredited Drug Dispensing Outlets – ADDO (drug outlets run under an Accredited Drug Dispenser) in the rural and peri-urban areas (Chalker et al., 2015). Community pharmacies stock all kinds of antibiotics, while ADDO stocks a few selected antibiotics; in both cases, however, antibiotics ought to be dispensed with a prescription (Chalker et al., 2015). Along with regulations about selling and dispensing antibiotics in Tanzania, unprescribed antibiotics continue to be sold in community drug shops (Ndaki et al., 2023). This study explores the drivers of unprescribed antibiotic dispensing in community drug outlets (CDOs) in the Dodoma region, Central Tanzania.

Methodology

Study design

This cross-sectional study was conducted in community drug shops in two districts of the Dodoma region, Central Tanzania.

Study sites and settings

Dodoma City Council houses the central business district of Dodoma region and represents the urban setting, while Chamba District Council represents the rural setting. Dodoma City Council (urban) has a population size of about 765,179, and Chemba District Council (rural) has a population size of about 339,333 (NBS, 2016a). Dodoma City Council covers approximately 2769 square kilometres and has four hospitals, 13 health centres, 48 dispensaries, 364 Accredited Drug Dispensing Outlets (ADDO) and 62 community pharmacies (NBS, 2016b); on the other hand, Chamba District Council covers a total of 7653 square kilometres with 4 health centres, 35 dispensaries and 87 ADDO (NBS, 2016b).

Data sources and study population

Data were collected from ADDO and community pharmacies; clients purchasing medicines and other items in these community drug outlets were requested to participate.

Sample size calculation

The sample size calculation was based on the unknown prevalence (P) of 50% with a 95% confidence level and was calculated using the survey formula described by Kothari (2004). The degree of precision employed was 5%, with a design effect of 1. The response rate was taken as 90%, resulting in a sample size of 427.

Sampling technique

The sampling technique employed was a multi-stage stratified random sampling. The Dodoma region is divided into seven districts, which, depending on their population densities, presence of modern infrastructure of roads and railways, presence of 3-star hotels and high density of shops -reflective of higher household income, were divided into rural (Chemba, Bahi, Mpwapwa, and Chamwino districts) and urban (Dodoma City Council, Kondoa and Kongwa District Councils) categories. Each group randomly selected one district to get an urban and rural representative district. The two districts randomly selected were Chemba District Council from the

rural category and Dodoma City Council from the urban category. In the second stage, probability proportionate to size sampling was used to decide the total number of community drug outlets to be included in the study between the two localities. In 2021, there were 426 community drug outlets in Dodoma City Council and about 87 in Chamba District Council. We would require five times the community drug outlets in Dodoma City Council as in Chamba District Council. Using community drug outlet lists kept by district Pharmacists, 54 community drug outlets were visited in Dodoma City Council and 10 in Chamba District Council. Ten customers were then randomly selected for interviews from each drug outlet.

Data collection

Data was collected using Open Data Kit (ODK) digital questionnaires and observation forms, which were translated into Swahili for easy comprehension among respondents and data collectors. Their suitability was tested in a pilot study before being adopted for use. Data collectors Using Android smartphones were recruited and oriented into the digital data collection kits. A detailed description of the Swahili-translated consent form was given and explained to all the potential participants (customers).

Data analysis

The collected data were downloaded from the KoBo Collect software in an Excel format, cleaned and then exported to R statistical software version 3.4.4 [15] for analysis. Antibiotic dispensing was used as an outcome variable, and univariate, bivariate, and multivariate analyses were performed. The univariate analysis involved calculating measures of central tendency, while bivariate analyses involved stratification of antibiotic self-medication based on several categorical variables. Finally, multivariate analyses were performed to determine the independent effect of variables on the probability of antibiotic dispensing.

Results

Socio-Demographic Characteristics of Respondents in Community Drug Outlets

A total of 64 drug outlets were visited in this study; the majority had both the necessary registration certificates [97.72% (59/61)] and pharmaceutical reference books [73.77 %; (45/61)] as per the guidelines by the Pharmacy Council of Tanzania. A total of 643 drug dispensing encounters were recorded, a majority [84.14 % (541/643)] of which were from Dodoma City Council (Table 1).

A majority [74.69% (482/643)] of the drug dispensing encounters were recorded in ADDO, and the overall prevalence of antibiotic dispensing was 24.88% (160/483), the majority [75% (120/160)] of which were dispensed without prescriptions. Of the encounters with antibiotics, 86.3% (138/160) were recorded in ADDO, and 58% (80/138) were beyond the ADDO stocking and dispensing jurisdiction. Amoxicillin, ampicillin/Cloxacillin, azithromycin, Ciprofloxacin and doxycycline accounted for over 70% of all the antibiotics dispensed in this study (Table 1).

Table 1: Socio-demographic characteristics of respondents in community drug outlets

Variable	Response	Number (%)
Sex	Male	319 (49.7)
	Female	324 (50.3)
Education level	None	68(10.58)
	Primary education	243(37.79)
	Secondary or more	332(51.63)
Types of drug outlets	ADDO	482(74.96)
	Community pharmacy	161(25.04)
Presence of drug outlet registration certificates	NO	2(2.28)
	YES	59(97.72)

 https://dx.doi.org/10.4314/thrb.v26i3.12

Presence of Pharmaceutical reference books	NO	16(26.23)
	YES	45(73.77)
Dispensing by qualification	Pharmacist	38(5.91)
	Pharm technician	130(20.22)
	Pharm assistant	41(6.38)
	Pharm dispenser (PD)	242(37.64)
	ADD	151(23.48)
	Nurse	30(4.67)
	Clinical officer	11(1.71)
District	Chamba District Council	102 (15.86)
	Dodoma City Council	541 (84.14)
Encounters with or without antibiotics	NO	483 (75.12)
	YES	160 (24.88)
Antibiotic encounters with prescription	NO	120(75)
	YES	40(25)

Stratification Analysis of Demographic Characteristics Against Antibiotic Dispensing

Antibiotic dispensing among female clients was 28.4% (92/324), slightly higher than 21.3% (68/319) of antibiotic dispensing recorded among males (p = 0.045). The proportion of antibiotic dispensing among clients attending community drug outlets in Chamba District Council was 41.2% (42/102), this being relatively higher when compared to 21.8% (118/541) of antibiotic dispensing among clients in Dodoma City Council (p = 0). The most common disease complaints that prompted antibiotic dispensing were cough (42.9%; 33/77; p = 0), sore throat (50%; 10/20; p = 0.015), urinary tract-related symptoms (93.3%; 28/30; p = 0), and wounds (53.7%; p = 0) (Table 2).

Table 2: Cross-tabulation of variables against antibiotic purchase or non-purchase

Characteristics	Antibiotic purchase = No, 483 (75.1%)	Antibiotic purchase = Yes, 160 (24.9%)	Chi-square test	p-value
Sex			4.31	0.045
Male	251(78.7%)	68 (21.3%)		
Female	232 (71.6%)	92 (28.4%)		
Age				0.021
Young (15 - 45)	379(73.2%)	139(26.8%)		
Old (46 and above)	104(83.2%)	21(16.8%)		
Place of residence			17.22	0
Chemba (Rural)	60(58.8%)	42(41.2%)		
Dodoma city (Urban)	423(78.2%)	118(21.8%)		
Education status			0.796	0.672
None	51(75%)	17(25%)		
Primary education	178(73.3%)	65(26.7%)		
Secondary education or more	254(76.5%)	78(23.5%)		
Runny nose			5.26	0.024
YES	66(85.7%)	11(14.3%)		
NO	417(73.7%)	149(26.3%)		
Stuffy nose			0.25	0.746

YES	9(69.2%)	4(30.8%)		
NO	474(75.2%)	156(24.8%)		
Cough			15.12	0
YES	44(57.1%)	33(42.9%)		
NO	439(77.6%)	127(22.4%)		
Sore throat			6.97	0.015
YES	10(50%)	10(50%)		
NO	473(75.9%)	150(24.1%)		
Fever			1.93	0.195
YES	50(68.5%)	23(31.5%)		
NO	433(76%)	137(24%)		
pain			34.36	0
YES	172(90.5%)	18(9.5%)		
NO	311(68.7%)	142(31.3%)		
Nausea and vomiting			1.08	0.432
YES	17(85%)	3(15%)		
NO	466(74.8%)	157(25.2%)		
Diarrhea			6.28	0.013
YES	49(89.1%)	6(10.9%)		
NO	434(73.8%)	154(26.2%)		
UTI symptoms				0
YES	2(6.7%)	28(93.3%)		
NO	469(78%)	132(22%)		
Wound			19.4	0
YES	19(46.3%)	22(53.7%)		
NO	464(77.1%)	138(22.9%)		

Logistic Regression Analysis

Un-Adjusted Logistic Regression

Compared to their female counterparts, the likelihood of antibiotic dispensing among male clients decreased by 7% (Un-adjusted Odds Ratio=0.93; 95%CI: 0.87-1; p = 0.038). There was a 1.51 times (Un-adjusted Odds Ratio =1.51; 95%CI: 1.39-1.64; p < 0.001) increase in the odds of antibiotic dispensing among participants in Dodoma City Council compared to those in Chamba District Council. Compared to all other dispensers, the odds of antibiotic dispensing among Pharmaceutical Dispensers (PD) decreased by 11% (Un-adjusted Odds Ratio =0.89;95%CI:0.81-0.97; p = 0.006). Compared to all other disease complaints, there was a two-times increase in the odds of antibiotic dispensing among clients reporting urinary tract-related symptoms (Un-adjusted Odds Ratio =2.05;95%CI: 1.77-2.38; p < 0.001), while that among clients with cough and sore throat increased by 1.22 times (Un-adjusted Odds Ratio =1.22;95%CI:1.11-1.35; p < 0.001) and 1.30 times (Un-adjusted Odds Ratio =1.30;95%CI:1.07-1.57; p = 0.008), respectively (Table 3).

Multivariate Logistic Regression Model

Compared to all other diseases conditions reported, antibiotic dispensing among individuals with runny nose decreased by 11% (Adjusted Odds Ratio =0.89; 95%CI: 0.81-0.98; p = 0.025) and increased by 2 times (Adjusted Odds Ratio =2.01; 95%CI: 1.75-2.31; p < 0.001) 1.29 times (Adjusted Odds Ratio =1.29;95%CI:1.18-1.41; p < 0.001), 1.31 times (Adjusted Odds Ratio =1.31;95%CI:1.11-1.54; p = 0.001), 1.18 times (Adjusted Odds Ratio

=1.18;95%CI:1.08-1.30; p = 0.001) and 1.23 times (Adjusted Odds Ratio =1.23; 95%CI: 1.23-1.57; p < 0.001) among those reporting urinary tract symptoms, cough, sore throat, fever and wounds respectively. Additionally, there was a 30% (Adjusted Odds Ratio =1.30;95%CI:1.18-1.43; p < 0.001) increase in the likelihood of antibiotic dispensing among participants presenting with medical prescriptions compared to those without prescriptions (Table 3).

Table 3: Un-adjusted and adjusted odds ratios of determinants for antibiotic dispensing in community drug outlets

		Unadjusted model		Adjusted model	
Determinants		Unadjusted Odds Ratio (95%CI)	p-value	Adjusted Odds Ratio (95%CI)	p-value
Sex	Female	Reference		Reference	
	Male	0.93(0.87,1)	0.038	0.96(0.91,1.02)	0.167
Age	Old	Reference		Reference	
	Young	1(0.996,1.0)	0.125	1(0.997,1.001)	0.515
District					
	Chamba District Council	Reference		Reference	
	Dodoma City Council	1.51(1.39,1.64)	<0.001	0.93(0.84,1.02)	0.106
Dispenser qualification		Reference		Reference	
	Clinical officer	1.78(1.38,2.31)	<0.001	1.77(1.41,2.24)	<0.001
	One-year trained dispenser	0.89(0.81,0.97)	0.006	0.94(0.87,1.02)	0.163
	Pharmaceutical Technician	0.86(0.78,0.95)	0.004	0.97(0.87,1.08)	0.532
	Pharmaceutical assistant	0.94(0.81,1.07)	0.398	0.95(0.83,1.08)	0.402
	Pharmacist	0.93(0.80,1.09)	0.374	0.97(0.82,1.14)	0.699
	Nurse	0.82(0.70,0.97)	0.019	0.89(0.76,1.04)	0.133
Drug outlet type	ADDO	Reference		Reference	
	Pharmacies	0.94(0.87,1.02)	0.137	0.92(0.84,1.01)	0.070
Runny nose	No	Reference		Reference	
	Yes	0.89(0.80,0.98)	0.022	0.89(0.81,0.98)	0.024
Stuffy nose	No	Reference		Reference	
	Yes	1.06(0.84,1.35)	0.621	1.05(0.85,1.28)	0.671
Cough	No	Reference		Reference	
	Yes	1.22(1.11,1.35)	<0.001	1.29(1.18,1.41)	<0.001
Sore-throat	No	Reference		Reference	
	Yes	1.30(1.07,1.57)	0.008	1.31(1.11,1.54)	0.001
Fever	No	Reference		Reference	
	Yes	1.08(0.97,1.20)	0.165	1.18(1.08,1.30)	<0.001
Body pain	No	Reference		Reference	
	Yes	0.80(0.75,0.86)	<0.001	0.92(0.85,0.99)	0.020
Vomiting/nausea	No	Reference		Reference	
	Yes	0.90(0.74,1.09)	0.300	0.92(0.78,1.09)	0.326
Diarrhea	No	Reference		Reference	
	Yes	0.86(0.76,0.97)	0.012	0.92(0.83,1.02)	0.127
Wounds	No	Reference		Reference	
	Yes	1.36(1.19,1.56)	<0.001	1.39(1.23,1.57)	<0.001
UTI symptoms					
	No	Reference		Reference	
	Yes	2.05(1.76,2.37)	<0.001	2.01(1.75,2.31)	<0.001
Presence of a prescription					
	No	Reference		Reference	
	Yes	1.28(1.16,1.40)	<0.0001	1.21(1.10,1.33)	<0.0001

Discussion

Accredited Drug Dispensing Outlets (ADDO) are community drug outlets intended to serve rural and peri-urban communities with limited prescription-only antibiotics (Chalker et al., 2015). Nevertheless, the dispensing of antibiotics in ADDO was rampant; up to 80% of the antibiotics dispensed in this study were recorded in ADDO, even worse without prescriptions. Furthermore, 58% of the antibiotics dispensed in these drug shops were not on the allowable ADDO medicines list (Chalker et al., 2015). The observation in our current study contradicts the founding objectives of the ADDO program in Tanzania (Bigdeli et al., 2014; Chalker et al., 2015); thus, the need for more enhanced regulatory enforcement on the conduct of both the owners and dispensers of these drug shops.

The majority (75%) of the encounters with antibiotics in this study were dispensed without prescriptions; this is in contravention of the laws and regulations regarding the dispensing of antibiotics in community drug shops in Tanzania (The Pharmacy (Prescription Handling and Control) Regulations, 2020). Studies in Eastern Tanzania have also reported high levels of unprescribed antibiotic dispensing (Horumpende et al., 2018). In a study conducted using mystery clients directly asking for amoxicillin, over 80% of all the mystery clients were dispensed with antibiotics without having a prescription (Ndaki et al., 2021). This observation likely results from a lack of enhanced law enforcement mechanisms on the conduct of drug dispensers in these shops. Even though the Pharmacy Council of Tanzania developed the prescription handling and control regulation in 2020, the implementation of this regulation has not been heightened enough to deter drug dispensers from unprescribed antibiotic dispensing.

The drug dispensers in this study were accredited, one-year-trained pharmaceutical dispensers, pharmaceutical technicians, pharmaceutical assistants, pharmacists and, in some cases, nurses and clinicians. Antibiotic dispensing without a prescription in this current study was mainly documented among Accredited Drug Dispensers (ADD) and Pharmaceutical Dispensers (PD), the lowest cadres in the dispensing hierarchy; an observation likely to be influenced by a lack of emphasis on the dangers of un-prescribed antibiotic dispensing during their training and/or inability to contain dispensing pressure from customers and drug shop owners (Ndaki et al., 2021).

Compared to all other disease complaints, there was a 50% increase in the odds of antibiotic dispensing among clients with respiratory symptoms such as cough and sore throat. In a simulated client study on dispensing antibiotics in Tanzania, 34% of the clients presenting with cough and sore throat were dispensed with antibiotics (Chalker et al., 2015). In another simulated client study, all clients who reported a runny nose in ADDO and community pharmacies were dispensed with antibiotics (Horumpende et al., 2018). A systematic review on un-prescribed dispensing of antibiotics in community drug outlets in sub-Saharan Africa reported upper respiratory symptoms as conditions most dispensed with antibiotics (Belachew et al., 2021). Respiratory symptoms such as coughs, stuffy nose and runny nose may have a viral or allergic aetiology (Worku & Tewahido, 2018); using antibiotics in such cases is thus un-justified (Hoa et al., 2009). With this observation, there is a need for antibiotic stewardship programs among community drug outlet owners and dispensers on rational dispensing of antibiotics.

There was an increase in the odds of antibiotic dispensing among clients presenting with fever compared to the non-feverish; over a quarter of clients with fever in this study were dispensed with antibiotics. A similar observation has been reported in another study in Central Tanzania, where antibiotics were also dispensed and subsequently used for self-medication by feverish patients (Mabilika et al., 2022). In another study, over 70% of all individuals reporting fever were dispensed with antibiotics, 69.5 % of which were cephalosporins (Nepal et al., 2019). Even though fever is a common symptom of bacterial infections (Ndhlovu et al., 2015), it also remains common in other extra-bacterial infections and non-infectious conditions (Almaaytah et al., 2015; Mcgregor & Moore, 2015; Tun et al., 2016). It is vital that before antibiotics are instituted, patients' symptomatology must justify their use (WHO, 2021); in cases where microbiological tests can be sought, initiation of antibiotic therapy should await laboratory confirmation (WHO, 2015a).

Clients presenting with sore or painful urination in this study were two times more likely to be dispensed with an antibiotic as compared to the rest of the reported conditions. Several studies have also reported high levels

of antibiotic dispensing among clients reporting urinary tract-related symptoms; in a simulated client study on the un-prescribed dispensing of antibiotics, 83.3% of clients reporting urinary tract symptoms were dispensed with antibiotics (Almaaytah et al., 2015). In a systematic review of un-prescribed antibiotic dispensing, urinary tract-related symptoms accounted for 30.6% of all the cases with antibiotics (Batista et al., 2020). Additionally, a more contextually relevant study in Northern Tanzania reported an almost 100% antibiotic dispensing among simulated clients reporting a burning sensation during urination (Horumpende et al., 2018). Initiatives involving community engagement in mitigating the causes of urinary-related conditions and emphasis on pharmaceutical personnel on the need for laboratory diagnosis of suspected UTI cases before dispensing antibiotics are vital.

Furthermore, there was a high proportion of antibiotic dispensing to patients with wounds in this study. Even though there is supporting evidence on the wound healing impairment resulting from microbial interference warranting the use of antibiotics (Michael D.Caldwell, 2000), this happens only when the bacteria burden exceeds 104 colony forming units (CFU) per unit measure (Bowler et al., 2001). Antibiotics should thus be reserved for patients with limited ability to contain the infecting pathogens (Atiyeh et al., 2009). The WHO recommends that topical and systemic antibiotics be instituted to manage wounds only after the infecting agent has been identified and its antibiotic susceptibility ascertained (WHO, 2015b). While septic and chronic wounds might need antibiotics (Michael D. Calwell, 2000), antiseptics should instead be encouraged among patients with fresh wounds to allow natural tissue healing (Atiyeh et al., 2009).

Conclusions

This study reports high un-prescribed antibiotics dispensing in Community pharmacies and Accredited Drug Dispensing Outlets (ADDO). Most antibiotics in ADDO were beyond those stipulated in the ADDO's allowable dispensing list. Accredited drug and pharmaceutical dispensers were responsible for dispensing most unprescribed antibiotics. Without prescriptions, antibiotics were mostly dispensed for cough, sore throat, fever, wounds and urinary tract disturbances. The study, therefore, underscores the need for tailored community antibiotic stewardship campaigns on the dangers of antibiotic resistance among drug dispensers and the community at large and the adoption of more stringent law enforcement mechanisms by the relevant authorities to curb the unlawful stocking and dispensing of antibiotics in ADDO.

Acknowledgements

The authors acknowledge Frank Kisanko and Masunga James for their work during data collection and the Executive Directors of Chamba District Council and Dodoma City Council for granting permission to conduct this study in their respective areas.

Conflict of interest: None.

Ethics approval and consent to participate

Ethical clearance was sought from and granted by the Northern Zone Health Research Ethics Committee. Authorities in Dodoma were consulted for permission to undertake the study. The Informed Consent form was used to obtain consent from the participants.

Financial support: The University of Dodoma supported this work.

Authors' contributions: Richard James Mabilika and Emmanuel George Mang'ombe were all involved during proposal development and manuscript write-up. RJM and EGM performed data cleaning and analysis and interpreted the analysis.

Data Availability Statement: All data generated or analyzed during this study are available from the corresponding author upon reasonable request.

Transparency declarations

There is nothing to declare

References

Almaaytah, A., Mukattash, T. L., & Hajaj, J. (2015). Dispensing of non-prescribed antibiotics in Jordan. *Patient Preference and Adherence*, 9, 1389–1395. https://doi.org/10.2147/PPA.S91649

Atiyeh, B. S., Dibo, S. A., & Atiyeh, H. (2009). *Wound cleansing, topical antiseptics and wound healing*.

Batista, A. D., Rodrigues, D. A., Figueiras, A., Zapata-Cachafeiro, M., Roque, F., & Herdeiro, M. T. (2020). Antibiotic dispensation without a prescription worldwide: A systematic review. In *Antibiotics* (Vol. 9, Issue 11, pp. 1–49). MDPI AG. https://doi.org/10.3390/antibiotics9110786

Belachew, S. A., Hall, L., & Selvey, L. A. (2021). Non-prescription dispensing of antibiotic agents among community drug retail outlets in Sub-Saharan African countries: a systematic review and meta-analysis. In *Antimicrobial Resistance and Infection Control* (Vol. 10, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s13756-020-00880-w

Bigdeli, M., Peters, D. H., & Wagner, A. K. (2014). *Medicines in Health Systems: Advancing access, affordability and appropriate use* (D. H. P. A. K. W. Maryam Bigdeli, Ed.; 1st ed.). WHO. www.who.int

Bowler, P. G., Duerden, B. I., & Armstrong, D. G. (2001). Wound microbiology and associated approaches to wound management. In *Clinical Microbiology Reviews* (Vol. 14, Issue 2, pp. 244–269). https://doi.org/10.1128/CMR.14.2.244-269.2001

Chalker, J. C., Vialle-Valentin, C., Liana, J., Mbwasi, R., Semali, I. A., Kihiyo, B., Shekalaghe, E., Dillip, A., Kimatta, S., Valimba, R., Embrey, M., Lieber, R., Rutta, E., Johnson, K., & Ross-Degnan, D. (2015). What roles do accredited drug dispensing outlets in Tanzania play in facilitating access to antimicrobials? Results of a multi-method analysis. *Antimicrobial Resistance and Infection Control*, *4*(1). https://doi.org/10.1186/s13756-015-0075-2

Friedrich MJ. (2018). Antibiotic Consumption Increasing Globally. *JAMA*, *319*(19), 1973.

Hoa, N. Q., Larson, M., Chuc, N. T. K., Eriksson, B., Trung, N. V., & Stålsby, C. L. (2009). Antibiotics and paediatric acute respiratory infections in rural Vietnam: Healthcare providers' knowledge, practical competence and reported practice. *Tropical Medicine and International Health*, *14*(5), 546–555. https://doi.org/10.1111/j.1365-3156.2009.02267.x

Horumpende, P. G., Sonda, T. B., van Zwetselaar, M., Antony, M. L., Tenu, F. F., Mwanziva, C. E., Shao, E. R., Mshana, S. E., Mmbaga, B. T., & Chilongola, J. O. (2018). Prescription and non-prescription antibiotic dispensing practices in part I and part II pharmacies in Moshi Municipality, Kilimanjaro Region in Tanzania: A simulated clients approach. *PLoS ONE*, *13*(11). https://doi.org/10.1371/journal.pone.0207465

Jim O'Neill. (2014). *Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations*. https://wellcomecollection.org/works/rdpck35v

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques* (2nd Editio). New Age International Publishers.

Mabilika, R. J., Mpolya, E., & Shirima, G. (2022). Prevalence and predictors of self-medication with antibiotics in selected urban and rural Dodoma region, Central Tanzania districts: a cross-sectional study. *Antimicrobial Resistance & Infection Control*, *11*(1). https://doi.org/10.1186/s13756-022-01124-9

Mbwasi, R., Mapunjo, S., Wittenauer, R., Valimba, R., Msovela, K., Werth, B. J., Khea, A. M., Nkiligi, E. A., Lusaya, E., Stergachis, A., & Konduri, N. (2020). National Consumption of Antimicrobials in Tanzania: 2017–2019. *Frontiers in Pharmacology*, *11*. https://doi.org/10.3389/fphar.2020.585553

Mcgregor, A. C., & Moore, D. A. (2015). Infectious causes of fever of unknown origin. In *Clinical Medicine* (Vol. 15). www.rcplondon.ac.uk/shop

https://dx.doi.org/10.4314/thrb.v26i3.12

Michael D.Caldwell. (2000). Bacteria and Antibiotics in Wound Healing. *Surgical Clinics of North America*, *100*(4), 757–776.

Mshana, E., Mmbaga, B. T., & Chilongola, J. O. (2018). Prescription and non-prescription antibiotic dispensing practices in part I and part II pharmacies in Moshi Municipality, Kilimanjaro Region in Tanzania : A simulated clients approach. *PLoS ONE*, *13*(11), 1–14.

NBS. (2016a). *TANZANIA IN FIGURES National Bureau of Statistics Dar es Salaam*. https://www.nbs.go.tz/nbs/takwimu/references/Tanzania_in_Figures_2015.pdf

NBS. (2016b). *The United Republic of Tanzania Dodoma Region Basic Demographic and Socio-Economic Profile 2012 Population and Housing Census*. www.nbs.go.tz

Ndaki, P. M., Mushi, M. F., Mwanga, J. R., Konje, E. T., Ntinginya, N. E., Mmbaga, B. T., Keenan, K., Sabiiti, W., Kesby, M., Benitez-Paez, F., Sandeman, A., Holden, M. T. G., & Mshana, S. E. (2021). Dispensing antibiotics without prescription at community pharmacies and accredited drug dispensing outlets in Tanzania: A cross-sectional study. *Antibiotics*, *10*(8). https://doi.org/10.3390/antibiotics10081025

Ndaki, P. M., Mwanga, J. R., Mushi, M. F., Konje, E. T., Fredricks, K. J., Kesby, M., Sandeman, A., Mugassa, S., Manyiri, M. W., Loza, O., Keenan, K., Mwita, S. M., Holden, M. T. G., & Mshana, S. E. (2023). Practices and motives behind antibiotics provision in drug outlets in Tanzania: A qualitative study. *PLoS ONE*, *18*(August 8). https://doi.org/10.1371/journal.pone.0290638

Ndhlovu, M., Nkhama, E., Miller, J. M., & Hamer, D. H. (2015). Antibiotic prescribing practices for patients with fever transitioning from presumptive treatment of malaria to "confirm and treat" in Zambia: A cross-sectional study. *Tropical Medicine and International Health*, *20*(12), 1696–1706. https://doi.org/10.1111/tmi.12591

Nepal, A., Hendrie, D., Robinson, S., & Selvey, L. A. (2019). Survey of the pattern of antibiotic dispensing in private pharmacies in Nepal. *BMJ Open*, *9*(10). https://doi.org/10.1136/bmjopen-2019-032422

Sangeda, R. Z., Saburi, H. A., Masatu, F. C., Aiko, B. G., Mboya, E. A., Mkumbwa, S., Bitegeko, A., Mwalwisi, Y. H., Nkiligi, E. A., Chambuso, M., Sillo, H. B., Fimbo, A. M., & Horumpende, P. G. (2021). National antibiotics utilization trends for human use in Tanzania from 2010 to 2016 inferred from Tanzania medicines and medical devices authority importation data. *Antibiotics*, *10*(10). https://doi.org/10.3390/antibiotics10101249

The Pharmacy (Prescription Handling and Control) Regulations, 1 (2020). https://www.pc.go.tz/files/The%20Pharmacy%20%20(Accredited%20Drug%20Dispensing%20Outlets)%20Standards%20and%20Ethics%20for%20Dispensations%20of%20Medicines%20Regulations%20G.N%20185%20of%202019.pdf

The Pharmacy Regulations, 185 1 (2019).

Tun, Z. M., Moorthy, M., Linster, M., Su, Y. C. F., Coker, R. J., Ooi, E. E., Low, J. G. H., Smith, G. J. D., & Tam, C. C. (2016). Patterns of medication use and factors associated with antibiotic use among adult fever patients at Singapore primary care clinics. *Antimicrobial Resistance and Infection Control*, *5*(1). https://doi.org/10.1186/s13756-016-0146-z

Van Boeckel, T. P., Brower, C., Gilbert, M., Grenfell, B. T., Levin, S. A., Robinson, T. P., Teillant, A., & Laxminarayan, R. (2015). Global trends in antimicrobial use in food animals. *Proceedings of the National Academy of Sciences*, *112*(18), 5649–5654. https://doi.org/10.1073/pnas.1503141112

Ventola, C. L. (2015). The Antibiotic Resistance Crisis Part 1 : Causes and Threats. *PT*, *40*(4), 277–283.

WHO. (2014). *Antimicrobial Resistance: Global Report on Surveillance*. Https://Apps.Who.Int/Iris/Handle/10665/112642. https://reliefweb.int/sites/reliefweb.int/files/resources/9789241564748_eng.pdf

https://dx.doi.org/10.4314/thrb.v26i3.12

WHO. (2015a). *GLASS Methodology for surveillance of national antimicrobial consumption Global Antimicrobial Resistance and Use Surveillance System (GLASS)*. Https://Www.Who.Int/Publications/i/Item/9789240012639. https://www.who.int/publications/i/item/9789240012639

WHO. (2015b). *Prevention and management of wound infection: Guidance from WHO's Department of Violence and Injury Prevention and Disability and the Department of Essential Health Technologies*. Https://Www.Who.Int/Publications-Detail-Redirect/Prevention-and-Management-of-Wound-Infection. https://www.who.int/publications/i/item/prevention-and-management-of-wound-infection

WHO. (2016). *WHO Report on Surveillance of Antibiotic Consumption*. Https://Www.Who.Int/Publications/i/Item/9789241514880. https://www.who.int/publications/i/item/who-report-on-surveillance-of-antibiotic-consumption

WHO. (2020, July 31). *Antibiotic resistance*. https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance

WHO. (2021, July 22). *Antimicrobial resistance*. Https://Www.Who.Int/News-Room/Fact-Sheets/Detail/Antimicrobial-Resistance. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

Worku, F., & Tewahido, D. (2018). Retrospective Assessment of Antibiotics Prescribing at Public Primary Healthcare Facilities in Addis Ababa, Ethiopia. *Interdisciplinary Perspectives on Infectious Diseases*, *2018*. https://doi.org/10.1155/2018/4323769

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.13

Orofacial cleft patterns and risk factors among patients at Mbeya Zonal Referral Hospital, Tanzania: A retrospective descriptive study

Hery Mwakayoka[1,], Anange Lwilla[2], Willyhelmina Olomi[2], Flaviana Nyatu[1], Ekaristo Mwang'ande[1], Clement N Mweya and Omary Khamis[1]*

[1]Mbeya Zonal Referral Hospital P. O. Box 419, Mbeya, Tanzania, [2]Mbeya Medical Research Center, National Institute for Medical Research, P.O Box 2410, Mbeya, Tanzania, [3]Mbeya College of Health and Allied Sciences, University of Dar es Salaam, P.O Box 608, Mbeya, Tanzania

Abstract

Background: Despite the global impact of orofacial clefts, there is limited information on their patterns and risk factors in Tanzania. This study aims to examine the patterns and risk factors of orofacial clefts among patients in the Southern Highlands of Tanzania treated at Mbeya Zonal Referral Hospital in collaboration with the Smile Train program.

Methods: A retrospective descriptive study was conducted at Mbeya Zonal Referral Hospital, analyzing data from November 2021 to June 2022 obtained from the Smile Train database. Descriptive and analytical methods were used with Stata 14.0, and a p-value of <0.05 was considered statistically significant.

Results: A total of 65 patients were treated during the study period, with 64.6% being male. The median age at the procedure was six months (IQR 3-10 months). The majority (33.8%) of patients were from Chunya district. The most common type of cleft was cleft lip (83.1%), followed by clefts of the hard and soft palate. Nine patients had clefts involving the lip, hard palate, and soft palate. Age at the procedure was associated with the severity of the cleft (OR 5.45, CI: 1.09-27.28, p-value: 0.039). No significant associations were found between cleft severity and gender, family history, antenatal clinic attendance, or other malformations.

Conclusions: Understanding the patterns and types of orofacial clefts through routine clinical data is crucial for assessing the disease burden and allocating resources effectively. This study underscores the importance of routine data collection in identifying trends and potential areas for further research. Additional comprehensive studies are needed to investigate the causal factors and broader implications of these findings.

Keywords: Orofacial Clefts, Smile Train Program, Mbeya Zonal Referral Hospital, Epidemiological Patterns, Congenital Anomalies.

Background

Orofacial clefts are considered the most common congenital malformations of the head and neck region, compromising about 65% of all head and neck anomalies identified among live births (Antoszewski & Fijałkowska, 2016). The global prevalence of cleft lip and palate has shown a decline in recent years; however, data quality remains inconsistent across regions, often lacking crucial information on variables such as gender and the severity of morphological abnormalities (Zhou et al., 2022). In Tanzania, available data, largely derived from a study conducted between October 2004 and July 2009, indicated a prevalence of 2.8% associated with congenital anomalies (Manyama et al., 2011). The etiology of orofacial clefts is complex, involving multiple genetic and epigenetic (environmental) factors (Brender & Weyer, 2016). Notably, some environmental factors, such as temperature variation,

[*]**Corresponding author:** Hery Mwakayoka, email: hmwakayoka2000@yahoo.co.uk

exhibit seasonal patterns that have been correlated with an increased incidence of orofacial clefts (Wehrung & Hay, 1970).

Several environmental and lifestyle factors contribute to the incidence of orofacial clefts, with maternal smoking during early pregnancy associated with a 1.5- to 2-fold increased risk of these congenital anomalies (Shaw et al., 1996). Additionally, gender disparities exist, with males generally presenting milder forms of cleft lip, cleft lip and palate, or cleft palate, while females tend to experience more severe cases (Nagase et al., 2010). Moreover, individuals with orofacial clefts often exhibit poorer work ability and a lower quality of life compared to those without congenital deformities (Reis et al., 2018). Early rehabilitation and intervention have shown substantial improvements in health-related quality of life and work ability (Phua & de Chalain, 2008). In Tanzania, limited research has been conducted on the prevalence and risk factors of orofacial clefts, highlighting the need for further studies to understand these factors better and to develop effective treatment and prevention strategies.

The management and monitoring of orofacial clefts are crucial for the affected individuals' speech, hearing, feeding, and maxillary growth (Phua & de Chalain, 2008). The Mbeya Zonal Referral Hospital, in collaboration with the Smile Train program, has been at the forefront of managing orofacial clefts in the Southern Highlands of Tanzania. This study aims to describe the patterns of orofacial clefts among patients managed by the hospital, focusing on patients from November 2021 to June 2022. By using data from the SMILE TRAIN database, this research seeks to fill the knowledge gap, provide a better understanding of the burden, and aid in the appropriate allocation of healthcare resources for affected populations. This study also presents an opportunity to identify potential areas for further research, ensuring improved outcomes for patients with orofacial clefts.

Methods

Study settings and location

This study was conducted at the Mbeya Zonal Referral Hospital, the largest government health facility in the Southern Highlands zone of Tanzania. The hospital receives referral patients from seven regions: Njombe, Ruvuma, Songwe, Rukwa, Iringa, Katavi, and Mbeya.

Study design

This research was a retrospective descriptive study aimed at understanding the pattern of orofacial clefts among patients from the Southern Highlands of Tanzania. Data were collected from November 2021 to June 2022 from the SMILE TRAIN database and hospital records.:

Sample size

The study included 65 patients who were attended to for orofacial clefts during the specified period. The sample comprised children with cleft lip alone, cleft palate alone, and those with both cleft lip and palate (soft and hard).

Data collection

Data were obtained from documented patient records at the hospital, the electronic medical system of the Mbeya Zonal Referral Hospital, and the SMILE TRAIN database. Key variables included patient demographics, clinical details of the orofacial cleft, family history, and maternal history, such as antenatal clinic attendance and alcohol use during pregnancy.

Study instruments

Data collection was facilitated through standardized forms used in the hospital and SMILE TRAIN programs. Information was systematically reviewed and recorded by trained data collectors to ensure accuracy and completeness.

Study analysis

 https://dx.doi.org/10.4314/thrb.v26i3.13

Data were cleaned and analyzed using Stata 14.0. Descriptive statistical methods such as frequencies and percentages were used for categorical variables, while means, standard deviations, medians, and interquartile ranges were used for numerical data. The chi-square test or Fisher exact test measured associations between variables. Multivariable logistic regression models were applied to adjust for potential confounding effects. A p-value of <0.05 was considered statistically significant. Data was presented in tables and charts to visualize findings comprehensively.

Results

From November 2021 to June 2022, a total of 65 patients with orofacial clefts were treated at the Mbeya Zonal Referral Hospital with support from the Smile Train program. The majority of the patients were male (64.6%), and the median age at the time of the procedure was six months (IQR 3-10 months). Most of the procedures were performed between the ages of 4 and 12 months. A significant proportion of the patients (33.8%) were residents of the Chunya district, while others came from various regions within the Southern Highlands (Table 1).

Table 1: Characteristics of patients attended (n=65)

Characteristic		Frequency (%)
Gender	Female	23 (35.4)
	Male	42 (64.6)
Age at procedure*	1-3 months	18 (27.7)
	4-12 months	37 (56.9)
	>1 year	10 (15.4)
Location	Kyela	1 (1.5)
	Chunya	22 (33.8)
	Mbarali	8 (12.3)
	Mbeya	10 (15.4)
	Mbozi	8 (12.3)
	Rungwe	2 (3.1)
	Songwe	10 (15.4)
	Other	4 (6.1)
Severity of the cleft	Less severe	43 (66.1)
	Severe	22 (33.9)
Procedure done	Cleft palate	12 (18.5)
	Lip bilateral	5 (7.7)
	Lip unilateral	48 (73.8)
Family history of any cleft	No	53 (81.5)
	Yes	12 (18.5)
Maternal alcohol history	No	55 (84.6)
	Yes	10 (15.4)
Antenatal clinic booking**	Early	52 (81.2)
	Late	12 (18.8)
Other congenital malformations	None	57 (87.7)
Procedure done	Cardiac	2 (3.1)
	Club feet	2 (3.1)
	Genital	3 (4.6)
	Talipes equinovarus	1 (1.5)

** It is recommended that clefts are repaired for at least three months unless the patient is not physically fit for the procedure.*

*** As per WHO recommendation, one should have started antenatal visits at 17 weeks of gestation*

 https://dx.doi.org/10.4314/thrb.v26i3.13

Table 2 shows the frequency of the cleft lip and palate by anatomical distribution. Thirty-three patients had a left cleft lip, while 27 had a right-side cleft lip. The majority (65%) of those with a cleft lip had a complete cleft. A total of 19 patients had a left-side cleft of the hard palate, while 6 had a right-sided cleft hard palate. The majority (21/25) of these patients had a complete cleft of the hard palate. Twenty-three patients presented with a cleft lip, which involved the left alveolar, while 15 presented with a cleft lip with right alveolar involvement. Twenty patients had a cleft of the soft palate and among these patients, 65% had complete cleft soft palate (Table 2).

Table 2: Showing frequencies of cleft lip and palate by anatomical distribution

Characteristics (n)		Frequency (%)
Left cleft lip (33)	Complete	23 (69.7)
	Incomplete	10 (30.3)
Right cleft lip (27)	Complete	16 (59.3)
	Incomplete	11 (40.7)
Left cleft hard palate (19)	Complete	15 (78.9)
	Incomplete	4 (21.1)
Right cleft hard palate (6)	Complete	6 (100)
	Incomplete	0 (0)
Cleft lip with left alveolar involvement (23)	Complete	13 (56.5)
	Incomplete	10 (43.5)
Cleft lip with right alveolar involvement (15)	Complete	9 (60.0)
	Incomplete	6 (40.0)
Cleft soft palate (20)	Complete	13 (65.0)
	Incomplete	7 (35.0)

When assessing the anatomical overlap of the clefts, nine patients had a cleft involving both the lip, hard and soft palate. Seven patients had both a hard and soft cleft palate. Only four patients had cleft of the soft palate (Figure 1).

 https://dx.doi.org/10.4314/thrb.v26i3.13

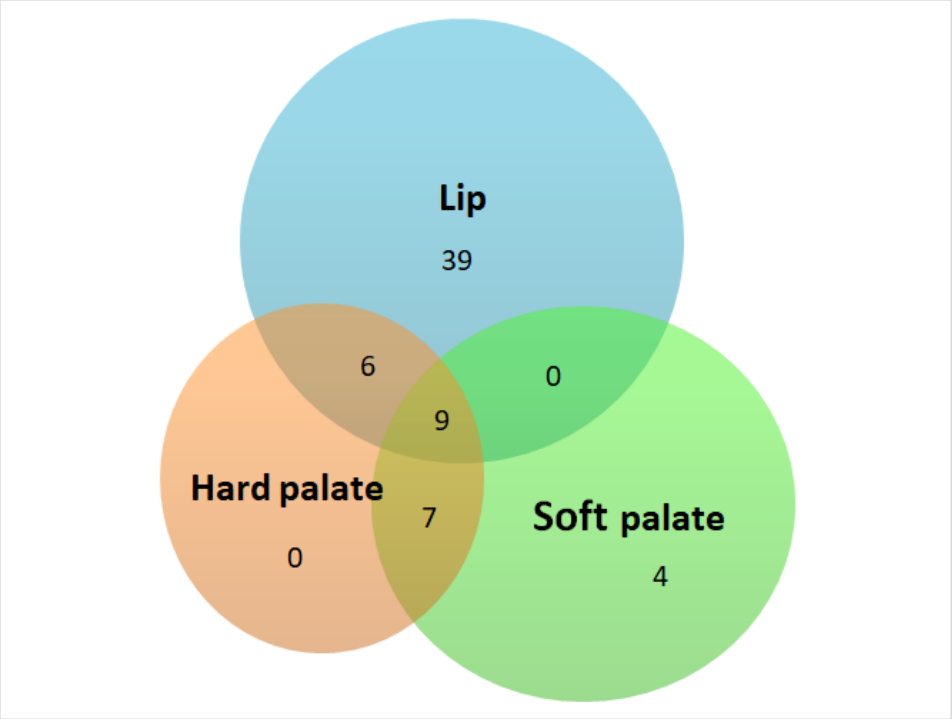


Figure 1: A Venn diagram showing the frequencies and anatomical overlap of clefts n=65

A total of 22 patients were classified as having a severe cleft, depending on the anatomical position and overlap of different clefts. Age at procedure was associated with severity of the cleft, where those aged 4-12 months had 5.45 times the odds of having a severe cleft compared to those aged 1-3 months (CI; 1.09-27.28, p-value; 0.039) and those aged more than one year had eight times the odds of a severe cleft compared to those aged 1-3 months (CI; 1.17-54.72, p-value; 0.034). Patients whose mothers had a positive maternal alcohol history had about three times the odds of a severe cleft compared to those who did not have an alcohol history (OR; 3.66, CI; 0.91-14.72), though there was no statistical evidence for this association. Other factors such as gender, family history of cleft, time of antenatal clinic booking and presence of other malformations did not show any evidence of an association with severity of cleft (Table 3).

Table 3: Showing the distribution of patient characteristics in relation to severity n=22

Characteristic	Total (%)	n (%)	OR (CI)	P-value†
Gender				
Female	23 (35.4)	8 (34.8)	1	
Male	42 (64.6)	14 (33.3)	0.94 (0.32, 2.74)	0.906
*Age at procedure**				
1-3 months	18 (27.7)	2 (11.1)	1	
4-12 months	37 (56.9)	15 (40.5)	5.45 (1.09, 27.28)	0.039
>1 year	10 (15.4)	5 (50.0)	8 (1.17, 54.72)	0.034
Family history of any cleft				
No	53 (81.5)	17 (32.1)	1	
Yes	12 (18.5)	5 (41.7)	1.51 (0.42, 5.46)	0.531
Maternal alcohol history				
No	55 (84.6)	16 (29.1)	1	
Yes	10 (15.4)	6 (60.0)	3.66 (0.91, 14.72)	0.064

 https://dx.doi.org/10.4314/thrb.v26i3.13

*Antenatal clinic booking***				
Early	52 (81.2)	19 (36.5)	1	
Late	12 (18.8)	3 (25.0)	0.58 (0.14, 2.40)	0.439
Other malformations				
No	57 (87.7)	20 (35.1)	1	
Yes	8 (12.3)	2 (25.0)	0.62 (0.11, 3.34)	0.564

Severity was defined as any co-occurrence of a cleft lip (be it unilateral or bilateral) and a cleft palate or just a cleft palate itself. Two categories were created "severe" and "less severe"
*** It is recommended that clefts are repaired at least at three months of age unless the patient is not physically fit for the procedure.*
**** As per WHO recommendation, one should have started antenatal visits at 17 weeks of gestation.*
† LR test p-value

Table 4 shows the association between patient characteristics and different cleft types. There was strong evidence of an association between gender and cleft of the alveolar, where male patients had 0.22 times the odds of cleft of the alveolar compared to the females (CI; 0.07-0.67, p-value 0.005). However, other anatomical clefts did not show an association with gender. Cleft lip and cleft palate were strongly associated with age at the procedure, where older ages had higher odds of both lip and palate clefts. However, no association was observed between cleft of the alveolar and age at the procedure (Table 4). Other factors such as family history of any cleft, maternal alcohol history and time of antenatal booking of the mothers of patients and presence of other malformations did not show any association with any of the anatomical types of clefts.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.13

Table 4: Showing the distribution of patient characteristics about different cleft types (n=65)

Characteristic	Total N (%)	Cleft Lip n (%)	OR (CI)	Pvalue†	Cleft Palate†† n (%)	OR (CI)	Pvalue†	Cleft Alveolar n (%)	OR (CI)	Pvalue†
Gender										
Female	23 (35.4)	21 (91.3)	1		9 (39.1)	1		17 (73.9)	1	
Male	42 (64.6)	33 (78.6)	0.35 (0.07, 1.78)	0.171	17 (40.5)	1.06 (0.37, 2.99)	0.916	16 (38.1)	0.22 (0.07, 0.67)	0.005
*Age at procedure**										
1-3 months	18 (27.7)	18 (100)	1		2 (11.1)	1		11 (61.1)	1	
4-12 months	37 (56.9)	32 (86.5)	9.6 (1.98, 46.5)	0.005	18 (48.7)	7.58(1.52, 37.73)	0.013	19 (51.4)	0.67 (0.21, 2.11)	0.496
>1 year	10 (15.4)	4 (40.0)	1		6 (60.0)	12 (1.73, 83.45)	0.012	3 (30.0)	0.27 (0.05, 1.42)	0.123
Family history of any cleft										
No	53 (81.5)	44 (83.0)	1		19 (35.9)	1		25 (47.2)	1	
Yes	12 (18.5)	10 (83.3)	1.02 (0.19, 5.48)	0.979	7 (58.3)	2.50 (0.69, 8.98)	0.155	8 (66.7)	2.24 (0.60, 8.35)	0.218
Maternal alcohol history										
No	55 (84.6)	46 (83.6)	1		20 (36.4)	1		26 (47.3)	1	
Yes	10 (15.4)	8 (80.0)	0.78 (0.14, 4.31)	0.782	6 (60.0)	2.63(0.66, 10.42)	0.165	7 (70.0)	2.60(0.61, 11.12)	0.180
*Antenatal clinic booking***										
Early	52 (81.2)	44 (84.6)	1		20 (38.5)	1		29 (55.8)	1	
Late	12 (18.8)	10 (83.3)	0.91 (0.17, 4.95)	0.912	5 (41.7)	1.14 (0.32, 4.09)	0.837	4 (33.3)	0.39 (0.11, 1.48)	0.158
Other malformations										
No	57 (87.7)	47 (82.3)	1		23 (40.4)	1		30 (52.6)	1	
Yes	8 (12.3)	7 (87.5)	1.49 (0.16, 13.4)	0.713	3 (37.5)	0.89 (0.19, 4.08)	0.877	3 (37.5)	0.54 (0.12, 2.48)	0.421

** It is recommended that clefts are repaired at least at three months of age unless the patient is not physically fit for the procedure.*
*** As per WHO recommendation, one should have started antenatal visits at 17 weeks of gestation.*
† LR-test p-value except for age at procedure
††This included both soft and hard palates.

Discussion

This study is one of the few in Tanzania and the first in the Southern Highlands to describe the patterns and explore the factors associated with orofacial clefts. The study's findings indicate a higher prevalence of orofacial clefts among males, accounting for 64.6% of the total cases. This male predominance aligns with previous research conducted in Mwanza, Tanzania, and Tokyo, Japan,

where similar patterns were observed (Brender & Weyer, 2016; Manyama et al., 2011). However, contrasting results were reported in South Africa, underscoring potential geographic and demographic variations in orofacial cleft incidence (Hlongwa et al., 2019). The predominance of cleft lip over other types of orofacial clefts was another key finding, with 83.1% of cases presenting cleft lips. This result is consistent with studies conducted in Mwanza, Nigeria, and Norway, where cleft lips were also more prevalent (Hlongwa et al., 2019; Kurita et al., 2021; Manyama et al., 2011). These findings highlight the need for region-specific studies to better understand the epidemiology of orofacial clefts.

Notably, 33.8% of the patients in this study were residents of the Chunya district, an area known primarily for mining activities and agricultural undertakings. This high prevalence rate calls for epidemiological studies to explore the potential causal link between environmental factors, such as mining activities, and the incidence of orofacial clefts. Environmental factors, such as exposure to harmful chemicals and poor maternal nutrition associated with such occupational environments, could be contributing factors (Candotto et al., 2019; Kurita et al., 2021; Wilcox et al., 2007). The large influx of patients from a specific geographic location emphasizes the need for targeted public health interventions and awareness campaigns in high-risk areas to mitigate the prevalence of orofacial clefts.

The median age at the procedure was six months, with most patients undergoing surgery between four and twelve months. This relatively early timing of surgical intervention aligns with recommended practices and reflects the well-coordinated efforts of the Smile Train program in the region (Louis et al., 2018). Early surgical intervention is crucial for improving outcomes related to speech, hearing, feeding, and maxillary growth (Aycart & Caterson, 2023). However, age at the procedure was also found to be positively associated with the severity of the orofacial cleft, suggesting that more severe cases might require timely and multiple surgical interventions. This association should be interpreted cautiously, as the timing of surgery also depends on the patient's general health and readiness for surgery rather than delayed presentation to healthcare facilities (Hamdan et al., 2023). This finding underscores the importance of early diagnosis and comprehensive care protocols to address the complexities of severe orofacial clefts.

The study also explored the association between various environmental factors and the severity of orofacial clefts. While maternal alcohol consumption was associated with about three times the odds of having a severe cleft, the association did not reach statistical significance, possibly due to the small sample size and potential responder bias (Kurita et al., 2021). Although epidemiological studies have shown the role of environmental factors such as alcohol and smoking in the onset of orofacial malformations, these factors were not significantly represented in this study (Fell et al., 2022; Inchingolo et al., 2022). Environmental exposure and genetic predispositions are complex and require larger, multi-centered studies to draw definitive conclusions. Moreover, the lack of significant associations between gender, family history, time of antenatal clinic booking, and the presence of other malformations with the severity of orofacial clefts calls for further investigations into other potential risk factors.

This study's main limitation lies in its small sample size, which restricted the ability to conduct more robust statistical analyzes and multivariable regressions to adjust for potential confounding variables. The hospital-based nature of the dataset may also limit the generalizability of the findings to a larger population, as it may not represent undiagnosed or untreated cases in the community. Furthermore, the reliance on routine data collection and patient records may lead to information gaps or inaccuracies, impacting the study's comprehensiveness. Social desirability bias might have influenced the self-reporting of maternal habits, such as alcohol consumption, leading to underreporting. For future research, larger, population-based studies with detailed data collection and possibly genetic analysis are recommended to provide a more comprehensive understanding of the

patterns and risk factors associated with orofacial clefts. Despite these limitations, this study contributes valuable insights into the epidemiology of orofacial clefts in the Southern Highlands of Tanzania and underlines the importance of targeted public health interventions and further research to improve outcomes for affected individuals.

Conclusions

This study offers valuable insights into the patterns and risk factors associated with orofacial clefts among patients in the Southern Highlands of Tanzania, particularly those treated at the Mbeya Zonal Referral Hospital in collaboration with the Smile Train program. The predominance of cleft lip, especially on the left side, and the higher incidence among males align with global observations but also underscore the need for region-specific data to address unique environmental and genetic factors. A significant proportion of patients from the Chunya district point to potential environmental exposures that warrant further epidemiological investigation. Early surgical intervention, facilitated by the Smile Train initiative, has demonstrated effectiveness in managing these congenital anomalies, emphasizing the importance of timely medical care. While factors like maternal alcohol consumption showed a positive association with cleft severity, the small sample size limits definitive conclusions.

Additionally, no significant associations were found between cleft severity and gender, family history, or antenatal care timing, suggesting the need for more extensive, multi-centered studies to unravel the complex etiology of orofacial clefts. Understanding these factors is crucial for developing targeted public health interventions and allocating resources effectively. This study highlights the importance of routine data in informing healthcare practices and identifying gaps in current research. Future studies should aim for larger sample sizes and possibly incorporate genetic analyzes to provide a more comprehensive understanding. Despite these limitations, this research contributes to the foundational knowledge required to improve healthcare outcomes for individuals with orofacial clefts in Tanzania.

Acknowledgments

We would like to express our profound gratitude to the Mbeya Zonal Referral Hospital management and staff for their invaluable support and cooperation during this study. We are particularly grateful to the dental team for their tireless efforts in collecting and maintaining the patient data, which has been instrumental in this research. A special thanks to the Smile Train program for their continued dedication and support in providing resources and medical care to patients with orofacial clefts. Their collaboration and financial assistance have been crucial for both the treatment of patients and the successful completion of this study. We also wish to acknowledge the research committee at Mbeya for providing the necessary ethical clearance and guidance throughout this study. Our thanks extend to the National Institute for Medical Research - Mbeya Medical Research Center (NIMR-MMRC) as well as the Executive Director of Mbeya Zonal Referral Hospital for their permission and administrative support. Our sincerest gratitude goes to the families and patients who participated in this study. Your willingness to share your experiences has contributed significantly to the understanding of orofacial clefts in the Southern Highlands of Tanzania.

Author's contributions

HM, AL, WO and OH designed the study and wrote the manuscript. HM, AL, WO, OH, FN, EM, CNM and OH reviewed and edited the manuscript. HM, AL and CNM contributed to the final manuscript. All authors reviewed the manuscript.

Funding

None

Availability of data and materials

All data generated or analyzed during this study is included in this published article.

Declarations

Ethical approval and consent to participate

Ethical clearance to carry out the study was sought from Mbeya Research Committee. Permission was obtained from the Executive director of Mbeya Zonal Referral Hospital and the director of NIMR - MMRC and informed consent was also sought from patients and patient's parents for patients below 18 years, and their participation was voluntarily after seeking informed consent from them.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author Details

[1] Mbeya Zonal Referral Hospital P. O. Box 419, Mbeya, Tanzania
[2] Mbeya Medical Research Center, National Institute for Medical Research, P.O Box 2410, Mbeya, Tanzania
[3] Mbeya College of Health and Allied Sciences, University of Dar es Salaam, P.O Box 608, Mbeya, Tanzania

References

Antoszewski, B., & Fijałkowska, M. (2016). Prevalence of cleft lip and/or palate in children from Lodz between years 1981-2010. *Congenital Anomalies*, *56*(2), 60–64. https://doi.org/10.1111/cga.12133

Aycart, M. A., & Caterson, E. J. (2023). Advances in Cleft Lip and Palate Surgery. *Medicina*, *59*(11), 1932. https://doi.org/10.3390/medicina59111932

Brender, J. D., & Weyer, P. J. (2016). Agricultural Compounds in Water and Birth Defects. *Current Environmental Health Reports*, *3*(2), 144–152. https://doi.org/10.1007/s40572-016-0085-0

Candotto, V., Oberti, L., Gabrione, F., Greco, G., Rossi, D., Romano, M., & Mummolo, S. (2019). Current concepts on cleft lip and palate etiology. *Journal of Biological Regulators and Homeostatic Agents*, *33*(3 Suppl. 1), 145-151. DENTAL SUPPLEMENT.

Fell, M., Dack, K., Chummun, S., Sandy, J., Wren, Y., & Lewis, S. (2022). Maternal Cigarette Smoking and Cleft Lip and Palate: A Systematic Review and Meta-Analysis. *The Cleft Palate Craniofacial Journal*, *59*(9), 1185–1200. https://doi.org/10.1177/10556656211040015

Hamdan, M., Yang, X., Mavura, M., Saleh, M., Kannani, G., Haonan, K., Al-Danakh, A., Zhaohui, X., Zezhong, G., Hyokju, R., Amado, B., Yanying, R., & Xin, C. (2023). Factors associated with delayed reporting for surgical care among patients with surgical acute abdomen attended at Muhimbili National Hospital: Tanzania. *BMC Gastroenterology*, *23*(1), 59. https://doi.org/10.1186/s12876-023-02659-w

Hlongwa, P., Levin, J., & Rispel, L. C. (2019). Epidemiology and clinical profile of individuals with cleft lip and palate utilising specialised academic treatment centres in South Africa. *PLOS ONE*, *14*(5), e0215931. https://doi.org/10.1371/journal.pone.0215931

Inchingolo, A. M., Fatone, M. C., Malcangi, G., Avantario, P., Piras, F., Patano, A., Di Pede, C., Netti, A., Ciocia, A. M., De Ruvo, E., Viapiano, F., Palmieri, G., Campanelli, M., Mancini, A., Settanni, V., Carpentiere, V., Marinelli, G., Latini, G., Rapone, B., … Dipalma, G. (2022). Modifiable Risk Factors of Non-Syndromic Orofacial Clefts: A Systematic Review. *Children*, *9*(12), 1846. https://doi.org/10.3390/children9121846

Kurita, H., Motoki, N., Inaba, Y., Misawa, Y., Ohira, S., Kanai, M., Tsukahara, T., & Nomiyama, T. (2021). Maternal alcohol consumption and risk of offspring with congenital malformation: The Japan Environment and Children's Study. *Pediatric Research*, *90*(2), 479–486. https://doi.org/10.1038/s41390-020-01274-9

Louis, M., Dickey, R. M., & Hollier, L. H. (2018). Smile Train: Making the Grade in Global Cleft Care. *Craniomaxillofacial Trauma & Reconstruction*, *11*(1), 1–5. https://doi.org/10.1055/s-0037-1608700

Manyama, M., Rolian, C., Gilyoma, J., Magori, C. C., Mjema, K., Mazyala, E., Kimwaga, E., & Hallgrimsson, B. (2011). An assessment of orofacial clefts in Tanzania. *BMC Oral Health*, *11*, 5. https://doi.org/10.1186/1472-6831-11-5

Nagase, Y., Natsume, N., Kato, T., & Hayakawa, T. (2010). Epidemiological Analysis of Cleft Lip and/or Palate by Cleft Pattern. *Journal of Maxillofacial and Oral Surgery*, *9*(4), 389–395. https://doi.org/10.1007/s12663-010-0132-6

Phua, Y. S., & de Chalain, T. (2008). Incidence of oronasal fistulae and velopharyngeal insufficiency after cleft palate repair: An audit of 211 children born between 1990 and 2004. *The Cleft Palate-Craniofacial Journal: Official Publication of the American Cleft Palate-Craniofacial Association*, *45*(2), 172–178. https://doi.org/10.1597/06-205.1

Reis, B. B., Lins, L., Spínola, L. G., & Carvalho, F. M. (2018). Quality of life, work ability, and facial deformities. *Revista Brasileira de Medicina Do Trabalho*, *16*(3), 318–326. https://doi.org/10.5327/Z1679443520180278

Shaw, G. M., Wasserman, C. R., Lammer, E. J., O'Malley, C. D., Murray, J. C., Basart, A. M., & Tolarova, M. M. (1996). Orofacial clefts, parental cigarette smoking, and transforming growth factor-alpha gene variants. *American Journal of Human Genetics*, *58*(3), 551–561.

Wehrung, D. A., & Hay, S. (1970). A study of seasonal incidence of congenital malformations in the United States. *British Journal of Preventive & Social Medicine*, *24*(1), 24–32. https://doi.org/10.1136/jech.24.1.24

Wilcox, A. J., Lie, R. T., Solvoll, K., Taylor, J., McConnaughey, D. R., Abyholm, F., Vindenes, H., Vollset, S. E., & Drevon, C. A. (2007). Folic acid supplements and risk of facial clefts: National population based case-control study. *BMJ (Clinical Research Ed.)*, *334*(7591), 464. https://doi.org/10.1136/bmj.39079.618287.0B

Zhou, Y., Mao, X., Zhou, H., Qin, Z., Wang, L., Cai, Z., & Yu, B. (2022). Epidemiology of birth defects based on a birth defect surveillance system in Southern Jiangsu, China, 2014-2018. *The Journal of Maternal-Fetal & Neonatal Medicine: The Official Journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians*, *35*(4), 745–751. https://doi.org/10.1080/14767058.2020.1731459

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.14

Navigating Barriers: Challenges and Strategies for Adopting Artificial Intelligence in Qualitative Research in Low-Income African Contexts

Kahabi Ganka Isangula[1*]

[1]Aga Khan University, School of Nursing and Midwifery, Dar Es Salaam, Tanzania.

Abstract

Introduction: AI is transforming qualitative research. It enhances efficiency, accuracy, and depth in studies. Technologies like machine learning (ML), natural language processing (NLP), and large language models (LLMs) simplify tasks like transcription, coding, and thematic analysis. However, in low-income African settings, there are barriers to AI adoption. These include ethical concerns, infrastructure limitations, financial constraints, and technical skill gaps. Issues around data privacy and the dehumanization of research also add challenges.

Methods: This paper explores the challenges and opportunities of AI in qualitative research in low-income African contexts. It uses a descriptive approach, reviewing literature and personal experiences from rural African settings. The paper highlights how AI can democratize research, promote multilingual inclusivity, and improve analysis.

Results and Recommendations: To integrate AI effectively, capacity-building, ethical frameworks, infrastructure investments, community engagement, and partnerships are crucial. If these challenges are addressed, AI could empower researchers in low-resource settings. This would lead to more relevant, equitable qualitative studies and help tackle Africa's unique challenges. AI can drive informed decision-making in public health, education, and social cohesion.

Keywords: Artificial intelligence, qualitative research, Africa, low-income Africa, ethical concerns, technical skills, financial accessibility

Introduction

The invention of artificial intelligence (AI) has increasingly revolutionized research methodologies by introducing tools that significantly enhance efficiency, accuracy, and depth. AI integrates technologies such as machine learning (ML), natural language processing (NLP), and neural networks, enabling machines to simulate human intelligence (Shoenbill, Kasturi, & Mendonca, 2023; Huawei Technologies, 2023). These technologies are increasingly adopted in research for automating repetitive tasks, analyzing large datasets, and identifying patterns that might otherwise go unnoticed. In qualitative research, AI has demonstrated profound utility, particularly in theory development, transcription, translation, coding, and thematic analysis (Christou, 2023; Morgan, 2023; Anis & French, 2023; Nashwan & Abukhadijah, 2023; Hitch, 2024), highlighting its transformative and ongoing value.

AI-powered tools have transformative applications in qualitative research, particularly in automating data transcription, enhancing multilingual analysis, and generating comprehensive insights. Delve, Ho, & Limpaecher (2024) highlight how AI speech-to-text technologies streamline transcription of interviews, focus groups, and recorded observations, significantly reducing researchers' time and effort. Additionally, AI supports data analysis through NLP and large language models (LLMs), facilitating efficient coding, thematic analysis, and trend identification in large datasets. Nashwan and Abukhadijah (2023) emphasize the role of LLMs in expediting data processing,

* **Corresponding author:** kahabi.isangula@aku.edu **Tel: +255628333332**

integration, and triangulation, ensuring analytical rigor while managing complex datasets. Moreover, AI enhances multilingual research by processing diverse languages and dialects, a critical capability in linguistically diverse contexts. Hitch (2024) exemplifies this through ChatGPT's utility in augmenting reflexive thematic analysis. AI tools also contribute to generating qualitative insights by synthesizing data from varied sources.

Christou (2023) proposes a framework that leverages the synergy between researchers' cognitive skills and AI capabilities, enabling theory creation and refinement. Collectively, these advancements position AI as a critical tool in advancing the efficiency, depth, and equity of qualitative research.

Qualitative research is indispensable in African contexts for understanding complex social phenomena, addressing public health challenges, and shaping locally tailored policies. For example, qualitative research has been pivotal in studies exploring health-seeking behaviors (Ssemata *et al*., 2024; Lyimo *et al*., 2024), barriers to education (Pallangyo & Isangula, 2023; Adamson & Brown, 2024), and fostering social cohesion (Adetunji *et al.,* 2023). The continent's diverse cultural, linguistic, and socio-economic conditions demand approaches beyond the scope of quantitative methods justifying for the continued need of qualitative research. Traditional qualitative methods are widely used in low-income African settings due to limited access to advanced technologies and skillsets.

For instance, a recent article titled 'manual data coding with MS Word' (Isangula, Kelly & Wamoyi, 2024) highlights the technical and financial constraints faced by researchers in low-income African contexts. However, these methods are time-intensive and resource-demanding. While AI offers promising solutions to enhance efficiency and depth, its adoption in low-income African regions remains constrained by infrastructural, financial, and technical barriers. This paper examines the challenges and opportunities associated with adopting AI in qualitative research within low-income African contexts. The findings aim to support researchers in these settings by highlighting AI's potential as a critical tool for enhancing the efficiency and effectiveness of qualitative research practices.

Methods

This article adopts a descriptive approach, combining personal experiences of conducting qualitative research in rural African settings with a synthesis of existing literature on the applications of AI in research. It places particular emphasis on the relevance of AI to low-income African contexts, drawing on data sources such as personal insights, peer-reviewed journal articles, research institution reports, and case studies.

Results: Trends and Rationale for AI adoption in African contexts

There is a growing interest in the application of AI within African contexts. Nuwer (2024), in her recent article "*Why AI Might Be a Game-Changer for Africa*" published in *Nature*, highlights how researchers across the continent are leveraging AI to design tailored solutions for health, development, and other critical sectors. Numerous scholarly publications and technical briefs have explored the challenges and opportunities associated with AI applications in African contexts (Kiemde & Kora, 2020; Ade-Ibijola & Okonkwo, 2023; Azaroual, 2024; Mienye, Sun & Ileberi, 2024; Falebita & Kok, 2024).

Consequently, the volume of scholarly outputs focusing on the application of AI within African contexts is steadily increasing (Kondo *et al.,* 2023), reflecting a rising interest in leveraging AI to address the continent's unique challenges across various sectors, including health, education, agriculture, and public policy.

Researchers in low-income African contexts are increasingly exploring the application of AI across various disciplines. For instance, a scoping review by Sukums, Mzurikwao, Sabas, et al. (2023)

identified 18 studies in Tanzania utilizing ML and deep learning for disease prediction, diagnosis, and vaccine stock optimization. Similarly, in Uganda, Mirugwe (2024) reported over 38 articles employing statistical learning, machine learning, and deep learning to manage large volumes of healthcare data. Ephraim *et al.* (2024) highlighted the valuable role of AI in enhancing the efficiency and accuracy of medical laboratories across Sub-Saharan Africa. In Tanzania, Isangula and Haule (2024) pioneered the development of a cough audio classifier for diagnosing respiratory diseases, building on extensive Western literature on AI applications in respiratory health. These examples underscore the growing recognition of AI's transformative potential to address low-income Africa-specific challenges in health, resource optimization, and data management, fostering innovative solutions tailored to the continent's unique needs.

The adoption of AI in qualitative research presents a transformative opportunity for addressing longstanding challenges faced by researchers in low-income African contexts. Problems with qualitative research in these settings include the labor-intensive nature of research processes such as data collection, transcription, coding, and analysis. These processes are often constrained by limited human and financial resources, time, technical capacity, and accessibility to advanced tools (Kumwenda *et al.,* 2017; Kassa *et al*., 2024; Isangula, Kelly & Wamoyi, 2024). AI-powered tools can significantly alleviate these challenges by streamlining processes, enhancing accuracy, and opening new avenues for insights.

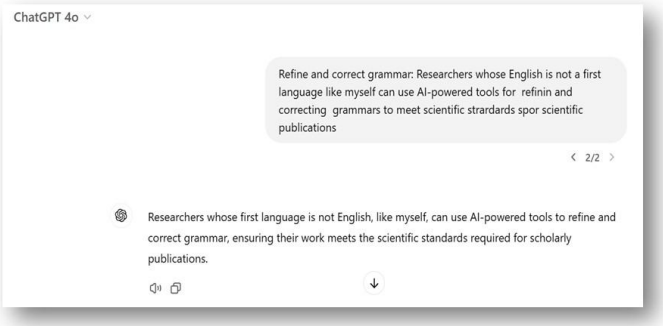
One of the key advantages of AI in qualitative research lies in its ability to automate transcription, coding and analysis. Speech-to-text technologies, such as those discussed by Delve, Ho, and Limpaecher (2024), can convert recorded interviews and focus groups into written text with remarkable speed and accuracy. This capability not only saves time but also reduces the costs associated with manual transcription services, making qualitative research more feasible in resource-constrained settings. Furthermore, AI tools equipped with NLP and LLMs enable researchers to efficiently analyze textual data, identify themes, and uncover trends within large datasets. Nashwan and Abukhadijah (2023) highlight how LLMs facilitate data integration and triangulation, ensuring analytical rigor and enriching the depth of qualitative insights.

AI also may address the linguistic diversity inherent in African contexts. With over 2,000 languages spoken across the continent, multilingual analysis is often a significant barrier. AI-powered tools could process and analyze data in multiple languages and dialects, enhancing inclusivity and equity in research (Ekuma, 2024). Researchers for whom English is not a first language, can utilize AI-powered tools to refine and correct grammar, ensuring their work meets the linguistic and scientific standards required for academic publications (Figure 1). Tools such as ChatGPT have been emphasized for their role in augmenting thematic analysis across languages, enabling researchers to bridge linguistic divides and produce more representative findings (Hitch, 2024; Jalali & Akhavan, 2024).

Moreover, AI offers opportunities to overcome challenges related to small sample sizes, a common limitation in traditional qualitative research. Tools that synthesize and analyze data from various sources enable researchers to draw robust conclusions despite sample size constraints (Anis & French, 2023). In addition, AI can democratize access to research tools, empowering local researchers with technologies that were previously inaccessible due to financial or infrastructural constraints. This aligns with broader efforts to decolonize research and build local capacities in African academia (Shams, Zowghi, & Bano, 2023; Bali, Garba & Ahmadu, 2024). Overall, the adoption of AI in qualitative research holds immense potential for transforming research practices in low-income African contexts.

 https://dx.doi.org/10.4314/thrb.v26i3.14

Figure 1



Fears of AI Application in Research

While AI offers transformative potential, its integration into qualitative research has elicited significant fears among researchers, both within and outside African contexts, due to ethical, technical, and societal concerns. Within the ethics realm, key issues revolve around data privacy, confidentiality, and research integrity (Floridi & Cowls, 2019; Akabayashi, Nakazawa, & Ino, 2022; Costa, 2023; Marshall & Naff, 2024). AI tools often require vast amounts of data, increasing the risk of sensitive information being exposed or misused. Consequently, researchers have emphasized the importance of robust data governance frameworks to protect participants' identities and ensure compliance with ethical standards (Floridi & Cowls, 2019).

Additionally, AI-driven analyses may perpetuate biases embedded in training datasets, potentially skewing results and compromising the equity and integrity of research findings (Nashwan & Abukhadijah, 2023). Concerns specific to qualitative research include fears that AI tools could enable researchers to generate entire manuscripts without collecting or analyzing original data, undermining the authenticity and rigor of the research process. Discussions with Tanzanian researchers revealed fears about the misuse of AI to bypass data collection and analysis, with calls for journal editors to implement stricter measures to verify the correctness of submitted manuscripts. A scoping review of AI application in healthcare conducted in Tanzania (Sukums *et al.*, 2023) recommended the development of national AI policies and regulatory frameworks to facilitate the adoption of responsible and ethical AI solutions in the health sector, aligned with the WHO's guidance on the ethics and governance of AI for health.

Within the technical realm, challenges related to limited familiarity with AI in low-income African contexts and the inadequate reliability of AI algorithms persist. Articles on AI applications in Tanzania and Africa highlight a lack of awareness among researchers, policymakers, and community members, perpetuating fears and misconceptions about its use (Sukums *et al.*, 2023; Stuart, 2024; Ponera & Madila, 2024). This has led to repeated calls for capacity-building interventions to enhance understanding and application of AI in these contexts.

While AI-powered tools excel in processing and analyzing large datasets, their accuracy depends heavily on the quality of the underlying data and algorithms. Errors in transcription, coding, or thematic analysis can undermine the validity of research findings (Jalali & Akhavan, 2024; Akhavan & Jalali, 2024). Ensuring the transparency and accountability of AI tools is therefore critical for building

trust in their application, particularly in qualitative research conducted in low-income Africa. Moreover, the 'black box' nature of many AI models—where the internal decision-making processes remain opaque—poses additional challenges (Hassija, Chamola & Mahapatra, 2024). This lack of transparency makes it difficult for researchers to fully understand, explain, or justify the results generated by these tools. Addressing these issues is essential for the responsible integration of AI into research methodologies.

Within the societal realm, fears about the role of AI in qualitative research extend to its impact on human researchers. Some researchers worry that AI-powered tools may overshadow the human contribution in qualitative research, particularly in the interpretation and contextualization of data, thus 'hijacking' the human element crucial for such studies (Akabayashi, Nakazawa, & Ino, 2022) and creating 'over-dependency and reduced critical thinking' among researchers (Stuart, 2024). Furthermore, critics argue that over-reliance on AI could devalue the nuanced, interpretive skills of researchers, shifting the focus from human expertise to machine efficiency (Anis & French, 2023). Relatedly, Hitch (2024) warns of the potential loss of critical reflexivity—a cornerstone of qualitative inquiry—as researchers increasingly shift on delegating analytical tasks to machines. This shift may also exacerbate existing inequalities, as access to advanced AI tools remains limited in low-income African regions, potentially widening the gap between well-resourced and under-resourced research communities. As a result, many advocate for cautious and judicious application of AI in qualitative research, as emphasized by Akabayashi and Nakazawa (2022) and Anis and French (2023).

A substantial body of research and technical reports highlights other critical societal concerns surrounding the adoption of AI in low-income African contexts. One of the foremost issues is the technical skill gap, as many low-income African researchers lack the expertise required to effectively utilize AI tools. This gap is exacerbated by limited training opportunities and the unavailability of user-friendly technologies tailored to local needs (Ade-Ibijola & Okonkwo, 2023; Azaroual, 2024).

The lack of adequate capacity-building initiatives restricts the ability of local researchers to leverage AI effectively in their work. Additionally, the fear of job displacement is a significant concern. Automating tasks traditionally performed by research assistants, such as transcription and data analysis, raises concerns about potential job losses, particularly in communities where employment opportunities are already scarce. Financial barriers further hinder the adoption of AI, as the high costs associated with acquiring, maintaining, and updating AI technologies make them inaccessible to many institutions. These challenges are compounded by infrastructural limitations, including unreliable internet access, frequent power outages, and inadequate computational resources, which pose significant hurdles to the effective deployment of AI tools (Kiemde & Kora, 2020; Ade-Ibijola & Okonkwo, 2023; Azaroual, 2024).

Another critical issue is the lack of cultural and contextual relevance in many AI tools. Designed primarily for global markets, these technologies often fail to consider Africa's unique linguistic and cultural diversity. For instance, many AI systems struggle to process local languages and dialects accurately, limiting their usability in research settings (Ahmed *et al.,* 2023). Researchers have often highlighted the need for AI solutions that are adaptable to Africa's specific cultural and linguistic contexts to ensure equitable and effective integration (Uchechukwu, 2018; Kiemde & Kora, 2020; Ade-Ibijola & Okonkwo, 2023; Azaroual, 2024; Mienye, Sun & Ileberi, 2024; Falebita & Kok, 2024). These challenges suggest that while AI holds considerable promise for advancing qualitative research, its adoption must be approached with caution, particularly in African contexts.

Recommendations for Optimizing AI Use in Low-income Africa

Despite the challenges associated with applying AI in qualitative research, Africa must harness its transformative potential while addressing its limitations. A multifaceted approach to AI integration in

low-income African contexts is essential, combining capacity building, infrastructure development, ethical oversight, and localized innovation. These elements, detailed below, are critical for maximizing the benefits of AI in Africa.

A growing body of research on AI applications across disciplines in African contexts emphasizes the urgent need to enhance AI literacy among researchers, policymakers, and community members (Sukums *et al*., 2023; Ayanwale *et al*., 2024; Ewa, 2024; Mienye, Sun & Ileberi, 2024; Falebita & Kok, 2024). These studies highlight the critical role of training programs and workshops in equipping diverse stakeholders in Africa with the skills necessary to effectively use AI tools.

Consequently, there are overwhelming calls for governments and academic institutions to prioritize capacity-building initiatives as a means of bridging the technical skill gap that continues to hinder AI adoption in African contexts (Ewa, 2024; Mienye, Sun & Ileberi, 2024). Ade-Ibijola and Okonkwo (2023) emphasize the importance of integrating AI training into academic curricula, ensuring that future researchers are prepared to leverage AI's transformative capabilities. Furthermore, Ewa (2024) advocates for introducing AI skills education as early as primary school to cultivate foundational knowledge and foster long-term familiarity with AI technologies. Such initiatives are essential to building a workforce and society that can engage with and benefit from AI innovations in a responsible and impactful way.

Building the capacity of low-income African qualitative researchers to optimize the use of AI requires strong partnerships and collaborations. Collaborations with international organizations, universities, and technology firms can foster knowledge exchange, provide technical support, and reduce associated costs. For instance, partnerships with institutions like UNESCO and global tech companies have demonstrated effectiveness in delivering tailored AI solutions to resource-constrained settings (Azaroual, 2024).

A practical example of such collaboration is a team which is currently partnering with experts from United Kingdom on Medical Research Council-funded grant by proposing an innovation aimed at enhancing respiratory disease diagnostic pathways in rural Tanzania through AI-powered cough analysis. A key aspect of this partnership is the exchange of AI knowledge, which plays a critical role in building local expertise and capacity. These types of collaborations not only facilitate access to advanced AI tools and training resources but also enable researchers to overcome financial and technical barriers, thus paving the way for sustainable and impactful AI integration in qualitative research across Africa. By leveraging such partnerships, African researchers can harness the transformative potential of AI while addressing local challenges in a meaningful way.

Another significant barrier to the adoption of AI in African contexts is the absence of ethical frameworks and guidelines to ensure its responsible use (Kiemde & Kora 2022; Sukums *et al*., 2023; Ayanwale *et al*., 2024; Ewa, 2024; Mienye, Sun & Ileberi, 2024; Ade-Ibijola & Okonkwo, 2023; Azaroual, 2024; Stuart, 2024). The establishment of robust ethical frameworks is widely recommended to safeguard data privacy, promote research integrity, mitigate biases, and respect the cultural values unique to African contexts. These frameworks are crucial for ensuring that AI technologies are applied responsibly and equitably. A critical aspect is building the capacity of African institutional review boards (IRBs) to review and monitor AI-powered research effectively. This includes developing mechanisms to oversee the ethical use of increasingly prevalent web-based AI datasets, which are often used for research purposes (McKay *et al.,* 2023; Bouhouita-Guermech, Gogognon & Bélisle-Pipon, 2023).

Strengthening IRBs can help ensure compliance with ethical standards and the responsible conduct of AI-driven research in low-income Africa. Furthermore, engaging local communities in discussions about data privacy, informed consent, and the societal implications of AI applications is another essential step. Such engagement fosters trust and helps address concerns about how

personal and community data are collected and used (Floridi & Cowls, 2022). Moreover, ethical guidelines must emphasize transparency in AI algorithms, ensuring that their operations are understandable and accountable, thereby preventing misuse and building public confidence in AI systems. Incorporating these recommendations into national and institutional policies will be pivotal in promoting responsible AI use across Africa while addressing the unique ethical challenges posed by technology.

The potential of AI applications cannot be fully realized in low-income African contexts under the current infrastructure limitations. Investing in foundational infrastructure is essential to enable widespread AI adoption, particularly in low-income regions. For instance, many rural areas in Africa face limited connectivity, inadequate power supply, and insufficient computational resources, all of which impede AI deployment and utilization. Expanding affordable internet access, electricity, and digital infrastructure is critical to addressing the systemic barriers that hinder the effective use of AI in these settings (Ade-Ibijola & Okonkwo, 2023; Mienye, Sun & Ileberi, 2024). It is no doubt that improving digital connectivity, particularly in rural and underserved areas, is a prerequisite for scaling AI-driven solutions. Kiemde and Kora (2020) emphasize that enhanced internet penetration not only supports AI adoption but also facilitates access to global knowledge resources and collaborations. Furthermore, initiatives aimed at improving energy infrastructure are vital for ensuring the reliability of AI systems, especially in resource-constrained environments where power outages are common.

In addition to physical infrastructure, investment in digital ecosystems, such as data centers and cloud computing platforms, is necessary to support the computational demands of AI technologies (Azaroual, 2024; Stuart, 2024). Building such infrastructure requires partnerships between governments, private sector actors, and international development organizations to pool resources and expertise. Moreover, fostering innovation through local technology hubs and incubators can enable the creation of context-specific AI solutions tailored to the unique needs of African communities. Supporting local tech startups and encouraging the development of AI solutions designed for low-income African contexts can address unique challenges, such as linguistic diversity and cultural sensitivity.

Local innovation ecosystems can also create sustainable research tools that are more aligned with the continent's socio-economic realities (Hitch, 2024). Ultimately, addressing these infrastructural challenges is foundational for unlocking AI's transformative potential in Africa, empowering researchers, policymakers, and communities to leverage AI for sustainable development. Other suggestions include promoting open-source solutions that offers a crucial pathway for increasing the accessibility of AI tools in low-income African contexts. Encouraging the adoption of open-source AI platforms can significantly reduce costs, making advanced tools more affordable for researchers in resource-constrained settings (Masanja & Mkumbo, 2020; Silva, Coutinho & Costa, 2023; Bali, Garba & Ahmadu, 2024).

These tools also enable customization, allowing researchers to tailor solutions to address specific challenges relevant to their regions. Open-source initiatives empower low-income African researchers to innovate independently while fostering collaboration across disciplines and geographies. Furthermore, financial investment and support for low-income African researchers are indispensable for advancing AI adoption. While there is a growing influx of international funding aimed at fostering disruptive innovations in Africa, it is equally critical for low-income African governments to establish dedicated funding mechanisms. Grants, public-private partnerships, and subsidies for AI-related initiatives can help reduce the financial burden on academic and research institutions (Anis & French, 2023). Strengthening domestic funding structures ensures a sustainable approach to supporting AI innovation within the continent.

Moreover, developing localized AI solutions tailored to low-income African contexts is another vital strategy. These solutions should integrate multilingual capabilities and culturally sensitive algorithms to ensure their relevance and inclusivity (Bali, Garba & Ahmadu, 2024). Engaging local communities in the design and development processes using human design centered approaches can help address unique societal needs and foster trust in AI applications (Nkwo & Orji, 2028; Eke, Chintu, & Wakunuma, 2023; Lazem, Peters & Shipepe, 2024). Incorporating community input ensures that AI tools align with the values, languages, and expectations of their intended users. Finally, creating collaborative networks within African countries is essential for fostering knowledge sharing and pooling resources among researchers. Some African nations are ahead in terms of AI adoption, providing an opportunity for co-learning and capacity building across borders. Platforms that facilitate the exchange of AI-related insights, experiences, and best practices can accelerate innovation and promote equitable growth in AI capabilities (Masanja & Mkumbo, 2020). These collaborative efforts also amplify the voices of African qualitative researchers in global discussions on AI ethics and governance, ensuring their perspectives are represented on the international stage.

Conclusion

AI holds immense potential to revolutionize qualitative research in Africa by addressing longstanding challenges. Automating the labor-intensive research processes, enhancing analytical precision, and enabling multilingual research in low-income African contexts can significantly improve the efficiency and depth of qualitative studies. AI-powered tools, such as automated transcription and NLP, offer opportunities to overcome linguistic diversity, reduce costs, and increase accessibility for researchers. These advancements have the potential to transform the research landscape in low-income Africa, enabling more inclusive and contextually relevant findings.

Realizing this potential requires a strategic and multifaceted approach to address technical, ethical, and societal challenges. Developing robust ethical frameworks, strengthening the capacity of local IRBs, and promoting transparency in AI tools are critical for safeguarding data privacy and ensuring research integrity. Investments in foundational infrastructure, such as reliable internet connectivity, electricity, and computational resources, are equally essential. Additionally, fostering collaborations between governments, academic institutions, and international organizations can enhance resource sharing and reduce costs, while open-source platforms can democratize access to advanced AI tools. Tailoring AI solutions to Africa's cultural and linguistic diversity and involving local communities in their development is crucial to building trust and ensuring relevance. Finally, establishing collaborative networks within the continent can amplify African voices in global AI discussions, fostering innovation and equitable growth. By addressing these challenges, Africa can harness AI's transformative capabilities to advance qualitative research and drive sustainability.

Funding Statement: None
Ethical Statement: This article did not require ethical board approval because it did not directly involve humans or animals.
Conflict of Interest Statements: None
Acknowledgements: None
Author contribution statement: The sole author conceptualized and drafted the manuscript for publication
Grant Number: None

References

Adamson L., Brown R. (2024). Exploring children's experiences of schooling in Tanzania: How the 'hidden curriculum' undermines aspirations for sustainable development. *Children & Society*, 00, 1–16. https://doi. org/10.1111/chso.12847

Ade-Ibijola A., Okonkwo C. (2023). Artificial Intelligence in Africa: Emerging Challenges. In: Eke D.O., Wakunuma K. & Akintoye S., Eds., Responsible AI in Africa, *Social and Cultural Studies of Robots and AI*, Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-08215-3_5

Adetunji A., Silva M., Tulsiani N. J., Adediran M. (2023). "Like a broom tied together": A qualitative exploration of social cohesion and its role in community capacity strengthening to support integrated health in Nigeria. *PLOS global public health*, *3*(10), e0002508. https://doi.org/10.1371/journal.pgph.0002508

Ahmed M. I., Spooner B., Isherwood J., Lane M., Orrock E., Dennison A. (2023). A Systematic Review of the Barriers to the Implementation of Artificial Intelligence in Healthcare. *Cureus*, *15*(10), e46454. https://doi.org/10.7759/cureus.46454

Akabayashi A., Nakazawa E., Ino H. (2022). Could artificial intelligence hijack author contributions? *Nature*, 606(7915), 653–653. https://doi.org/10.1038/d41586-022-01697-w

Akhavan A., Jalali M.S. (2024). Generative AI and simulation modeling: how should you (not) use large language models like ChatGPT, System Dynamics Review. *System Dynamics Society*, 40(3). https://doi.org/10.1002/sdr.1773

Anis S., French J. A. (2023). Efficient, Explicatory, and Equitable: Why Qualitative Researchers Should Embrace AI, but Cautiously. *Business & Society*, *62*(6), 1139-1144. https://doi.org/10.1177/00076503231163286

Ayanwale M.A., Adelana O.P., Molefi P.R., Adeeko O., Ishola A.M. (2024). Examining artificial intelligence literacy among pre-service teachers for future classrooms. *Computers and Education Open*, 6:100179. https://doi.org/10.1016/j.caeo.2024.100179

Azaroual F. (2024). *Artificial Intelligence in Africa: Challenges and Opportunities*. Policy Brief. PB 23-24. https://www.policycenter.ma/sites/default/files/2024-09/PB_23_24%20%28Azeroual%29%20%28EN%29.pdf

Bali B., Garba E.J., Ahmadu A.S. *et al.* (2024). Analysis of emerging trends in artificial intelligence for education in Nigeria. *Discov Artif Intell*, 4, 110. https://doi.org/10.1007/s44163-024-00163-y

Bouhouita-Guermech S., Gogognon P., & Bélisle-Pipon J. C. (2023). Specific challenges posed by artificial intelligence in research ethics. *Frontiers in artificial intelligence*, 6, 1149082. https://doi.org/10.3389/frai.2023.1149082

Christou P. (2023). The Use of Artificial Intelligence (AI) in Qualitative Research for Theory Development. *The Qualitative Report*, *28*(9), 2739-2755. https://doi.org/10.46743/2160-3715/2023.6536

Costa P.A. (2023). Qualitative Research Methods: do digital tools open promising trends? *Arquivos*, 59: 59. http://orcid.org/0000-0002-4644-5879

Delve., Ho L., Limpaecher A. (2024). *AI in Qualitative Data Analysis* https://delvetool.com/blog/ai-in-qualitative-data-analysis

Eke D.O., Chintu S.S., Wakunuma K. (2023). *Towards Shaping the Future of Responsible AI in Africa.* In: Eke, D.O., Wakunuma, K., Akintoye, S. (eds) Responsible AI in Africa. Social and Cultural Studies of Robots and AI. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-08215-3_8

Ekuma K. (2024). Artificial Intelligence and Automation in Human Resource Development: A Systematic Review. *Human Resource Development Review*, *23*(2), 199-229. https://doi.org/10.1177/15344843231224009

Ephraim R.K.D., Kotam G.P., Duah E., Ghartey F.N., Mathebula E.M., Mashamba-Thompson T.P. (2024). Application of medical artificial intelligence technology in sub-Saharan Africa: Prospects for medical laboratories. *Smart Health*, 33, 100505. https://doi.org/10.1016/j.smhl.2024.100505.

Ewa M.A. (2024). Artificial Intelligence (AI) Literacy, An Investment for Enhancing Educators' Skills in AI Powered Primary Schools in Nigeria. *International Journal of Research and Innovation in Social Science*, 1226-1238. https://dx.doi.org/10.47772/IJRISS.2024.804093

Falebita O.S., Kok P.J. (2024). Strategic goals for artificial intelligence integration among STEM academics and undergraduates in African higher education: a systematic review. *Discov Educ* 3, 151. https://doi.org/10.1007/s44217-024-00252-1

Floridi L., Cowls J. (2019). A Unified Framework of Five Principles for AI in Society. *Harvard Data Science Review*, 1(1). https://doi.org/10.1162/99608f92.8cd550d1

Hassija V., Chamola V., Mahapatra A. *et al.* (2024). Interpreting Black-Box Models: A Review on Explainable Artificial Intelligence. *Cogn Comput* 16, 45–74. https://doi.org/10.1007/s12559-023-10179-8

Hitch D. (2024). Artificial Intelligence Augmented Qualitative Analysis: The Way of the Future? *Qualitative health research*, *34*(7), 595–606. https://doi.org/10.1177/10497323231217392

Huawei Technologies Co. Ltd. (2023). *A General Introduction to Artificial Intelligence.* In: Artificial Intelligence Technology. Springer, Singapore. https://doi.org/10.1007/978-981-19-2879-6_1

Isangula K. G., Haule R. J. (2024). Leveraging AI and Machine Learning to Develop and Evaluate a Contextualized User-Friendly Cough Audio Classifier for Detecting Respiratory Diseases: Protocol for a Diagnostic Study in Rural Tanzania. *JMIR research protocols*, *13*, e54388. https://doi.org/10.2196/54388

Isangula K. G., Kelly S., & Wamoyi J. (2024). Manual Qualitative Data Coding Using MS Word for Students and Early Career Researchers in Resource-Constrained Settings. *International Journal of Qualitative Methods*, *23*. https://doi.org/10.1177/16094069241299223

Jalali, M.S. and Akhavan, A. (2024), Integrating AI language models in qualitative Research: Replicating interview data analysis with ChatGPT. *Syst. Dyn. Rev*, 40: e1772. https://doi.org/10.1002/sdr.1772

Kassa R.T., Endale S.B., Bekele Y.A., Wolde-Eyesus E.T., Ambessa H.B. *et al.* (2024). Opportunities and Challenges of Qualitative Research in Academic Health Sciences in Ethiopia. *Health & Social Care in the Community*, 6000619, 10. https://doi.org/10.1155/2024/6000619

Kiemde M.A., Kora A.D. (2020). The Challenges Facing the Development of AI in Africa. *2020 IEEE International Conference on Advent Trends in Multidisciplinary Research and Innovation (ICATMRI)*, Buldhana, India, 1-6. https://doi.org/10.1109/ICATMRI51801.2020.9398454

Kiemde S.M.A., Kora A.D. (2022). Towards an ethics of AI in Africa: rule of education. *AI Ethics* 2, 35–40. https://doi.org/10.1007/s43681-021-00106-8

Kondo T.S., Diwani S.A., Nyamawe A.S. *et al.* (2023). Exploring the status of artificial intelligence for healthcare research in Africa: a bibliometric and thematic analysis. *AI Ethics*. https://doi.org/10.1007/s43681-023-00359-5

Kumwenda S., Niang E. H. A., Orondo P. W., William P., Oyinlola L., Bongo G. N., Chiwona, B. (2017). Challenges facing young African scientists in their research careers: A qualitative exploratory study. *Malawi medical journal: the journal of Medical Association of Malawi*, *29*(1), 1–4. https://doi.org/10.4314/mmj.v29i1.1

Lazem S., Peters A., Shipepe A. (2024). *AfriCHI2023 Workshop proposal: Human-Centric Responsible AI. In Proceedings of the 4th African Human Computer Interaction Conference (AfriCHI '23).* Association for Computing Machinery, New York, NY, USA, 304–305. https://doi.org/10.1145/3628096.3629076

Lyimo E. J., Msangi M., Zangira A. J., Msaki R. V., Lekey A. *et al.* (2024). Healthcare-seeking behaviours among mother's having under-five children with severe wasting in Dodoma and Mbeya regions of Tanzania-A qualitative study. *PLOS global public health*, 4(1), e0001943. https://doi.org/10.1371/journal.pgph.0001943

Marshall D.T., Naff D.B. (2024). The Ethics of Using Artificial Intelligence in Qualitative Research. *Journal of Empirical Research on Human Research Ethics*,19(3):92-102. https://doi.org/10.1177/15562646241262659

Masanja N.M., Mkumbo H. (2020). The Application of Open-Source Artificial Intelligence as an Approach to Frugal Innovation in Tanzania. *International Journal of Research and Innovation in Applied Science (IJRIAS)*, 5:3. https://api.semanticscholar.org/CorpusID:236475078

McKay F., Williams B.J., Prestwich G. *et al.* (2023). Artificial intelligence and medical research databases: ethical review by data access committees. *BMC Med Ethics* 24, 49. https://doi.org/10.1186/s12910-023-00927-8

Mienye I.D., Sun Y., Ileberi E. (2024). Artificial intelligence and sustainable development in Africa: A comprehensive review. *Machine Learning with Applications*, 18: 100591. https://doi.org/10.1016/j.mlwa.2024.100591

Mirugwe A. (2024). Adoption of Artificial Intelligence in the Ugandan Health Sector: a review of literature. *SSRN Electronic Journal*. http://dx.doi.org/10.2139/ssrn.4735326

Morgan D. L. (2023). Exploring the Use of Artificial Intelligence for Qualitative Data Analysis: The Case of ChatGPT. *International Journal of Qualitative Methods*, 22. https://doi.org/10.1177/16094069231211248

Nashwan A. J., & Abukhadijah H. (2023). Harnessing Artificial Intelligence for Qualitative and Mixed Methods in Nursing Research. *Cureus*, *15*(11), e48570. https://doi.org/10.7759/cureus.48570

Nawer R. (2024). Why AI might be a game-changer for Africa, *Nature.* S14; 633. https://media.nature.com/original/magazine-assets/d41586-024-02987-1/d41586-024-02987-1.pdf

Nkwo M., Orji R. (2018). *Persuasive technology in African context deconstructing persuasive techniques in an African online marketplace.* In: ACM International Conference Proceeding Series. pp89–98, Association for Computing Machinery. https://doi.org/10.1145/3283458.3283479

Pallangyo E., & Isangula K. (2023). Promoting Students' Meaningful Engagement in Active Learning Within a Group Setting: Reflections on Teaching and Learning Using Brookfield's Four Lenses Model. *Journal of Higher Education Theory and Practice*, 23(10). https://doi.org/10.33423/jhetp.v23i10.6194

Ponera J.M., Madila S.S. (2024). *Harnessing the Use of Artificial Intelligence among Higher Education Institutions in Tanzania: Challenges and Prospects*. http://repository.mocu.ac.tz/xmlui/handle/123456789/1287

Shams R.A., Zowghi D., Bano M. (2023). AI and the quest for diversity and inclusion: a systematic literature review. *AI Ethics*. https://doi.org/10.1007/s43681-023-00362-w

Shoenbill K.A., Kasturi S.N., Mendonca E.A. (2023). *Artificial Intelligence, Machine Learning, and Natural Language Processing.* In: Daaleman T.P., Helton M.R. (eds) Chronic Illness Care. Springer, Cham. https://doi.org/10.1007/978-3-031-29171-5_36

Silva D.G., Coutinho C., Costa C.J. (2023). Factors influencing free and open-source software adoption in developing countries—an empirical study. *Journal of Open Innovation: Technology, Market, and Complexity,* 9:1, 100002. https://doi.org/10.1016/j.joitmc.2023.01.002.

Ssemata A.S., Smythe T., Sande S., *et al*. (2024). Exploring the barriers to healthcare access among persons with disabilities: a qualitative study in rural Luuka district, Uganda. *BMJ Open,* 14:e086194. https://doi.org/10.1136/bmjopen-2024-086194

Stuart E.M. (2024). Effects of Artificial Intelligence on the Academic Competency of Students of Higher Learning Institutions: A Case Study of Kampala International University in Tanzania. *Tanzanian Journal of Multidisciplinary Studies*, *1*(2). https://journal.kiut.ac.tz/index.php/tzjms/article/view/122

Sukums F., Mzurikwao D., Sabas D., Chaula R. *et al.* (2023). The use of artificial intelligence-based innovations in the health sector in Tanzania: A scoping review. *Health Policy and Technology*, 12: 1. https://doi.org/10.1016/j.hlpt.2023.100728.

Uchechukwu. A. (2018). Inclusive Generative AI for Accessibility and Local Knowledge Systems: Preserving African Cultural Heritage Through Technology. https://doi.org/10.13140/RG.2.2.23141.72169

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.14

Prevalence of hypertension and associated factors in Dar es Salaam semi-urban, Tanzania: A community-based cross-sectional study

Lilian Leonard Fweja[1 2], Akwilina Wendelin Mwanri[1] and Cornelio N. Nyaruhucha[1]*

[1]Sokoine University of Agriculture, Department of Human Nutrition and Consumer Sciences, P.O Box 3006, Chuo Kikuu, Morogoro, [2]Open University of Tanzania, Department of Biological and Food Sciences, Morogoro Regional Centre, P.O Box 2062, Morogoro

ABSTRACT

Background: Hypertension is a major cause of disability and death globally. While several studies have assessed the prevalence of hypertension in Tanzania, most of these studies have focused on urban and rural areas.

Objective: This study aimed to assess the prevalence of hypertension and its associated risk factors in semi-urban areas of Dar es Salaam, Tanzania.

Methods: A community-based cross-sectional study was conducted in semi-urban areas of Dar es Salaam between May and July 2023. A total of 408 adults aged 18 years and above were selected through multistage cluster sampling. Data were gathered using interviewer-administered questionnaires that included questions on socio-demographics, dietary intake, physical activity, smoking, and alcohol consumption. Anthropometric measurements such as height, weight, waist and hip circumferences, and blood pressure were also taken using standard procedures. Descriptive and inferential statistics were performed using IBM SPSS version 23. Logistic regression analysis was used to identify factors associated with hypertension.

Results: The average age of participants was 40.4±13.9 years, with women making up 49% of the sample. The prevalence of hypertension was 24% (n=98). Factors associated with hypertension included; Age (AOR=1.103, 95% CI: 1.08–1.13), Male gender (AOR=2.21, 95% CI: 1.18–4.11), Obesity (AOR=5.266, 95% CI: 2.38–11.63), High vegetable consumption (AOR=3.237, 95% CI: 1.276–6.315), High consumption of sweet soft drinks (AOR=3.214, 95% CI: 1.720–6.004) and Consumption of sugary snacks (AOR=2.656, 95% CI: 1.154–6.112)

Conclusion: Hypertension was highly prevalent among residents of semi-urban areas in Dar es Salaam. Regular screening for early detection and management is essential. Additionally, public health interventions should focus on promoting healthier lifestyles to reduce the risk of hypertension and other non-communicable diseases.

Keywords: Prevalence, hypertension, associated factors, Semi-urban, Dar es Salaam

Introduction

Noncommunicable diseases (NCDs) have emerged as the leading cause of death globally, posing a significant challenge to public health (Schutte *et al*., 2021).

Hypertension, also known as high blood pressure, is a critical medical condition that can lead to various non-communicable diseases (NCDs), such as cardiovascular diseases, stroke, heart failure, dementia, and kidney diseases (Angelo *et al*., 2020). It occurs when the systolic blood pressure (SBP) exceeds 140 mmHg and/or the diastolic blood pressure (DBP) exceeds 90 mmHg (Unger *et al*., 2020a). Normal systolic and diastolic blood pressure levels are crucial for proper organ function, particularly in vital organs such as the brain, heart, and kidneys, which promote

* **Corresponding author**: lilyfweja@gmail.com

overall health and well-being (Unger *et al*., 2020b). Therefore, managing hypertension is essential to reduce the risk of NCDs.

Globally, hypertension is responsible for approximately 17.9 million deaths annually, making it the leading cause of death and disability. Despite its severe impact, hypertension often remains undetected and poorly controlled (Wakjira *et al*., 2022). In recent years, there has been a notable shift in the burden of hypertension from high-income countries to low- and middle-income countries, particularly in Sub-Saharan Africa (Schutte *et al*., 2021). The inadequate awareness levels, coupled with insufficient treatment and management rates, are significant contributing factors to the disparities in hypertension rates between high-income and low- and middle-income countries (Unger *et al*., 2020b).

Numerous studies have been conducted in Tanzania to ascertain the prevalence of hypertension in various regions, with rates ranging from 25% to 60% (Galson *et al*., 2017; Katalambula *et al*., 2017; Khamis *et al*., 2020; Muhihi *et al*., 2020; Pallangyo, 2020). The results of these studies have shown that unhealthy habits such as excess body weight (obesity), unhealthy diets, and alcohol consumption are strongly associated with high blood pressure. However, these studies focused on rural and/or urban areas, thus, limited data is available for semi-urban settings.

It is imperative to assess the prevalence rate of hypertension among semi-urban dwellers to tailor healthcare strategies specific to their needs. Semi-urban areas are experiencing rapid modernization, which has led to altered dietary patterns and sedentary lifestyles, resulting in increased rates of hypertension.

Methodology

Study area, design, and population.

This cross-sectional study was conducted in six semi-urban wards situated in Dar es Salaam from May to July, 2023. Dar es Salaam is the biggest city in terms of industrial development and population. It is characterized by rapid urbanization and modernization with lifestyle changes, particularly in dietary intake and physical activities. The 2022 National Population and Housing Census showed that Dar es Salaam has the highest population in Tanzania, with about 5.4 million inhabitants, accounting for about ten percent of the country's total population. This study included individuals aged 18 and above residing in Dar es Salaam semi-urban wards. Pregnant women, and individuals who were severely ill were excluded from the study.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.14

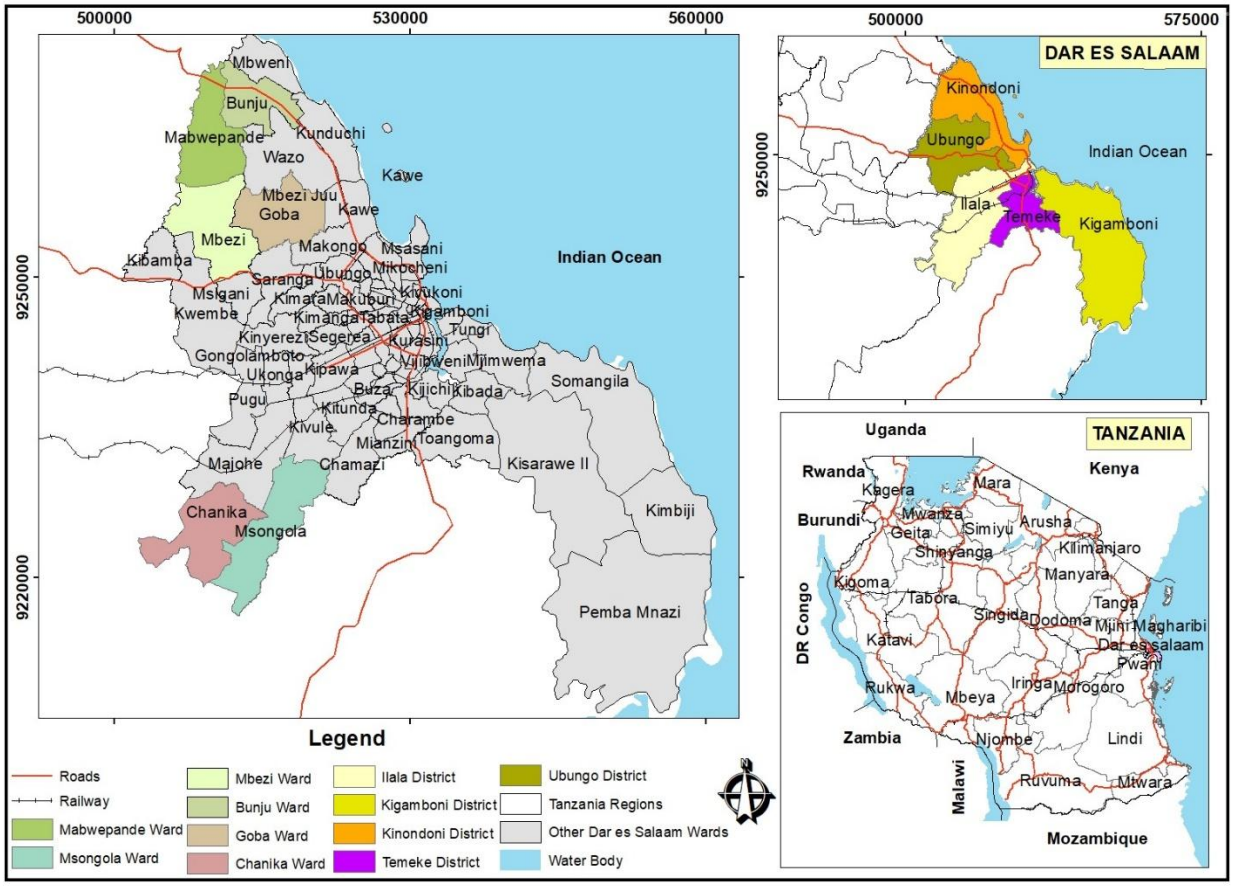


Fig 1. Map of the study area

Sample size and Sampling Procedure

The study's sample size was determined based on a hypertension prevalence rate of 59.6% in urban in Dar es Salaam (Pallangyo, 2020). The desired precision was set at 5%, with a 95% confidence level and a 10% non-response rate. As a result, a total sample size of 407 was deemed appropriate.

A multi-stage sampling method was utilized to select participants. The first stage involved a randomized selection of three districts from the five districts in Dar es Salaam: Kinondoni, Ubungo, and Ilala. Two semi-urban wards were randomly selected from each district in the second stage. In the third stage, two streets were chosen from each selected ward using a simple random sampling approach. Finally, in the fourth stage,34 households were selected from each street. All eligible respondents within each household were then included in the study.

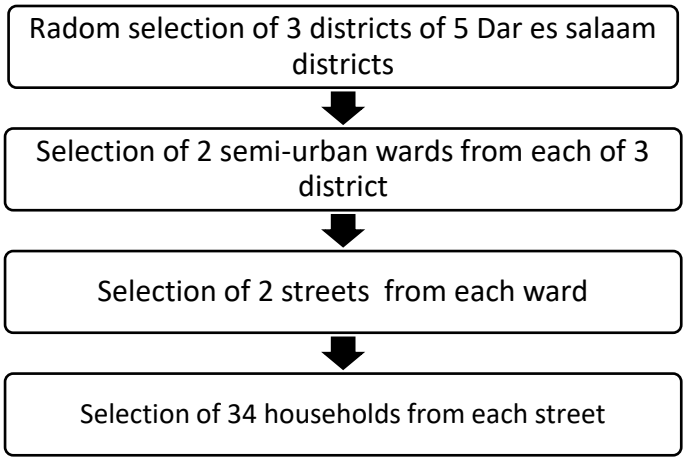


Figure 1: Flow chart of the sampling procedure

Data collection tool and procedure

A modified version of the WHO STEPS questionnaire for non-communicable disease surveillance was used to gather socio-demographic and behavioural data. The socio-demographic information collected encompassed age, gender, marital status, education level, and occupation. Age was collected as a continuous variable and later categorized into four distinct groups: young adult (18–29 years), middle adult (30–39 years), mature adult (40–59 years), and old adult (60 years or above). The highest level of formal education was assessed education attained. Marital status was classified into two categories: single and married or cohabiting. Occupation was evaluated as a categorical variable with three options: unemployed, self-employed, and formal employment.

Lifestyle behaviours assessed included smoking, alcohol consumption, dietary habits and physical activity. The dietary assessment was done by asking the respondents about the frequency of consumption of the following foods: fruits, vegetables, whole grains, sugary drinks/snacks, and high-fat foods in a week. Physical activity was assessed by using the Global Physical Activity Questionnaire (GPAQ version 2) endorsed by the WHO for its STEP-wise Approach to NCD risk factors surveys. This was done by asking participants to recall and estimate the amount of time they spend doing different types of activity (activity at work, walking, sports, and recreational). The physical activity level was measured by metabolic equivalents (MET) in minutes per week in the domain of work, transport, and recreational activity, and it was divided into two groups: low physical activity (≤599 MET-min/week), high physical activity (≥ 600 MET-min/week based on GPAC classification (World Health Organization (WHO), 2012).

Blood pressure was measured utilizing the OmronHEM-712 digital blood pressure machine. The subject was instructed to rest in a seated position for at least five minutes before three readings were taken from their left arm (Unger *et al*., 2020b). The three measurements were taken at an interval of at least five minutes, and an average of the last two readings was used. Identification of a hypertensive individual was based on the criteria established by the World Health Organization and the American Heart Association (Unger *et al*., 2020b). A person was classified as hypertensive if reported to be previously diagnosed as hypertensive or using medications.

Anthropometric measurements included weight, height, and hip and waist circumferences. During the measurement process, participants were instructed to wear light clothing and no shoes. The SECA 803 digital weighing scale was used to measure each participant's body weight to the nearest 0.1 kg. The height-measuring instrument, the MC-210 portable stadiometer, was employed to measure height to the nearest 0.1cm with the participant in a standing position, heels perpendicular to the portable stadiometer. Waist circumference was measured to the nearest 0.1cm at the midpoint between the iliac crest and the lower border of the ribs using a non-stretchable measuring tape. Three measurements were taken for each anthropometric measurement, and the average of the last two measurements was recorded.

The Body mass index (BMI) was computed by dividing an individual's weight by the square of their height (kg/m^2). The BMI categories were derived from the guidelines set by the World Health Organization and include underweight (BMI< 18.5), average weight (BMI 18.5-24.99), overweight (BMI 25-29.99), and obesity (BMI ≥30) (WHO, 2000). To identify abdominal obesity, waist circumference (WC) is taken into account, where a WC greater than 102 cm for men and 88 cm for women was classified as increased risk. Participants were classified as normal when waist circumference was less than 94 cm for men and 80 cm for women (WHO, 2000). Another parameter to assess body composition was the waist-hip ratio (WHR), calculated by dividing the waist by the hip circumference. For men, a normal WHR was categorized as ≤1 and while for women, a normal WHR was <0.8 (WHO, 2000).

Statistical Analysis

The study data was entered and analyzed using IBM-Statistical Package for Social Sciences version 23 software for Windows. Categorical data was summarized using frequencies and percentages. The chi-squared test was employed to establish any associations between individual categorical variables and hypertension. Both bivariate and multivariate logistic regression were utilized to identify the factors associated with hypertension. Firstly, a bivariate logistic regression analysis was conducted to examine the relationship of each independent variable with hypertension. Independent variables were age, BMI, waist circumference, smoking status, physical activity and consumption of sweet beverages. The multivariate logistic regression model subsequently included the variables with a P <0.2 at 95% CI from the bivariate analysis. The multivariate analysis was run using the backward elimination method for the chosen variables. The variables that showed P <0.05, with 95% CI, were considered statistically significant factors for hypertension. Odds ratios (OR) with their 95% CI were calculated to measure the strength of the association.

Ethical Approval

The research was granted ethical approval by the National Health Research Ethics Committee (NatHREC) of the National Institute for Medical Research (NIMR), with reference number NIMR/HQ/R.8a/Vol.IX/4300. The President's Office of Regional Administration and Local Government (PORALG) provided permission to conduct this study in the respective regions and districts. Before data collection, informed written consent was obtained from all respondents, who were assured that their participation was voluntary and that any information collected would be kept confidential

Results

Socio-demographic characteristics of the respondents

The study involved a total of 408 adults aged 18 years or older, with an average age of 40.4±13.9 years. The gender distribution of the participants was almost equal, with males constituting 51% (n=208) of the sample. The majority of the respondents (34.8%, n=139) fell within the age range of 40 to 59 years old. Furthermore, approximately one-third (42.4%, n=173) of the participants had pursued post-secondary education. Notably, 51% (n=205) of the participants were single (Table 1).

Table 1: Demographic characteristics of the study population (N=408)

Variables	Frequency	Percentage
Age		
18-29	103	25.8
30-39	116	29.1
40-59	139	34.8
60 and above	41	10.3
Mean (SD)	40.40 (SD13.9)	
Sex		
Male	208	51
Female	200	49
Education level		
No formal schooling	11	2.7
Primary school	117	28.7
Secondary/ High school	107	26.2
Collage/university	147	36.0
Postgraduate degree	26	6.4

 https://dx.doi.org/10.4314/thrb.v26i3.14

Marital Status		
Single	205	51.0
Cohabitating/ Married	197	49.0
Occupation		
Formal employment	167	41.0
Self – employed	209	51.4
un – employed	31	7.6
Average income per month		
≤250,000	114	27.9
More than 250,000, ≤500,000	110	27.0
More than 500,000, ≤750,000	100	24.5
More than 750,000, ≤1,000,000	41	10.0
More than 1,000,000	36	8.8
Refused to respond	7	1.7

Anthropometric characteristics and prevalence of hypertension

The findings revealed that 24% (n=98) of the participants had hypertension, with a higher prevalence in males (26.5%, n=53) than in females (21.6%, n=45). Additionally, 34.6% (n=141) of the participants were overweight, while 22.8% (n=93) were obese. Notably, obesity and overweight were more prevalent in females, with 41.3% (n=86) being overweight and 31.3% (n=65) being obese, compared to 27.5% (n=55) and 14% (n=28) for males, respectively.

Furthermore, the study assessed abdominal obesity based on waist circumference and waist-to-hip ratio. It was found that 40.7% (n=166) of the participants had abdominal obesity based on waist circumference, while 39% (n=78) of males and 42.3%(n=88) of females had an average waist circumference. Based on the waist-to-hip ratio, about 43% (n=175) were classified as abnormal (Table 2).

Table2. Anthropometric characteristics and prevalence of hypertension (N =408.)

	Total		**Males**		**Females**	
	n	**%**	**n**	**%**	**n**	**%**
Hypertension status						
Normal Bp	310	76.0	147	73.5	163	78.4
Hypertensive	98	24.0	53	26.5	45	21.6
Family history of hypertension						
No	265	65.9	126	63.9	139	67.8
Yes	137	34.1	71	34.1	66	32.2
BMI						
Underweight	9	2.2	6	3	3	1.4
Normal	165	40.4	111	55.5	54	26.0
Overweight	141	34.6	55	27.5	86	41.3
Obese	93	22.8	28	14	65	31.3
Waist Circumference						
Normal	166	40.7	78	39	88	42.3

Abnormal (Substantially increased)	103	25.2	51	25.5	52	25.0
Abnormal (increased risk)	139	34.1	71	35.5	68	32.7
Waist/Hip ratio class						
Normal	233	57.1	115	57.5	118	56.7
Abnormal	175	42.9	85	42.5	90	43.3

Lifestyle behaviour of respondents

The findings showed that a significant majority of the respondents (92.9%, n=379) reported never having smoked, while 66.9% (n=273) confirmed that they have never consumed alcohol. About 67% (n=272) of the respondents had low physical activity levels (Table3)

Table 3. Lifestyle Behavior of respondent (N=408)

Variable		Female (%)	Male (%)
Smoking			
Never smoked	379 (92.9)	207 (99.5)	172 (86.0)
Ever smoked	29 (7.1)	1 (0.5)	28 (14)
Alcohol use			
Never	273 (66.9)	152 (73.1)	130 (65.0)
Ever	126 (33.1)	56 (26.9)	70 (35.0)
Fruits			
Never	10 (2.4)	3 (1.4)	7 (3.5)
1-3 times/wk	150 (36.8)	72 (34.6)	71 (35.5)
4-7 times/wk	248 (60.8)	133 (66.8)	115 (61)
Vegetables			
Never	*16 (3.9)*	6 (2.9)	10 (5.0)
1-3 times/wk	70 (17.1)	38 (18.3)	32 (16.0)
4-7 times/wk	322 (79.0)	164 (78.8)	158 (79.0)
Wholegrains			
Never	66 (16.2)	36 (17.3)	30 (15.0)
1-3 times/wk	147 (36.0)	92 (44.2)	103 (51.5)
4-7 times/wk	195 (47.8)	80 (38.5)	67 (33.5)
Sweet beverages			
Never	*60 (14.7)*	41 (19.7)	19 (9.5)
1-3 times/wk	175 (42.9)	104 (50.0)	71 (35.5)
4-7 times/wk	173 (42.4)	63 (30.3)	110 (55.0)
Sweet snacks			
Never	*83 (22.8)*	40 (23.1)	43 (22.5)
1-3 times/wk	152 (41.7)	75 (43.5)	77 (40.3)
4-7 times/wk	129 (35.4)	58 (33.4)	71 (37.2)
Fried foods			
Never	*29 (7.1)*	19 (9.1)	10 (5.0)
1-3 times/wk	188 (46.1)	99 (47.6)	89 (44.5)
4-7 times/wk	191 (46.8)	90 (43.3)	101 (50.5)
Physical activity			
Low physical activity	272 (66.7)	148 (71.2)	124 (62.0)
High Physical activity	136 (33.3)	60 (28.8)	76 (38.0)

Factors Associated with Hypertension

Different factors were assessed for significant association with hypertension in bivariate analyses. In multivariable logistic regression analysis, age, male gender, obesity, high consumption of vegetables, sweet soft drinks and sugary snacks were identified as the major risk factors for becoming hypertensive. The odds of being hypertensive increased with an increase in age (AOR of 1.103 95% CI: 1.08–1.13). Obese individuals were 5.266 times (AOR= 5.27, 95% CI: 2.38–11.63) more likely to develop hypertension compared to normal/underweight counterparts. Males are 2.21 times (AOR= 2.21, 95% CI: 1.18–4.11) more likely to develop hypertension compared to female counterparts. The odds of being hypertensive among participants who consumed sugary soft drinks more than 3 times per week was three times (AOR=3.214, 95% CI: 1.720-6.004) compared to those who consumed less than three times a week. The odds of being hypertensive among participants who consumed sugary snacks more than 3 times per week was two times (AOR=3.214, 95% CI: 1.720-6.004) compared to those who consumed them less than three times a week. Also, the odds of being hypertensive among participants who consumed vegetables more than 3 times per week was three times (AOR=3.237, 95% CI: 1.276-6.315) compared to those who consumed them less than three times a week (Table 4).

Table 4 Multivariate Logistic Regression analysis of factors associated with hypertension in Dar es Salaam Semi urban (n=408)

Variable	Category	Hypertension		COR (95% CI)	AOR (95% CI)
		No (%)	Yes (%)		
Age mean		37	52	1.088 (1.067-1.111) *	1.103 (1.076-1.131) *
Gender	Female	163 (78.4)	45 (21.6)	1	1
	Male	147(73.5)	53 (26.5)	1.306 (0.83-2.06)	2.207 (1.185-4.112)*
Marital status	Single	159 (77.2)	47 (22.8)	1	1
	Married/ Cohabitating	145 (74.0)	51 (26.0)	1.190 (0.754-1.877)	0.611 (0.313-1.190)
Employment	Formal employment	129 (77.2)	38 (22.8)	1	1
	self-employment	157 (75.1)	52 (24.9)	1.124 (0.697-1.815)	1.587(0.755-3.339)
	un-employed	23 (74.2)	8 (25.8)	1.181 (0.489-2.853)	0.563(0.122-2.599)
Education	No formal/ primary education	93 (72.7)	35 (27.3)	1	1
	Secondary education	86 (80.4)	21(19.6)	0.649 (0.351- 1.201)	0.861 (0.349-2.127)
	University/ College	131 (75.7)	42 (24.3)	0.852 (0.506-1.435)	1.129 (0.456-2.799)
Monthly Income	≤250,000	91	23	1	1
	More than 250,000, ≤500,000	88	22	1.133 (0.431-2.978)	1.060 (0.406-2.766)
	More than 500,000, ≤750,000	73	27	1.326 (0.508-3.459)	0.709 (0.252-1.993)
	More than 750,000, ≤1,000,000	28	13	1.643 (0.442-6.102)	0.582 (0.150-2.256)
	More than 1,000,000	24	12	0.479 (0.050-4.614)	0.761(0.204-2.840)
Family history of hypertension	No	122 (86.5)	19 (13.5)	1	1
	Yes	188 (70.7)	78 (29.3)		1.905 (0.876-4.142)
BMI	Underweight/normal	152 (87.4)	22 (12.6)	1	1
	Overweight	102 (72.3)	39 (27.7)	2.642 (1.480-4.717)*	1.781 (0. 839-3.777)*
	Obese	56 (60.2)	37 (39.8)	4.565(2.480-8.403)*	5.266 (2.384-11.634)*
	Normal	145	21	1	1

Waist circumference	Abnormal (Substantially increased)	70	33	3.255 (1.756-6.033)*	0.492(0.073-3.305)
	Abnormal (increased risk)	95	44	3.198 (1.789-5.715)*	1.251(0.261-5.994)
Waist to hip ratio	Normal	185 (79.4)	48 (20.6)	1	1
	Abnormal	125 (71.4)	50 (28.6)	1.542 (0.977-2.433)	1.401 (0.624-3.145)
Smoking	Never smoked	295 (77.8)	84 (22.2)	1	1
	Ever smoked	15 (51.7)	14 (48.3)	3.278 (1.521-7.062) *	0.800 (0.236-2.710)
Alcohol use	No	220 (78.0)	62 (22.0)	1	1
	Yes	90 (71.4)	36 (28.6)	1.419 (0. 880-2.290)	1.029 (0.524-2.019)
Physical Activity	Inactive	190	86	1	1
	Active	119	12	0.233 (0.124- 0.435)*	0.591(0.239-1.463)
Fruits	0-3 times/wk	115 (75.2)	38 (24.8)	1	1
	4-7 times/wk	190 (76.6)	58 (23.4)	0.924 (0.577-1.478)	0.650(0.334-1.267)
Vegetables	0-3 times/wk	72 (83.7)	14 (16.3)	1	1
	4-7 times/wk	238 (73.9)	84 (26.1)	1.815 (0.972-3.388)	3.237(1.276-6.315)*
Wholegrains	0-3 times/wk	205 (78.5)	56 (21.5)	1	1
	4-7 times/wk	105 (71.4)	42 (28.6)	1.464 (0.921-2.329)	1.785(0.935-3.407)
Sweet beverages	0-3 times/wk	235 (81.0)	55 (19.0)	1	1
	4-7 times/wk	75 (63.6)	43 (36.4)	2.450(1.522-3.944)*	3.214 (1.720-6.004)*
Sweet snacks	0-3 times/wk	182 (77.4)	53 (22.6)	1	1
	4-7 times/wk	112 (64.7)	17 (35.3)	1.889 (0.995-3.586)	2.656 (1.154-6.112)*
Fried foods	0-3 times/wk	170(78.3)	47 (21.7)	1	1
	4-7 times/wk	135 (70.7)	56 (29.3)	1.533 (0.961-2.446)	1.623(0.778-3.390)

Note: The abbreviation 95% CI =confidence interval, AOR=Adjusted odds ratio, COR =Crude odds rationumber 1 indicates reference in categorical variables at *significance at p<0.05; multivariate analysis also includes the presence of complications with no significant association.

DISCUSSION

This study aimed to assess the risk score, prevalence, and associated factors of hypertension in semi-urban Dar es Salaam. The results indicated that one in four respondents were hypertensive. This high prevalence is associated with a high prevalence of overweight and obesity among the participants, particularly as the majority of participants were aged between 40-59 years.

Results show that the prevalence of hypertension in semi-urban Tanzania is much lower compared to community-based cross-sectional studies conducted by Pallangyo (2020) in urban Tanzania (57%) and Katalambula et al. (2017) among adults aged 25-64 in Arusha city (45%). However, it is higher than the prevalence reported in a community-based randomized trial in Kisarawe (a rural district) (19.9%). This discrepancy could be due to the differences in levels of urbanization between the two settings. The prevalence in our study is slightly lower than the results from a community-based survey in Morogoro Rural, Tanzania (29.3%) (Muhihi et al., 2020). The high prevalence of hypertension in rural Morogoro may be attributable to the exclusion of individuals younger than 25 years and the purposeful selection of two districts (Kilombero and Ulanga) with high rates of cardiovascular disease (CVD) deaths reported in previous studies.

Although studies have been conducted in other semi-urban areas in Sub-Saharan Africa, the prevalence of hypertension in our study is much lower than the 55.5% reported in a community-based cross-sectional study by Olamoyegun et al. (2016) among adults aged 18 years and older in semi-urban Nigeria. This high difference in prevalence may be explained by the higher mean age of participants in the Nigerian study compared to ours (61.7 vs. 40.4 years). The prevalence of hypertension in our study is slightly higher than

the 18.6% reported in a study by Sackou et al. (2019) in a peri-urban area of Abidjan, Côte d'Ivoire. The difference may be due to variations in study settings and demographic characteristics. However, our results are similar to those obtained by Twinamasiko et al. (2018), which found the prevalence of systolic and diastolic hypertension to be 24.5% and 31%, respectively, among adults in Uganda's peri-urban areas. The similarity could be due to the comparable study design and the fact that both study areas are undergoing rapid urbanization.

The prevalence of hypertension increased with age, which is consistent with findings from other community-based cross-sectional studies (Katalambula et al., 2017; Twinamasiko et al., 2018; Tesfaye et al., 2019; Muhihi et al., 2020; Pallangyo, 2020; Umuerri & Aiwuyo, 2020; Solomon et al., 2023). Older individuals were more likely to have hypertension compared to younger ones. This is due to physiological changes, such as the hardening of arteries with advancing age, as well as a reduction in physical activity, which increases an individual's risk of hypertension as they age. Therefore, population aging may lead to an increase in the prevalence of hypertension in this community.

Despite being less obese than females, males were at a higher risk of hypertension. This could be attributed to biological sex differences as well as behavioral factors, such as smoking and excessive alcohol consumption (Singh et al., 2017). Similarly, several other studies have found that being male increases the odds of hypertension (Muhihi et al., 2020; Olamoyegun et al., 2016; Singh et al., 2017).

Our study also found that an elevated body mass index (BMI) is a significant risk factor for hypertension. Specifically, individuals classified as obese had a fivefold increased likelihood of developing hypertension compared to those classified as normal-weight or underweight. This increased risk can be attributed to various physiological and metabolic changes associated with overweight and obesity, including insulin resistance, sympathetic nervous system overactivity, vascular smooth muscle cell proliferation, and increased renal sodium retention, all of which contribute to the onset of hypertension (Savica et al., 2010). Moreover, adipose-derived cytokines, such as leptin, along with structural and functional renal changes, further contribute to the increased risk of hypertension in overweight or obese individuals (Savica et al., 2010). Our findings are consistent with those from previous community-based cross-sectional studies (Katalambula et al., 2017; Singh et al., 2017; Twinamasiko et al., 2018; Tesfaye et al., 2019; Muhihi et al., 2020) and a meta-analysis by Ayalew et al. (2023).

Additionally, we found that daily consumption of sugary sweetened beverages and snacks was significantly associated with hypertension. High consumption of sugary foods and drinks leads to excess calorie intake and weight gain, which in turn increases an individual's risk of developing hypertension. High fructose intake, for example, can lead to increased sodium absorption, activation of renal sympathetic nerve activity, and an increase in blood pressure (Valenzuela et al., 2021). Similarly, cohort studies by Hernández-López et al. (2022) and a meta-analysis by Kim & Je (2016) found a positive association between the consumption of sugar-sweetened and artificially sweetened beverages and the risk of hypertension.

Contrary to our expectations, high consumption of vegetables was associated with an increased risk of hypertension. This could be due to the preparation methods involving excessive salt or frying, which may reduce the health benefits of vegetables. We recommend further research to investigate this relationship more thoroughly, considering the potential influence of other dietary factors and lifestyle habits.

Conclusion and Recommendations

In conclusion, this study highlights the high prevalence of hypertension among semi-urban residents in Dar es Salaam. The identified risk factors, such as high consumption of sugary soft drinks and snacks, and obesity, are modifiable, while older age and male gender are non-modifiable. It is clear that implementing preventive measures and promoting healthy lifestyles are essential to reducing the prevalence and incidence of hypertension, as well as other non-communicable diseases. To achieve this, increasing awareness about hypertension and healthy lifestyle choices (such as a balanced diet and regular physical activity) is crucial. This can be done through community workshops, mass media campaigns, and social media platforms. These efforts will not only benefit the current population but also contribute to the long-term well-being of the community.

Strengths and Limitations of the Study

It is important to acknowledge the limitations of our study. First, the cross-sectional nature of the study means that causal relationships cannot be established. Second, we did not administer a comprehensive food frequency questionnaire, which limits our ability to fully characterize the dietary patterns of the community and correlate these behaviors with hypertension. Despite these limitations, the study has notable strengths. It is the first investigation into the prevalence of hypertension in a semi-urban area of Tanzania, and its findings are relevant not only to Tanzania but also to other sub-Saharan African countries. Furthermore, it is the first study in Tanzania to assess the hypertension risk score in non-hypertensive adults.

Conflicts of Interest

The authors declared no conflicts of interest.

Authors contribution

LF conceived the idea, developed the proposal, designed the study, participated in data collection, management, analysis and interpretation of the results, and drafted the manuscript. AWM and CN assisted in the design and the proposal development, supervised the study procedures, and revised subsequent manuscript drafts. All authors read and approved the final version of the manuscript

Acknowledgements

The authors sincerely grateful to study participants for taking their valuable time in provision of data in this study.

Funding

The authors have received no funding for this work

References

Angelo, A. T., Geltore, T. E., Sciences, H., Aman, M., Science, H., Campus, D., Sciences, H., Tepi, M., & Aman, M. (2020). Lifestyle modification practice and associated factors among diagnosed hypertensive patients in Mizan Tepi University Teaching Hospital South west Ethiopia, 2019: cross-sectional study. *Pan African Medical Journal*, *2797*, 1–12.

Ayalew, T. L., Wale, B. G., & Zewudie, B. T. (2023). A systemic review and meta-analysis on the prevalence and associated factors of hypertension among adult clients in Ethiopia. *African Health Sciences*, *23*(4), 296–314.

Galson, S. W., Staton, C. A., Karia, F., Kilonzo, K., Lunyera, J., Patel, U. D., Hertz, J. T., & Stanifer, J. W. (2017). Epidemiology of hypertension in Northern Tanzania: a community-based mixed-methods study. *BMJ Open*, *7*, 1–10. https://doi.org/10.1136/bmjopen-2017-018829

Hernández-López, R., Canto-Osorio, F., Vidaña-Pérez, D., Torres-Ibarra, L., Rivera-Paredez, B., Gallegos-Carrillo, K., Velazquez, R., Ramírez, P., Barrientos-Gutiérrez, T., Salmerón, J., & López-Olmedo, N. (2022). Soft drink and non-caloric soft drink intake and their association with blood pressure: the Health Workers Cohort Study. *Nutrition Journal*, *21*(1), 1–10. https://doi.org/10.1186/s12937-022-00792-y

Katalambula, L. K., Meyer, D. N., Ngoma, T., Buza, J., Mpolya, E., Mtumwa, A. H., & Petrucka, P. (2017). Dietary pattern and other lifestyle factors as potential contributors to hypertension prevalence in Arusha City , Tanzania : a population-based descriptive study. *BMC Public Health*, *17*, 1–7. https://doi.org/10.1186/s12889-017-4679-8

Khamis, A. G., Senkoro, M., Mwanri, A. W., Kreppel, K., Mfinanga, S. G., Bonfoh, B., & Kwesigabo, G. (2020). Prevalence and determinants of hypertension among pastoralists in Monduli District , Arusha region in Tanzania : a cross-sectional study. *Archives of Public Health*, *78*(99), 1–12.

Kim, Y., & Je, Y. (2016). Prospective association of sugar-sweetened and artificially sweetened beverage intake with risk of hypertension. *Archives of Cardiovascular Diseases*, *109*(4), 242–253. https://doi.org/10.1016/j.acvd.2015.10.005

Muhihi, A. J., Anaeli, A., Mpembeni, R. N. M., Sunguya, B. F., Leyna, G., Kakoko, D., Kessy, A. T., Sando, M. M., Njelekela, M., & Urassa, D. P. (2020). Prevalence , Awareness , Treatment , and Control of Hypertension among Young and Middle-Aged Adults : Results from a Community-Based Survey in Rural Tanzania. *International Journal of Hypertension*, *2020*, 1–13.

Olamoyegun, M. A., Oluyombo, R., Iwuala, S. O., & Asaolu, S. O. (2016). Epidemiology and patterns of hypertension in semi-urban communities, South-Western Nigeria. *Cardiovascular Journal of Africa*, *27*(6), 356–360. https://doi.org/10.5830/CVJA-2016-037

Pallangyo, P. (2020). Hypertension in Urban Tanzania : A ticking time bomb. *Archivos de Medicina*, *16*(4), 9465.

Sackou, J. K., Tiadé, M. L., Hounsa, A. A., Malik, S. K., Coulibaly, M., Desquith, A. A., Kadjo, F. K., Agoua, S. A., Oga, S., & Kouadio, L. K. (2019). Prevalence and factors associated with hypertension in anonkoi 3, a peri-urban area in abidjan (Côte d'ivoire). *Journal of Public Health in Africa*, *10*(2). https://doi.org/10.4081/jphia.2019.1106

Savica, V., Bellinghieri, G., & Kopple, J. D. (2010). The effect of nutrition on blood pressure. *Annual review of nutrition*, *30*, 365–401. https://doi.org/10.1146/annurev-nutr-010510-103954

Schutte, A. E., Venkateshmurthy, N. S., & Dorairaj, P. (2021). HYPERTENSION COMPENDIUM Hypertension in Low-and Middle-Income Countries. *Circulation Research*, *128*(7), 808–826. https://doi.org/10.1161/CIRCRESAHA.120.318729

Shariq, O. A., & McKenzie, T. J. (2020). Obesity-related hypertension: a review of pathophysiology, management, and the role of metabolic surgery. *Gland surgery*, *9*(1), 80–93. https://doi.org/10.21037/gs.2019.12.03

Singh, S., Shankar, R., & Singh, G. P. (2017). Prevalence and Associated Risk Factors of Hypertension: A Cross-Sectional Study in Urban Varanasi. *International Journal of Hypertension*, *2017*, 1–10. https://doi.org/10.1155/2017/5491838

Solomon, M., Shiferaw, B. Z., Tarekegn, T. T., GebreEyesus, F. A., Mengist, S. T., Mammo, M., Mewahegn, A. A., Mengiste, B. T., & Terefe, T. F. (2023). Prevalence and Associated Factors of Hypertension Among Adults in Gurage Zone , Southwest Ethiopia , 2022. *SAGE Open Nursing*, *9*, 1–8. https://doi.org/10.1177/23779608231153473

Sukohar, A. (2021). Theory of Planned Behavior (TPB) and Hypertension Prevention. *Indian Journal of Forensic Medicine & Toxicology*, *15*(3), 2049–2053. https://doi.org/10.37506/ijfmt.v15i3.15616

Tesfaye, T. D., Temesgen, W. A., & Kasa, A. S. (2019). Prevalence and associated factors of hypertension in Amhara regional state city and its' surrounding rural districts: a community-based cross-sectional study. *African Health Sciences*, *19*(3), 2580–2590.

Twinamasiko, B., Lukenge, E., Nabawanga, S., Nansalire, W., Kobusingye, L., Ruzaaza, G., & Bajunirwe, F. (2018). Sedentary lifestyle and hypertension in a periurban area of mbarara, South Western Uganda: A population based cross sectional survey. *International Journal of Hypertension*, *2018*. https://doi.org/10.1155/2018/8253948

Umuerri, E. M., & Aiwuyo, H. O. (2020). *Prevalence and correlates of prehypertension and hypertension among adults in Delta State , Nigeria : a cross-sectional community-based study*. *54*(1), 48–57.

Unger, T., Borghi, C., Charchar, F., Khan, N. A., Poulter, N. R., Prabhakaran, D., Ramirez, A., Schlaich, M., Stergiou, G. S., Tomaszewski, M., Wainford, R. D., Williams, B., & Schutte, A. E. (2020a). Clinical Practice Guidelines 2020 International Society of Hypertension Global Hypertension Practice Guidelines International Society of Hypertension. *Hypertension*, *75*(6), 1334–1357. https://doi.org/10.1161/HYPERTENSIONAHA.120.15026

Unger, T., Borghi, C., Charchar, F., Khan, N. A., Poulter, N. R., Prabhakaran, D., Ramirez, A., Schlaich, M., Stergiou, G. S., Tomaszewski, M., Wainford, R. D., Williams, B., & Schutte, A. E. (2020b). Clinical Practice Guidelines 2020 International Society of Hypertension Global Hypertension

Practice Guidelines International Society of Hypertension. *Hypertension*, *75*(6), 1334–1357. https://doi.org/10.1161/HYPERTENSIONAHA.120.15026

Valenzuela, P. L., Carrera-Bastos, P., Gálvez, B. G., Ruiz-Hurtado, G., Ordovas, J. M., Ruilope, L. M., & Lucia, A. (2021). Lifestyle interventions for the prevention and treatment of hypertension. *Nature Reviews Cardiology*, *18*(4), 251–275. https://doi.org/10.1038/s41569-020-00437-9

Wakjira, H., Gobena, T., & Shore, H. (2022). Lifestyle modification practice and associated factors among diagnosed hypertensive patients in selected Hospitals in West Arsi Zone, Oromia Regional State, Ethiopia. *Journal of Cardiology and Cardiovascular Medicine*, *7*(006-012.), 6–12. https://doi.org/10.29328/journal.jccm.1001124

WHO. (2000). *Obesity : preventing and managing the global epidemic*. World Health Organization.

World Health Organization (WHO). (2012). *Global Physical Activity Questionnaire (GPAQ) Analysis Guide version* 2. WHO.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.16

Factors for Prime Vendor System Performance in Complementing Health Commodities in Public Health Facilities: A Case Study of Tanzania Mainland

Mathew Mganga[1], Stephen Kibusi[2], Romuald Mbwasi[3]*

[1]Presidents' Office, Regional Administration and Local Government – PORALG, Dodoma, [2]University of Dodoma, Dodoma and [3]St. John's University of Tanzania, Dodoma.

Abstract

Introduction: The World Health Organization (WHO) estimates that one-third of the global population lacks access to essential medicines, highlighting the importance of the Prime Vendor System (PVS) in improving supply chain efficiency. In Tanzania, the PVS was introduced in 2018 to complement the Medical Stores Department (MSD), which could meet only 60% of the demand. However, inefficiencies in the system have led to regional disparities in the availability of health commodities.

Aim: This study explored the factors affecting the performance of regional prime vendors in addressing the health commodities supply chain gap. Data was collected from 149 health facilities across different regions from June to September 2023. The findings revealed that while 83% of facilities had prime vendor tools, significant gaps in tool availability and regional variation in fulfillment rates and lead times were observed.

Results: *Prime Vendor Tools*: 83% of health facilities had these tools available, with price schedules being the most common. *Fulfillment Rate and Lead Time:* Fulfillment rates ranged from 74.9% to 91.5% across regions, with lead times of 17 to 27 days, which is longer than the recommended 14 working days. *Fulfillment Rate for Multiple Installments:* Orders were often delivered in multiple installments, with fulfillment rates varying from 65% to 92%.*Prime Vendor Performance:* Regional performance scores showed significant differences, with Mwanza scoring the highest at 91% and Morogoro the lowest at 79.22%.

Conclusion: The study concludes that while the PVS has improved commodity availability, issues like delayed lead times, inconsistent availability of management tools, and a lack of effective electronic platforms need to be addressed for better system performance.

Introduction

The Tanzania Health Sector Strategic Plan V (MoHCDGEC, 2021) highlights the need for existence of an efficient supply chain system for providing all households with essential health services that meet quality standards and are based on evidence-informed interventions through resilient health systems (MOHSW, 2017), there was a need for establishment of a PPP intervention (URT, 2009) like prime vendor system to improve the availability of essential health commodities in public health facilities by enhancing quality of products, order fulfillment rates, controlling costs, and increasing client/patient satisfaction (URT, 2009).

The World Health Organization (WHO) estimates that about one-third of the world's population lacks access to quality essential medicines and diagnostics, the performance of the prime vendor system plays an essential role in complementing the commodities availability at all levels of facilities (Kuwawenaruwaet al., 2020), the measurement of Performance for both Prime Vendor

[*]**Corresponding author:** Mathew Mganga; matayosemunyu@gmail.com

System and Prime Vendor is very crucial and important to determine commodities availability, and this performance is attained through availability of Prime Vendor Tools, fulfillment Rate and Lead time, Fulfillment Rate for Multiple Installments and Performance of Prime Vendor per Health Facility as stipulated in (Redcross, 2020).

In Tanzania, the Prime Vendor System (PVS) was a nationwide rollout and launched in 2018 (PORALG, 2022) to complement the Medical Stores Department (MSD), which could only meet 40% of the demand (Printz et al., 2013). The performance of the prime vendor system is measured, among other factors, through the availability of Prime Vendor Management tools (Redcross, 2020). Currently, the prime vendor system and prime vendors' performance are still not complementing the supply chain gap at 100% due to some inefficiencies observed during implementation (PORALG, 2022),

The success of Quality Health care provision relies heavily on efficient supply chain management systems, which ensure the consistent availability of quality medicines. Peripheral health facilities often face significant challenges in accessing these medicines due to poor performance of the available supply chain system, factors like availability of management tools, the capabilities of regional prime vendors, and the readiness of health facilities to utilize allocated complementary funds including user fees collection (Kuwawenaruwa, Wyss, et al., 2020);(Yadav, 2015);(Arney et al., 2014)&(Pyuza et al., 2023) may compromise the availabilities of health commodities.

While extensive research has examined the impact of the prime vendor system on the supply chain, few studies have explored/evaluated the factors affecting prime vendor system performance. So, this study aims to understand the factors for prime vendor system performance in complementing health commodities in Public Health facilities.

Materials and Methodology

Study Design

This research adopts an observational cross-sectional study design.

Study Population

The study population consisted of 149 health facilities from four regions in Tanzania's Mainland, namely Dodoma, Morogoro, Mtwara, and Mwanza, with thirteen diverse local government authorities (Phillips & Acheson, 2014).

Sample Size and Sampling

A total of 149 Health facilities were selected, including 4 Regional Referral Hospitals, 11 District hospitals, 51 health centers, and 83 dispensaries present in each council visited. Also, regions were selected based on their relevance to the research objectives, which include regions with and without medical store department zonal offices and regions with facilities having high consumption rates of health commodities. The councils were chosen randomly, ensuring representation of both rural and urban settings to capture diverse perspectives. This random selection of councils enhances the study's representativeness (Bacchetti & Leung, 2002).

Data collection and data processing

A retrospective data collection approach was done with the deployment of a standard checklist to extract the logistics information related to specific regional prime vendors at each health facility. These documents included MSD out-of-stock notifications, prime vendor invoices, delivery notes, inspection forms of consignments, orders sent to the prime vendors, and ledgers. the documents under observation and review were taken in a period between 2019 and 2022.

Data Analysis

Data collected were cleaned in an Excel document, with data analysis being conducted using SPSS version 25 and Microsoft Excel 365. due to its variables, the analysis was statistically descriptive based on findings, the mean, percentage, and sum of the results per each variable in all regions visited. The unit of analysis was the health facilities, and the majority of variables were the invoices. The results were demonstrated in graphs and tables (Elias & Mushi, 2024).

Ethical Considerations

The Ethics Committee of the University of Dodoma granted ethical approval and registration for the study. In addition, the Office of the Presidents of the Local Government Regional Administration and the Ministry of Health in Tanzania granted permission for access to all facilities supporting/ implementing the Prime Vendor System within the Regional Secretariat and Local Government Authorities as well as four regional referral hospitals (Dodoma, Morogoro, Mtwara and Mwanza).

Results

The study was conducted across four regions: Dodoma, Morogoro, Mtwara, and Mwanza. A total of 149 health facilities were visited, comprising 4 Regional Referral Hospitals (3%), 11 District Hospitals (7%), 51 Health Centers (34%), and 83 Dispensaries (56%).

The study focused on four key variables: the availability of prime vendor system management tools, the fulfillment rate and lead time for full consignments, the fulfillment rate for partial consignments, and the performance of the prime vendors per health facility assessed using the Prime Vendor System Monitoring & Evaluation tool. Data were collected and analyzed for each health facility and then aggregated by region to provide a comprehensive overview of the performance in each region (Kazi, 2012).

Availability of prime vendor tools

Using an observational approach, the availability of Prime Vendor implementation tools was examined in each health facility. To ensure the fidelity of the Prime Vendor system implementation, each facility was required to have a minimum of four specific tools: a copy of the price schedules for the respective Prime Vendor, a copy of the contract with the respective regional Prime Vendor, a copy of the Prime Vendor Implementation Manual, and a copy of the Monitoring and Evaluation tool.

A descriptive analysis was conducted on all collected data, with results presented in tables and charts. These results illustrate the availability of the required tools in the visited health facilities across the four regions. The unit of analysis for this variable was the individual health facility.

A total of 149 health facilities were assessed for the availability and use of prime vendor tools. The evaluation included 38 health facilities in Mtwara, 38 health facilities in Morogoro, 37 health facilities in Mwanza, and 36 health facilities in Dodoma.

	Number of Health Facilities	HF with Tools	HF with no Tools
DISPENSARY	83	62 (75%)	21 (25%)
DISTRICT HOSPITAL	11	11 (100%)	0 (0%)
HEALTH CENTER	51	48 (94%)	3 (6%)
REGIONAL REFERRAL HOSPITAL	4	3 (75%)	1 (25%)
Total Health Facilities	**149**	**124 (83%)**	**25 (17%)**

Among 149 health facilities visited across the four regions, the majority, 124 (83%), had prime vendor tools available, while 25 (17%) did not. Notably, among the health facilities visited, Mtwara had the highest percentage of health facilities without prime vendor tools.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.16

Table 1: Health facilities without any Prime Vendor tools per Region

Health facilities without any Prime vendor tools per region (n – 25)		
	Health Facility	**Percent (%)**
Dodoma	1	4%
Morogoro	1	4%
Mwanza	3	12%
Mtwara	20	80%
Total	**25**	**100%**

The table above indicates that among the health facilities observed to have no prime vendor tools, the majority were from Mtwara (20 facilities), while 3 were from Mwanza, and 1 from Dodoma and Morogoro. Additionally, the researcher analyzed to see which among the prime vendor tools is mostly available at health facilities. The table below shows health facilities with prime vendor tools, it was observed that the most available and used tool was the price schedules from 124 HFs (83.2%). However, only 13 HFs (9.1%) had a copy of the contract with the prime vendor, 4 HFs (2.8%) had a copy of the Prime Vendor Implementation Manual, and only 2 HFs (1.4%) had a copy of the Monitoring and Evaluation tool. See table 2 and 3 respectively.

Table 2: Availability of individual Prime Vendor tool per Region

Prime Vendor Tools					
	Dodoma (n=36)	**Morogoro (n=38)**	**Mtwara (n=38)**	**Mwanza (n=37)**	**Overall**
A copy of Price schedules with respective Prime vendor	35 (97.2%)	37 (97.3%)	18 (47.3%)	34 (91.9%)	124 (83.2%)
A copy of the contract respective to the Prime Vendor	10 (27.8%)	1 (2.6%)	1 (2.6%)	1 (2.7%)	13 (9.1%)
A copy of the Prime Vendor Implementation Manual	1 (2.8%)	2 (5.2%)	0 (0.0%)	1 (2.7%)	4(2.8%)
A copy of M&E Tool	1 (2.8%)	0 (0.0%)	0 (0.0%)	1 (2.7%)	2(1.4%)

Table 3: Availability of tools per level of health facility in each region visited

Mtwara			
	Number of Health Facility	**HF with Tools**	**HF with no Tools**
DISPENSARY	25	8 (32%)	17 (68%)
DISTRICT HOSPITAL	3	3 (100%)	0 (0%)
HEALTH CENTER	9	6 (67%)	3 (33%)
REGIONAL REFERRAL HOSPITAL	1	1 (100%)	0 (0%)
Total Health Facilities in Mtwara	**38**	**18 (47%)**	**20 (53%)**
Morogoro			

 https://dx.doi.org/10.4314/thrb.v26i3.16

	Number of Health Facility	HF with Tools	HF with no Tools
DISPENSARY	20	19 (95%)	1 (5%)
DISTRICT HOSPITAL	2	2 (100%)	0 (0%)
HEALTH CENTER	15	15 (100%)	0 (0%)
REGIONAL REFERRAL HOSPITAL	1	1 (100%)	0 (0%)
Total Health Facilities in Morogoro	**38**	**37 (97%)**	**1 (3%)**

Mwanza

	Number of Health Facility	HF with Tools	HF with no Tools
DISPENSARY	22	20 (91%)	2 (9%)
DISTRICT HOSPITAL	3	3 (100%)	0 (0%)
HEALTH CENTER	11	11 (100%)	0 (0%)
REGIONAL REFERRAL HOSPITAL	1	0 (0%)	1 (100%)
Total Health Facilities in Mwanza	**37**	**34 (91.9%)**	**3 (8.1%)**

Dodoma

	Number of Health Facility	HF with Tools	HF with no Tools
DISPENSARY	16	15 (94%)	1 (6%)
DISTRICT HOSPITAL	3	3 (100%)	0 (0%)
HEALTH CENTER	16	16 (100%)	0 (0%)
REGIONAL REFERRAL HOSPITAL	1	1 (100%)	0 (0%)
Total Health Facilities in Dodoma	**36**	**35 (97%)**	**1 (3%)**

The tables above present the availability of tools across health facilities in four regions: Mtwara, Morogoro, Mwanza, and Dodoma, with 47%, 97%, 91.9% and 97 %, respectively, indicating Mtwara had the lowest availability of Prime Vendor tools.

Fulfillment rate results for full consignments and Lead Time

At each health facility, the researcher evaluated the lead time and fulfillment rate of prime vendors for the respective region visited. In the four regions, the lead time and fulfillment rate of the prime vendor were calculated.

Fulfillment rate of respective regional Prime Vendors

The fulfillment rate is calculated by dividing the number of items received/delivered by the number of items ordered from the prime vendor and multiplying by 100%. During the assessment, the researcher reviewed the invoices for each health facility visit.

Table 4: Fulfillment rate of Prime Vendor in the respective region

Fulfillment Rate of PV in respective region	
	Mean % Fulfillment Rate
Mwanza	91.5%
Dodoma	88.5%
Mtwara	79.6%

https://dx.doi.org/10.4314/thrb.v26i3.16

Morogoro	74.9%

The analyzed data showed that from all health facilities visited in all 4 regions, the respective regional prime vendor was able to fulfill the orders above 74% - 91.5%. Which respective regional prime vendors of Morogoro had the highest Fulfillment rate of 91.5%, followed by Dodoma at 88.5%, Mtwara at 79.6% and Morogoro with 74.9% of fulfillment rate.

Lead time of respective regional prime vendor

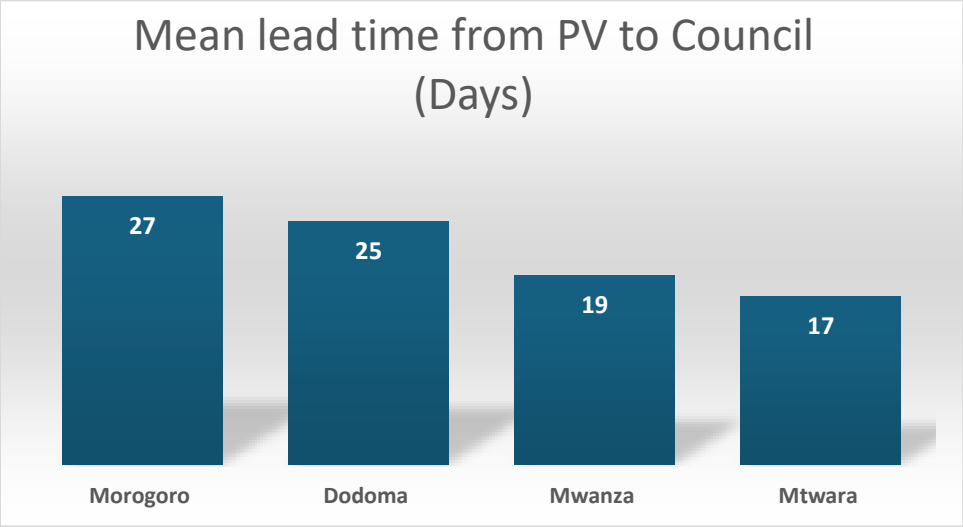
Lead time refers to the time taken to receive consignments from the prime vendor to the Council, from the Council to the health facility, and directly from the prime vendor to the health facility.
Overall, from all regions visited, the total number of days for delivering consignments from the prime vendor to the Council was longer (17–27 days) compared to the time taken to deliver consignments from the Council to health facilities (0–9 days). The table below shows the lead time for respective regional prime vendors before and after the transition of the prime vendor system.

Table 5: Mean Lead Time

Mean Lead Time			
	PV to Council	**Council to Health Facility**	**PV to Health facility**
Morogoro	27.4	9.18	37.2
Dodoma	24.78	4.39	28.84
Mwanza	19.3	0	41.32
Mtwara	17.14	0.75	18

Number of days took for consignment from Prime vendor to Council

Figure 1: Lead time from Prime Vendor to Council

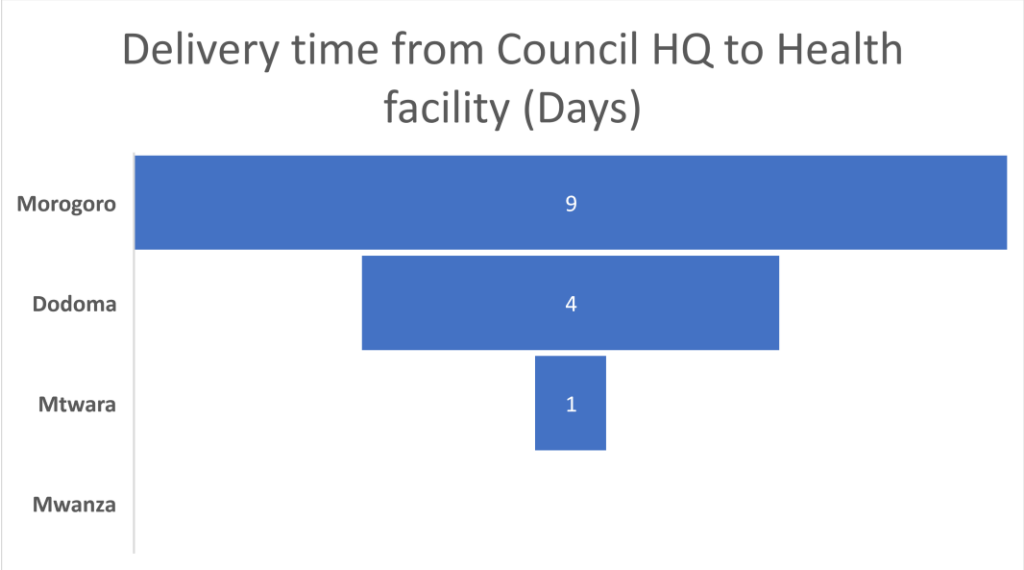


The figure above displays the number of days, on which the prime vendor took to deliver consignment from the Prime vendor to the agreed location at the Council Level.

Number of days took for consignment from Council to Health Facility

 https://dx.doi.org/10.4314/thrb.v26i3.16

Figure 2: Delivery time from council to health facility



The figure above shows that Morogoro had the longest lead time of an average 9.18 days to distribute from councils to the health facilities.

Fulfilment rate for orders with multiple instalments from prime vendor

It was observed that regional prime vendors often delivered orders in installments to complete the entire order. The majority of orders sent to the respective regional prime vendors required 2 installments (62%) to deliver consignments to health facilities and in some cases, it took 2 to 7 installments for the respective regional prime vendors to complete an order.

Table 6: Number of Installments per single order

Number of Instalments	Count	Percent (%)
2	56	62%
3	23	26%
4	4	4%
5	5	6%
6	1	1%
7	1	1%

The average fulfillment rate for all 4 regions visited, where orders were delivered in multiple installments, ranged from 65% to 92%.

Table 7: Fulfillment Rate for First and Overall Installments for PV orders

	Mean Fulfillment Rate (%) - First Installment	Mean Fulfillment Rate (%) - Overall Installments
Dodoma	47%	74%
Morogoro	52%	65%
Mtwara	62%	88%
Mwanza	80%	92%

Performance of Prime Vendor per Health Facility

Performance of prime vendor was analyzed using the standard Monitoring & Evaluation (M&E) .and it was measured across five aspects, Product Quality which was weighed (25%), Service Level (40%), Shelf Life (10%), Lead Time (15%), and Delivery Point (10%), totaling a 100% performance score.

From the results, it was noted that Mwanza had the highest performance at 91%, followed by Dodoma at 87.65%, Mtwara at 88.38%, and Morogoro at 79.22%. This indicates that the prime vendor system is, to a greater extent, effectively in complementing the Medical Store Department (MSD).

Table 8: Performance of Prime Vendor

Mean Performance of PV				
	Dodoma	**Morogoro**	**Mtwara**	**Mwanza**
Product Quality (25%)	25.00%	25.00%	25.00%	25.00%
Service Level (40%)	33.57%	30.82%	33.37%	40.00%
Shelf Life (10%)	10.00%	10.00%	10.00%	10.00%
Lead Time (15%)	9.08%	3.40%	10.00%	6.00%
Delivery Point (10%)	10.00%	10.00%	10.00%	10.00%
Mean Total Performance	**87.65%**	**79.22%**	**88.38%**	**91.00%**

Mwanza and Morogoro experience longer lead times to deliver the commodities at health facilities, the reasons being geographical challenges. For instance, from Mwanza to Ukerewe district, multiple modes of transportation were required to deliver consignments, which can impact the supply chain; similar reasons were observed in Morogoro.

Discussion

Availability of prime vendor tools

The study found that 124 facilities (83%) had prime vendor tools available, while 25 facilities (17%) did not. Mtwara had the highest percentage of facilities without these prime vendor management tools, highlighting a critical area for improvement. Among the available tools, the most commonly management tools found was the price schedules for prime vendors, present in 83.2% of the facilities, followed by Contracts (9.1%) and least were the PVS Implementational manual (2.8%) and monitoring and evaluation tools (1.4%) availabilities among all the visited health facilities respectively.

The study findings align with existing literature, highlighting common challenges in the implementation of prime vendor systems across different regions. Effective dissemination of tools and continuous training is critical for the success and sustainability of these systems, a theme consistently echoed in related studies. Further research and policy adjustments are needed to address these ongoing challenges, particularly at lower health facility levels (Lugada et al., 2022).

Fulfillment rate of Prime Vendors

The fulfillment rate of prime vendors varied significantly by region. Morogoro achieved the highest fulfillment rate at 91.5%, followed by Dodoma at 88.5%, Mtwara at 79.6%, and Morogoro at 74.9% concerning the supply chain gap observed.

Lead time

The lead time for delivering consignments from prime vendors to councils ranged from 17 to 27 days, contrary to the 14 working days recommended by the PVS Implementation manual (PORALG, 2022), with Morogoro experiencing the longest delays.

Performance of Prime Vendor per Health Facility

The performance of prime vendors was assessed using a standard Monitoring & Evaluation tool. Mwanza had the highest performance score at 91%, followed by Mtwara at 88.38%, Dodoma at 87.65%, and Morogoro at 79.22%. These scores reflect the overall effectiveness of the prime vendor system in complementing the Medical Stores Department and improving the availability of essential medicines.

The study also revealed that many orders required multiple installments to be fulfilled. Among the 149 health facilities, none of the orders were delivered once with single installments. the capacity varies from 62% of orders being delivered in two installments while up to 1% of orders were observed to be delivered in seven installments. The overall fulfillment rate for these orders ranges from 65% to 92%, indicating variability in the efficiency of prime vendors across different regions.

Conclusion

The findings from the study found that while most health facilities had access to only price schedules, there was a significant decline in the availability of other tools across regions and facilities. Also, the prime vendors generally achieved slightly higher fulfilment rates. Moreover, the period from order receipt to delivery is another critical problem where the study observed a significant delay in the delivery of health commodities from both the prime vendor to the council and the council to the health facility.

Recommendations

The study highlights three key areas for improvement in Tanzania's Prime Vendor System (PVS): inconsistent dissemination of prime vendor tools to lower-level facilities, which requires ongoing health sector programs; significant training gaps among staff, particularly in procurement processes and tool usage, which could be addressed through comprehensive training and refresher courses; and the need for prime vendors to improve delivery lead times to meet the 14-day standard, along with establishing larger regional warehouses to better handle demand.

List of Abbreviations

CHMT	Council Health Management Team
CMTs	Council Management Teams
DHIS2	District Health Information System
eLMIS	electronic Logistics Management Information System
ERP	Enterprise Resource Planning
GPS	Global Positioning System
ILS	Integrated Logistics System
IMPACT	Information Mobilized for Performance Analysis and Continuous Transformation
IRB	Institutional Review Board
MoH	Ministry of Health
MSD	Medical Stores Department
ODK	Open Data Kit
PORALG	President's Office Regional Administration and Local Government
PVS	Prime Vendor System
RHMT	Regional Health Management Teams

RS	Regional Secretary
RHMT	Regional Health Management Team
SAS	Statistical Analysis Software
TMDA	Tanzania Medicines and medical Devices Authority

Acknowledgements
Special thanks are extended to Dr Stephen Kibusi and Dr. Romuald Mbwasi for their collaboration, cooperation and great contributions to the review of this work and their technical guidance throughout the manuscript preparation for publication.

Authors Contributions
MM developed the proposal and study design and participated in planning, data collection, and data interpretation. MM acted as the principal investigator in all four regions visited, and MM supervised the data collection process. MM contributed to the training and management of data collection. RM and MM supported planning and organizing logistics. MM drafted the manuscript for input by the other authors. All authors read and approved the final manuscript.

Competing Interests
The authors declare that they have no competing interests.

References
Arney, L., Yadav, P., Miller, R., & Wilkerson, T. (2014). *Strategic contracting practices to improve procurement of health commodities*. Global Health Science and Practice, 2(3), 295–306. https://doi.org/10.9745/GHSP-D-14-00068

Bacchetti, P., & Leung, J. M. (2002). *Sample size calculations in clinical research* [7]. Anesthesiology, 97(4), 1028–1029. https://doi.org/10.1097/00000542-200210000-00050

Elias, L., & Mushi, L. (2024). *Effectiveness of prime vendor system on availability of medicines and medical supplies in the selected public health facilities in Arusha district council*. BMC Health Services Research, 24(1), 1–9. https://doi.org/10.1186/s12913-024-10581-4

Fossey, E., Harvey, C., Mcdermott, F., & Davidson, L. (2002). *Understanding and evaluating qualitative research Australian and New Zealand Journal of Psychiatry*. Journal of Psychiatry, 717–732.

Kazi, S. K. (2012). *Supply Chain Management Practices and Performance At Kenya Medical Supplies Agency a Management Research Project Submitted in Partial Fulfilment of the Requirement for the Degree of Master of Business*. 1–53.

Kuwawenaruwa, A.,, Tediosi, F., Tediosi, F., Obrist, B., Obrist, B., Metta, E., Metta, E., Chiluda, F., Wiedenmayer, K., Wiedenmayer, K., Wiedenmayer, K., Wyss, K., & Wyss, K. (2020). *The role of accountability in the performance of Jazia prime vendor system in Tanzania*. Journal of Pharmaceutical Policy and Practice, 13(1), 1–13. https://doi.org/10.1186/s40545-020-00220-8

Kuwawenaruwa, A., Wyss, K., Wiedenmayer, K., & Tediosi, F. (2020). *Cost and cost drivers associated with setting-up a prime vendor system to complement the national medicines supply chain in Tanzania*. *BMJ Global Health*, *5*(9), e002681. https://doi.org/10.1136/bmjgh-2020-002681

Lugada, E., Komakech, H., Ochola, I., Mwebaze, S., Olowo Oteba, M., & Okidi Ladwar, D. (2022). *Health supply chain system in Uganda: current issues, structure, performance, and implications for systems strengthening*. *Journal of Pharmaceutical Policy and Practice,* 15(1), 1–11. https://doi.org/10.1186/s40545-022-00412-4

Ministry of Health, T. (2017). *Report - Holistic Supply Chain Review_final draft* (p. 88).

MoHCDGEC. (2021). *Tanzania Health Sector Strategic Plan 2021-2026*. *2026*(July), 104.

MOHSW, T. (2017). *Policy - National Health Policy*. Ministry of Health, Community Development, Gender, Elderly, and Children, Tanzania, October, 1–55. https://extranet.who.int/nutrition/gina/en/node/8273

O'Neill, K., Viswanathan, K., Celades, E., & Boerma, T. (2016). *Monitoring, evaluation and review of national health strategies*. Strategizing National Health in the 21st Century: A Handbook, 39. http://www.who.int/healthsystems/publications/nhpsp-handbook-ch9/en/

Phillips, A., & Acheson, N. (2014). *Basic epidemiology*. Gynaecological Oncology for the MRCOG and Beyond, Second Edition, 1–14. https://doi.org/10.1017/CBO9781139696951.003

PORALG. (2022). *PRIME VENDOR SYSTEM IMPLEMENTATION MANUAL*. *1*(45), 3–6.

Printz, N., Amenyah, J., Serumaga, B., Van Wyk, D., USAID, & DELIVER. (2013). *Tanzania: Strategic Review of the National Supply Chain for Health Commodities*. Ministry of Health and Social Welfare, April, 111.

Pyuza, D., Mitiku, S., Swalehe, O., Kagisha, V., & Njunwa, K. J. (2023). *Performance of Jazia Prime Vendor System in ensuring availability of health commodities in Singida Region, Tanzania: a pre- and post-evaluation study*. Journal of Pharmaceutical Policy and Practice, 16(1), 1–9. https://doi.org/10.1186/s40545-023-00660-y

Redcross, I. F. of redcross and redcrescent soxieties(IFRC). (2020). *Project / programme monitoring and evaluation (M & E) guide*. www.ifrc.org

Setia, M. S. (2016). *Methodology series module 3: Cross-sectional studies*. Indian Journal of Dermatology, 61(3), 261–264. https://doi.org/10.4103/0019-5154.182410

URT. (2009). *National Public Private Partnership (PPP) Policy*. Prime Minister's Office, 1–16.

Vledder, M., Friedman, J., Sjöblom, M., Brown, T., & Yadav, P. (2019). *Improving Supply Chain for Essential Drugs in Low-Income Countries: Results from a Large Scale Randomized Experiment in Zambia*. Health Systems and Reform, 5(2), 158–177. https://doi.org/10.1080/23288604.2019.1596050

Yadav, P. (2015). *Health product supply chains in developing countries: Diagnosis of the root causes of underperformance and an agenda for reform*. Health Systems and Reform, 1(2), 142-154,. https://doi.org/10.4161/23288604.2014.968005

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.17

Cumulative effect of consanguinity on prenatal mortalities among offspring in Northern Morocco

Mohamed Hajjaji[1]* *Mohamed El Bakkali*[1] *AbdErrazzak Khadmaoui*[1]

[1]Laboratory of Genetics and Biometry, Department of Biology, Faculty of Sciences, IbnTofail University, Kenitra, Morocco

Abstract

Introduction: Consanguinity is a union between two individuals related as first cousins, second cousins or even more distant unions. This behaviour will contribute to the impoverishment of genetic variability and will offer a possibility of prenatal mortality.

Objective: In this context, we suggest modelling the cumulative effect of consanguinity of maternal and paternal grandparents across that of parents among socio-demographic differences on prenatal mortality indicators in Tetouan (Morocco).

Methods: Data were collected on 882 couples in 2017. We conducted multivariable logistic regression analysis for factors associated with prenatal mortalities and then generated the average adjusted predictions and marginal effects.

Results: Multiple logistic regression analyses show that, for first cousin once removed and first cousin paternal grandparents, the odds in favour of prenatal mortalities among the student's mother were 9.60 (aOR=9.60) and 3.90 (aOR=3.90) times greater than non-consanguineous, respectively, controlling for all other variables. Similarly, the odds in favour of prenatal mortalities among the offspring of these mothers was 3.62 (aOR=4.89) times greater when maternal grandparents were first cousins versus non-consanguineous. However, average adjusted predictions showed that when paternal grandparents were first cousins compared to non-consanguineous, and when paternal grandparents were first cousins once removed compared to non-consanguineous or second cousins, whatever the degree of parents' consanguinity, the predicted probability of prenatal mortalities was higher than 20% and 30% ($p \leq 0.05$), respectively. Furthermore, for first cousin maternal grandparents compared to other degrees of consanguinity, concerning all degrees of parents' consanguinity, the predicted probability of prenatal mortalities was between 20% and 48% ($p \leq 0.05$).

Conclusion: Accumulation of close biological relationships in several generations increases the probability of prenatal mortalities among offspring. A better understanding of the cumulative effect of consanguinity by socio-demographic factors can inform more-targeted interventions to reduce pregnancy wastage.

Keywords: Consanguinity; Prenatal mortalities; Adjusted Predictions; Marginal Effects.

Introduction

Consanguinity is a special case of marital relationship. It's defined as a union between two individuals related as second-degree cousins or closer with a coefficient of consanguinity (F) equal to or greater than 0.0156 (Bittles, 2001). Consanguinity can include more distant unions which can go up to a coefficient of inbreeding F = 0.0039 (Hamamy et al., 2011). The Arab-Muslim populations are the most affected by consanguineous marriages, whose rates can range from 28% in Lebanon and up to 56% in Saudi Arabia (El-Kheshen & Saadat, 2013; El Mouzan et al., 2008). First cousins are the most common among all other types of consanguineous unions (Bener & Hussain, 2006; Ben Halim et al., 2016). In Morocco, this rate is still high and varies between 23.7% and 25.38% (Hajjaji et

* **Corresponding Author:** Mohamed Hajjaji, Email: mohamed.hajjaji4@uit.ac.ma

al., 2020; Ossmani et al., 2018). Other non-Arab countries are also affected by these matrimonial practices, namely Turkey 33.9% (YÜKSEL et al., 2009), Iran 38.6% (Saadat et al., 2004), Pakistan 62% (Jabeen & Malik, 2014) and Brazil 20.5% (Lima et al., 2019).

Consequently, this behaviour will contribute to the impoverishment of the genetic variability and will offer a possibility of manifestation of deleterious or harmful genes in the genotype of the population, and therefore a harmful effect on the health profile (Fareed & Afzal, 2017). Most authors who have examined prenatal mortality confirm the increase in prenatal mortality rate among consanguineous couples (Bittles, 2001; Bener & Hussain, 2006; Mousa et al., 2023). The closer the biological relationship between couples, the greater the risk of prenatal mortality among their offspring. Reproductive wastage (abortion and stillbirths) is higher among women from first-cousin marriage compared to non-consanguineous (Bener & Hussain, 2006; Fareed et al., 2017).

The studied population was students living in Tetouan province. According to the 2019 Provincial Monography of Tetouan (Morocco), published by "Haut Commissariat au Plan", this population stands at 573 784. The urban provincial agglomeration comprises 416,988 inhabitants, compared to 156,796 inhabitants in rural areas, reflecting an urbanization rate of 72.7%. This province is characterized by a total illiteracy rate and overall poverty rates of 27.5% and 10.67%, respectively. To our knowledge, few studies take into account the cumulative effect of consanguinity through several generations, among socio-demographic characteristics on reproductive outcomes. And those studies place a strong emphasis on the sign and statistical significance of effects. But they give us a little practical feel for the substantive significance of the findings. In this context, we suggest modelling the cumulative effect of consanguinity of maternal and paternal grandparents across that of parents among socio-demographic differences on prenatal mortality indicators.

Materials and Methods

Study Design

This is a prospective study carried out in 2017 on a sample of 1500 couples from parents and grandparents' generation. Data were collected through face-to-face interviews with students randomly selected from those enrolled at Abdelmalek Essaadi University in Tetouan, via a pre-established questionnaire. We clarified the objective of the study to each interviewed student and got their consent. After excluding those refusing to continue the interview and the incomplete questionnaires (618 out of 1500), we collected an amount of demographic and socio-cultural information for a total of 882 couples from parents' and grandparents' generations.

Modelling and analytic strategy

The choice of our explanatory variable is based on knowledge of prenatal mortalities in consanguineous marriages (first cousins, first cousins once removed, second cousins and non-consanguineous) and the possible factors influencing it. Thus, the variables, which could have a relationship with the prenatal mortalities, were introduced in the logistic regression. An in-depth review of the data in the literature was essential beforehand (Bener & Mohammad, 2017; Hajjaji et al., 2021; Cheffi et al., 2022). The choice of variables is therefore based on their clinical relevance and knowledge of proven or supposed confounding factors (Hosmer Jr et al., 2013).

The explanatory variables, which were sufficiently linked to the dependent variable, were then preserved in the model. All variables whose significance level was less than 0.20 during the univariate analysis were included in the initial multiple logistic regression model. The threshold of 0.20 makes it possible to take into account variables, which could be factors of possible confusion or interaction terms. Variables forced ($p>0.20$) or known to be associated with two dichotomous responses were also included in the analysis (Preux et al., 2005; El Sanharawi & Naudet, 2013). Furthermore, to determine the best model when carrying out mathematical modelling using logistic regression, we focused on a strategy involving three stages: (1) variable specification, (2)

interaction assessment and (3) confounding assessment followed by consideration of precision (Kleinbaum & Klein, 2002). The purpose of this strategy was to obtain a valid estimate of an exposure-consanguinity relationship that accounts for confounding and effect modification. Finally, based on a fitted model, Average Adjusted Predictions (AAPs), Average Marginal Effects (AMEs) and Marginal Effects at Representative Values (MERVs) were used to have a practical feel for the substantive significance of the findings.

Many researchers place a strong emphasis on the sign and statistical significance of effects. The logistic regression models illustrate which effects are statistically significant, and the direction of the effects. But they give us a little practical feel for the substantive significance of the findings. However, there is often very little emphasis on the substantive and practical significance of the findings (Long & Freese, 2006). We then show how Adjusted Predictions and Marginal Effects can make the results for both discrete and continuous variables easier to understand and interpret and provide a much clearer picture of the effect differences, across degrees of consanguinity and socio-demographic factors on prenatal mortality, than the logistic regression do.

The interpretation of the odds ratio assumes that the other variables were held constant, but it doesn't require that they are held at specific values. We used the marginal effect to measure the change in the probability of prenatal mortalities for a change in each independent variable, controlling for all other variables at specific values. We used Average Adjusted Predictions (AAPs) and average marginal effects (AMEs), which provide a much clearer feel for the differences existing across categories or ranges of the independent variables than statistical significance testing does (Norton et al., 2019). In addition, we used the Marginal Effects at Representative Values (MERVs) to examine the degree of consanguinity differences in the predicted probabilities of prenatal mortalities across varying mothers' and father's ages at marriage.

The statistical software package Stata 14 is used in this analysis; in particular, we make heavy use of the Stata commands logit, margins, minicom and margins plot (Williams, 2012). All tests were two-tailed, and values of $p \leq 0.05$ were considered statistically significant.

Results

Logistic regression model

Table 1 presents the odds ratios and Confidence Interval at 95% for the full model. The multiple logistic regression analysis was conducted to predict the binary outcome variable, prenatal mortalities among offspring mothers or not, from a set of predictor variables. The degree of paternal grandparents' consanguinity predictor was a categorical variable with four levels. For first cousin once removed and first cousin paternal grandparents, the odds in favour of prenatal mortalities among mothers' offspring were 9.60 (aOR=9.60; CI: 1.20-77.19) and 3.90 (aOR=3.90; CI: 1.20-77.19) times greater than non-consanguineous, respectively, controlling for all other variables.

Similarly, the odds in favour of prenatal mortalities among the offspring of these mothers was 3.62 (aOR=4.89; CI: 1.10-12.63) times greater when maternal grandparents were first cousins versus the reference group (non-consanguineous maternal grandparents). For the father's age at marriage predictor, the odds were 0.91 (aOR=0.91; CI: 0.90-0.98), indicating that for each unit increase in age at marriage, the odds of having prenatal mortalities decreased by 9%. However, for the mother's age at marriage, the odds of having prenatal mortalities increased by 10% (aOR=1.10; CI: 1.04-1.13), controlling for all other variables.

The multivariate analysis of number of pregnancies of the student's mother and hypertension in mothers or their siblings with prenatal mortalities, controlling for other variables, indicated the risks of 1.42 and 2.61 times that mother had prenatal mortalities (aOR=1.42; CI: 1.25-1.62; aOR=2.61; CI:1.42-4.79, respectively). The combined effect of the degree of paternal grandparents' consanguinity and parents' consanguinity showed a significantly negative effect against prenatal mortalities (aOR=0.74; CI: 0.56-0.98).

Table 1: Adjusted Odds ratios (aOR) and the confidence interval (CI) of prenatal mortalities among the offspring of the student's mother, full model.

	aOR	p-value	CI at 95%
Parents' consanguinity			
Non-consanguineous	Ref		
Second cousins	1.69	0.425	0.46-6.22
First cousins once removed	5.74	0.171	0.47-70.17
First cousins	3.82	0.156	0.60-24.36
Paternal grandparents' consanguinity			
Non-consanguineous	Ref		
Second cousins	0.74	<0.657	0.19-2.82
First cousins once removed	**9.60**	**<0.033**	**1.20-77.19**
First cousins	**3.90**	**<0.048**	**1.1-14.95**
Maternal grandparents' consanguinity			
Non-consanguineous	Ref		
Second cousins	0.58	<0.367	0.18-1.87
First cousins once removed	0.22	<0.276	0.015-3.31
First cousins	**3.62**	**<0.043**	**1.10-12.63**
Diabetes among mothers or their siblings			
No-diabetic	Ref		
Diabetic	0.65	<0.192	0.33-1.24
Father's age at marriage	**0.91**	**<0.026**	**0.90-0.98**
Mother's age at marriage	**1.10**	**<0.002**	**1.04-1.13**
Complications during labor among student's mother			
No- cesarean delivery	Ref		
Cesarean delivery	0.52	<0.112	0.23-1.17
Level of education of the student's father			
Superior	Ref		
Secondary	0.58	<0.43	0.15-2.23
Primary	1.03	<0.96	0.27-3.88
Illiterate	1.76	<0.44	0.42-7.41
Number of pregnancies of student's mother	**1.42**	**<0.001**	**1.25-1.62**
Hypertension in mothers or their siblings			
No	Ref		
yes	**2.61**	**<0.002**	**1.42-4.79**

 https://dx.doi.org/10.4314/thrb.v26i3.17

Profession of student's maternal grandfather			
Public	Ref		
Liberal	0.82	<0.654	0.34-1.98
Farmer	0.64	<0.376	0.23-1.73
Paternal grandparents' consanguinity × parents' consanguinity	**0.74**	**<0.037**	**0.56-0.98**
Maternal grandparents' consanguinity × parents' consanguinity	0.88	<0.336	0.68-1.14
Hypertension among mothers or their siblings × parents' consanguinity	0.75	<0.141	0.51-1.10

Average adjusted predictions (AAPs) and average marginal effects (AMEs) for discrete independent variables

The AAPs in Figure 1 showed that, after taking into account other variables, about 32.10%, 27.20%, 41,30% and 36% of prenatal mortalities were predicted among offspring when paternal grandparents were non-consanguineous with non-consanguineous parents, non-consanguineous-with second cousin parents, second cousins with non-consanguineous parents and second cousins with second cousin parents, respectively. However, when paternal grandparents were first cousins, the prenatal mortalities were about 65.48%, 77.30%, and 82.05% among offspring of second cousin, first cousin, and first cousin once removed parents, respectively. When paternal grandparents were first cousins once removed, offspring had between 71.29% and 89.89% predicted probability of prenatal mortalities for all degrees of parents' consanguinity.

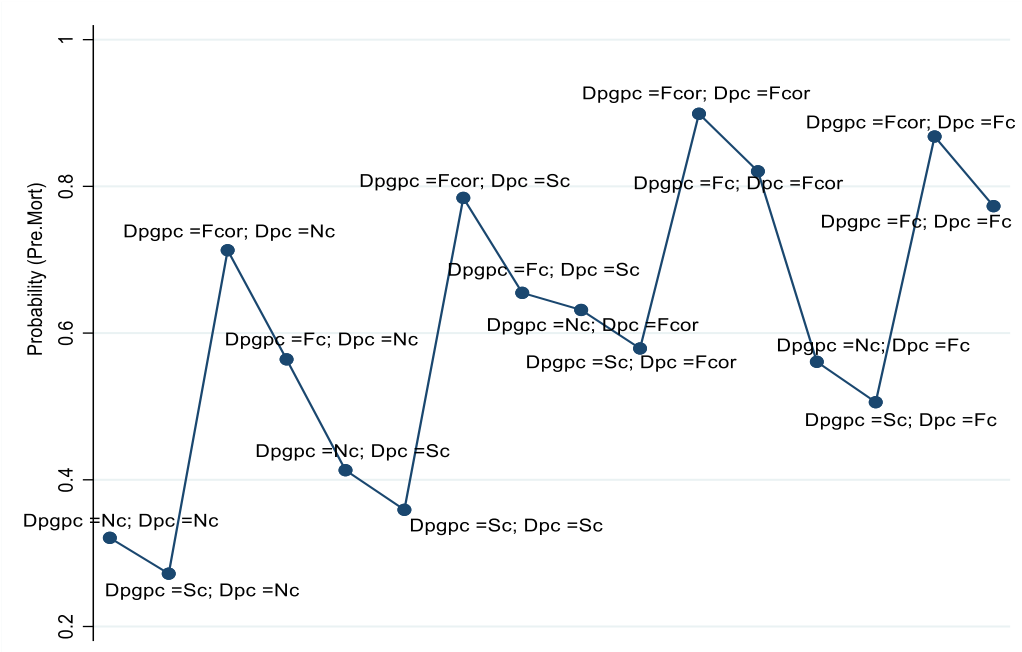


Figure 1: Average adjusted predictions of degree of paternal grandparents' consanguinity (Dpgpc) at different degrees of parents' consanguinity (Dpc) on prenatal mortalities (Pre.Mort). Fc: First cousin; Fcor: First cousin once remouved; Sc: Second cousin; Nc: Non-cosanguineous.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.17

The average marginal effects in Table 2 showed that about 44%, 42% and 21% more predicted probability of prenatal mortalities among offspring of first cousin once removed paternal grandparents with non-consanguineous parents, with second cousin parents and with first cousin parents group, than that occurring when paternal grandparents were second cousins and parents were non-consanguineous (71.29%-27.20%≈44%; p≤0.05), second cousins paternal grandparents with second cousins parents (78.42%-35.91%≈42%; p≤0.05) and first cousins paternal grandparents with second cousins parents (86.79%-65.48%≈21%; p≤0.05), respectively. Furthermore, the results showed that a difference (change) in prenatal mortality of 24% and 21% was statistically significant when paternal grandparents were first cousins with non-consanguineous parents and when paternal grandparents and parents were first cousins, compared to non-consanguineous paternal grandparents with non-consanguineous parents and non-consanguineous paternal grandparents with first cousins parents, respectively.

Table 2: Average Marginal Effects and 95% confidence intervals (CI) of Degree of grandparents' consanguinity at different degrees of parents' consanguinity on prenatal mortalities.

Degree of paternal grandparents' consanguinity × Degree of parents' consanguinity			
	Coefficient (Change)	p-value	CI for 95%
Dpgpc=Fc ; Dpc=Nc vs. Dpgpc = Nc ; Dpc=Nc	0.24	0.041	0.010-0.47
Dpgpc=Fc ; Dpc=Sc vs. Dpgpc = Nc ; Dpc=Sc	0.24	0.028	0.026-0.45
Dpgpc=Fc ; Dpc=Fc vs. Dpgpc =Nc ; Dpc=Fc	0.21	0.029	0.021-0.40
Dpgpc=Fcor ; Dpc=Nc vs. Dpgpc =Nc ; Dpc=Nc	0.39	0.010	0.094-0.68
Dpgpc=Fcor ; Dpc=Sc vs. Dpgpc =Nc ; Dpc=Sc	0.37	0.004	0.11-0.62
Dpgpc=Fcor ; Dpc=Fc vs. Dpgpc =Nc ; Dpc=Fc	0.30	0.012	0.067-0.54
Dpgpc=Fcor ; Dpc=Nc vs. Dpgpc =Sc ; Dpc=Nc	0.44	0.012	0.097-0.78
Dpgpc=Fcor ; Dpc=Sc vs. Dpgpc =Sc ; Dpc=Sc	0.42	0.008	0.11-0.73
Dpgpc=Fcor ; Dpc=Fc vs. Dpgpc =Fc ; Dpc=Sc	0.21	0.032	0.031-0.69
Degree of maternal grandparents' consanguinity × Degree of parents' consanguinity			
Dmgpc=Fc; Dpc=Nc vs. Dmgpc=Nc; Dpc=Nc	0.24	0.036	0.020-0.45
Dmgpc=Fc ; Dpc=Sc vs. Dmgpc=Nc ; Dpc=Sc	0.23	0.024	0.031-0.43
Dmgpc=Fc ; Dpc=Fc vs. Dmgpc=Nc ; Dpc=Fc	0.20	0.028	0.022-0.38
Dmgpc=Fc ; Dpc=Nc vs. Dmgpc=Sc ; Dpc=Nc	0.32	0.015	0.061-0.58
Dmgpc=Fc ; Dpc=Sc vs. Dmgpc=Sc ; Dpc=Sc	0.33	0.014	0.066-0.59
Dmgpc=Fc ; Dpc=Fcor vs. Dmgpc=Sc ; Dpc=Fcor	0.27	0.049	0.02-0.54
Dmgpc=Fc ; Dpc=Fc vs. Dmgpc=Sc ; Dpc=Fc	0.30	0.025	0.04-0.56
Dmgpc=Fc ; Dpc=Nc vs. Dmgpc=Fcor ; Dpc=Nc	0.44	0.008	0.11-0.76
Dmgpc=Fc ; Dpc=Sc vs. Dmgpc=Fcor ; Dpc=Sc	0.47	0.015	0.094-0.85
Dmgpc=Fc ; Dpc=Fc vs. Dmgpc=Fcor ; Dpc=Fc	0.48	0.046	0.01-0.94

Fc: First cousin; Fcor: First cousin once removed; Sc: Second cousin; Nc: Non-consanguineous; Dmgpc: Degree of maternal grandparents' consanguinity; Dpgpc: Degree of paternal grandparents' consanguinity; Dpc: Degree of parents' consanguinity.

Similarly, after controlling for other variables, the AAPs in Figure 2 showed that about 12.79%, 18.61%, 37,59% and 30.51% of prenatal mortalities were predicted, when maternal grandparents were first cousins once removed with a non-consanguineous, second cousin, first cousin once removed and first cousin parents, respectively.

These predicted probabilities increased significantly once the maternal grandparents were first cousins with non-consanguineous parents (57,88%), second cousins (66,17%) or first cousins (78,18%) respectively. The AMEs (table 2) showed that this difference in predicted probabilities of prenatal mortalities was significant between first cousin maternal grandparents with second cousin parents and first cousin once removed maternal grandparents with second cousin parents (66.17%-

 https://dx.doi.org/10.4314/thrb.v26i3.17

18.61%≈48%; p≤0.05) and between first cousin maternal grandparents with first cousin parents and first cousin once removed maternal grandparents with first cousin parents (78.18%-30.51%≈47%; p≤0.05).

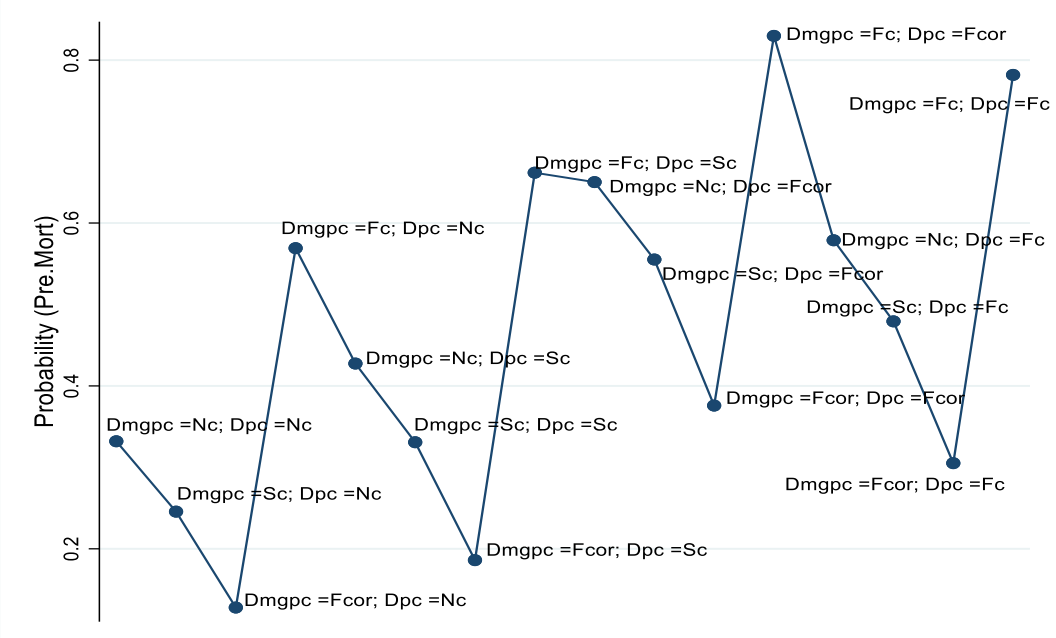


Figure 2: Average adjusted predictions of degree of maternal grandparents' consanguinity (Dmgpc) at different level of degree of parents' consanguinity (Dpc) on prenatal mortalities (Pre.Mort). Fc: First cousin; Fcor: First cousin once removed; Sc: Second cousin; Nc: Non-cosanguineous.

Marginal Effects at Representative Values for Independent Continuous Variables

The Marginal Effects at Representative Values (MERVs) for the degree of consanguinity of paternal grandparents, maternal grandparents and parents, according to the father and mother's age at marriage were presented in Figure 3. Figure 3a illustrates that when paternal grandparents were first cousins or first cousins once removed, the likelihood of prenatal mortalities increases significantly compared to second cousins or non-consanguineous paternal grandparents (p≤0.05).

While moving from second cousins and first cousins once removed maternal grandparents to first cousins maternal grandparents, our analysis recorded a greater number of mortalities (between 18.29% and 24.69%; p≤0.05). Figures 3c and 3d showed the MERVs for the three degrees of consanguinity among parents across varying mother and father ages at marriage, respectively. For first cousin once removed and first cousin parents, according to age at marriage, the predicted difference was higher than 25% (p≤0.05) compared to non-consanguineous or second cousin parents, whatever the father and mother's age at marriage.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.17

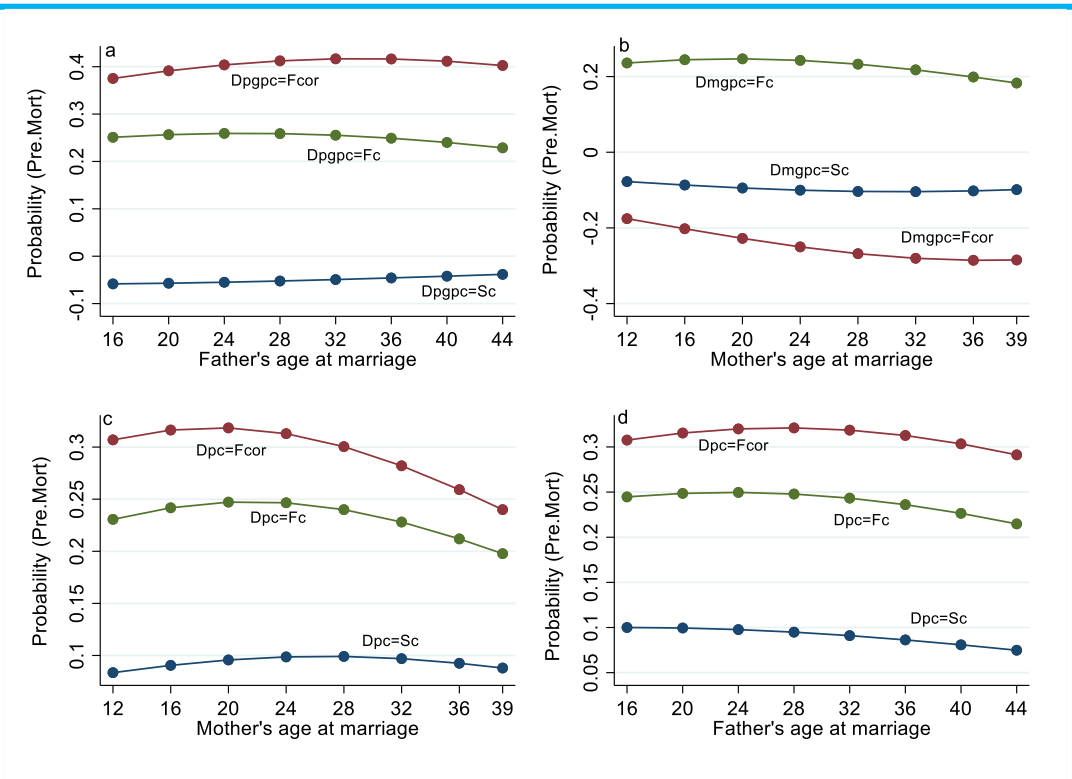


Figure 3: Marginal Effects at Representative Values for the degree of consanguinity among 3a paternal grandparents (Dpgpc), 3b maternal grandparents Dmgpc, 3c father and 3d mother on prenatal mortality (Pre.Mort), according to father's and mother's age at marriage.

Discussion

Previous studies revealed a positive association between consanguinity and the average number of pregnancies (Hosseini-Chavoshi et al., 2014; Riaz et al., 2016; Lynch et al., 2022). This would suggest that consanguineous marriage is responsible for an increase in births, but this difference will decrease after a higher wastage of pregnancies among consanguineous women (Bener & Hussain, 2006).

Based on the multiple logistic regression analysis, prenatal mortality among offspring was associated with the degree of consanguinity among grandparents. When paternal grandparents were first cousins once removed or first cousins, or when maternal grandparents were first cousins, prenatal mortalities were higher among students' siblings compared to non-consanguineous grandparents. This is unsurprising and consistent with the literature showing that consanguinity is a determinant factor of prenatal mortality (Shawky & Sadik, 2011; Halim et al., 2013; Kuntla et al., 2013; Moussouni et al., 2017; Warsy et al., 2020; Doke et al., 2021; Cheffi et al., 2022). It has been documented that marriage between relatives increases the incidence genetic disorders such as diabetes, heart diseases, asthma and hypertension. (Bener et al., 2007; Bener & Mohammad, 2017;Poorolajal et al., 2017; Wells, 2020; Hajjaji et al., 2023; Hardouz et al., 2023).

These factors may, in turn, lead to life-threatening for women and contribute to adverse reproductive outcomes (Al-Rahal, 2018; Oniya et al., 2019; Nasab et al., 2021). Our analysis showed that hypertension among mother and their siblings can cause an increase in prenatal mortalities up to 2.6 times compared to women not suffering from these diseases. Studies mention that pre-existing hypertension among women could be a risk factor for adverse prenatal outcomes (Gordon et al., 2013; Shahbazian et al., 2016; Magee et al., 2020).

The age of marriage can also affect prenatal mortalities. Our analyses showed that prenatal mortalities increased with age at marriage of the student's mother by 10% for a unit increase in the mother's age at marriage. This is confirmed by a study conducted recently in Nairobi, finding that

the odds of pregnancy loss are 6% more likely for a unit increase in women's age (Iddi et al., 2020). Other studies also reported that advanced maternal age is a risk factor for recurrent pregnancy loss and stillbirth (Huang et al., 2008; Gordon et al., 2013; Shahbazian et al., 2016; Cao et al., 2022). A possible explanation for this may be that younger mothers experience a lower prevalence of gestational hypertension and diabetes (Gordon et al., 2013; Maslowsky et al., 2020). However, our results showed a negative relationship between the father's age at marriage and prenatal mortalities, when controlling for all other variables. Men with higher education levels belonging to wealthy families were less likely to marry at an early age, which reduces prenatal mortality by providing a suitable and healthy environment during pregnancy (Chauhan et al., 2020).

AMEs show that a high accumulation of closer biological relationships between parents and grandparents produces more effect on prenatal mortalities than more distant relatives did. First cousins once removed paternal grandparents with non-consanguineous or second cousin parents showed 44% and 42% more chance to have prenatal mortalities compared to second cousin paternal grandparents with non-consanguineous or second cousin parents, respectively. Similarly, first-cousin maternal grandparents with first-cousin parents or first-cousin maternal grandparents with second-cousin parents had 48% and 47% more chance to have prenatal mortalities than did first-cousin once-removed maternal grandparents with first-cousin parents or first-cousin-removed maternal grandparents with second cousin parents. This made it possible to suggest that this risk increases by an increase in the cumulative degree of consanguinity among grandparents and parents.

It is well known that consanguinity leads to an increase in homozygosity by expression of some deleterious recessive genes (Jaouad et al., 2009; Tadmouri et al., 2009; Ahmad et al., 2013). The expression of these genes correlates with the accumulation of consanguinity in several generations and the closeness of relationships between spouses (Bittles, 2011; Bener & Hussain, 2006; Halim et al., 2013; Becker et al., 2015). According to Hajjaji et al (2023), when maternal grandparents were first-cousins, the risk of diabetes is high among offspring of those consanguineous women, and when parents and maternal grandparents were first-cousins this risk became 3 times greater compared to beyond first-cousin group. This may, in turn, lead to an increase in pregnancy wastage. Fareed et al have reported that the risk of prenatal mortality increases with the increase of homozygosity levels, so couples were 2.9, 3.1 and 5.9 more times at risk to have prenatal mortality when they are first cousins once removed, first cousins and double first cousins, compared to non-consanguineous couples (Fareed & Afzal, 2017).

When comparing consanguineous to non-consanguineous individuals, a higher proportion of chromosomal errors and congenital abnormalities are recorded among consanguineous offspring (Khamees & Al-Ouqaili, 2022; Pandith et al., 2022; Mousa et al., 2023; Melado et al., 2023). Recent studies show that those aberrations are involved in prenatal mortalities (Turki et al., 2016; Zhang et al., 2021). DNA-based studies suggested that selection could work early on homozygous embryos and increase prenatal mortality among offspring of consanguineous populations (Bittles & Black, 2010b; Bittles & Black, 2010a; Bult et al., 2019; Bult, C. J. et al. 2019). Numerous studies show that homozygous women for the methylenetetrahydrofolate reductase deficiency MTHFR (TT), prothrombin (FII) and factor V Leiden (FVL) mutation have an increased risk of Thromboembolic disorders (Tiwari et al., 2015; Dautaj et al., 2019; Nassour-Mokhtari et al., 2020; Khalife & Geitani, 2022). The presence of more than one Thromboembolic disorder among the same consanguineous individuals, increases prenatal mortality among their offspring (Najafi et al., 2019; Najafi et al., 2021; Shaker et al., 2021).

Considering the degree of consanguinity among grandparents and parents according to father and mother's age at marriage. The results of marginal effects at representative values (MERVs) showed that, when grandparents (paternal or maternal) or parents were first cousins the prenatal mortalities among the offspring were higer compared to non-consanguineous and second cousin ones, whatever the age at marriage of the father and the mother. Unlike the multiple logistic regression analysis, the MERVs didn’t show any significant effect of the age at marriage of the

student's mother and father on prenatal mortalities. These results disagree with those of other studies where advanced age at marriage is a risk factor for pregnancy loss (Huang et al., 2008; Ranji, 2012; Gordon et al., 2013; Shahbazian et al., 2016; Iddi et al., 2020). This contradiction may find its explication in the limited number of cases in the simple since the matrimonial status was divided into four categories. Another interpretation was that previous studies didn't take into account adjusted predictions and marginal effect, which provide a much clearer feel for the differences that exist across categories or ranges of the independent factors while studying the effect of age on prenatal mortality.

As with every research, our study also has some limitations and must be interpreted in the relevant context. Since the data were collected from students from one Moroccan university, this could be a selection bias excluding other regions. The history of prenatal mortality among mothers was self-reported by students. There might be an underestimation of the case number, especially since the participants' answers were based on the known mortalities. Some students find it difficult to answer this type of question, especially since this information is kept taboo for some of the interviewees and their mothers. The data did not also contain information about the provenance (urban/rural) of the students which may influence the prenatal mortality rate, knowing that individuals from urban origins constitute almost 75% of the population studied. This study was a preliminary research and future molecular investigations are solicited to explore the possible causal mechanisms.

Conclusion

A better understanding of the cumulative effect of consanguinity by socio-demographic factors can inform more targeted interventions to reduce pregnancy wastage in northern Morocco. In this study, we found that the increase in the cumulative degree of consanguinity increases the risk of prenatal mortalities. The use of adjusted predictions, marginal effects and marginal effects at representative values provides alternative ways by which the cumulative effect of consanguinity levels of maternal and paternal grandparents across that of parents can be visualized as a practical feel for the substantive significance of the findings.

References

Ahmad, S. F., Hameed, A., Jehangir, M., & Khttak, J. Z. K. (2013). Molecular study of a consanguineous family with autosomal recessive mental retardation and speech disorder. *Molecular Biology Research Communications*, *1*(2), 83–93.

Al-Rahal, N. K. (2018). Inherited bleeding disorders in iraq and consanguineous marriage. *International Journal of Hematology-Oncology and Stem Cell Research*, *12*(4), 272–280. https://doi.org/10.18502/ijhoscr.v12i4.105

Becker, R., Keller, T., Wegner, R., Neitzel, H., Stumm, M., Knoll, U., Stärk, M., Fangerau, H., & Bittles, A. (2015). Consanguinity and pregnancy outcomes in a multi-ethnic, metropolitan European population. *Prenatal Diagnosis*, *35*(1), 81–89.

Ben Halim, N., Hsouna, S., Lasram, K., Rejeb, I., Walha, A., Talmoudi, F., Messai, H., Sabrine Ben Brick, A., Ouragini, H., & Cherif, W. (2016). Differential impact of consanguineous marriages on autosomal recessive diseases in T unisia. *American Journal of Human Biology*, *28*(2), 171–180.

Bener, A., & Hussain, R. (2006). Consanguineous unions and child health in the State of Qatar. *Paediatric and Perinatal Epidemiology*, *20*(5), 372–378.

Bener, A., Hussain, R., & Teebi, A. S. (2007). Consanguineous marriages and their effects on common adult diseases: studies from an endogamous population. *Medical Principles and Practice*, *16*(4), 262–267.

Bener, A., & Mohammad, R. R. (2017). Global distribution of consanguinity and their impact on complex diseases: Genetic disorders from an endogamous population. *Egyptian Journal of*

Medical Human Genetics, *18*(4), 315–320.
Bittles, A. H. (2001). Consanguinity and its relevance to clinical genetics. *Clinical Genetics*, *60*(2), 89–98.
Bittles, A. H. (2011). Assessing the influence of consanguinity on congenital heart disease. *Annals of Pediatric Cardiology*, *4*(2), 111.
Bittles, A. H., & Black, M. L. (2010a). Consanguinity, human evolution, and complex diseases. *Proceedings of the National Academy of Sciences*, *107*(suppl 1), 1779–1786.
Bittles, A. H., & Black, M. L. (2010b). The impact of consanguinity on neonatal and infant health. *Early Human Development*, *86*(11), 737–741.
Bult, C. J., Blake, J. A., Smith, C. L., Kadin, J. A., Richardson, J. E., Anagnostopoulos, A., Asabor, R., Baldarelli, R. M., Beal, J. S., Bello, S. M., Blodgett, O., Butler, N. E., Christie, K. R., Corbani, L. E., Creelman, J., Dolan, M. E., Drabkin, H. J., Giannatto, S. L., Hale, P., … Zhu, Y. (2019). Mouse Genome Database (MGD) 2019. *Nucleic Acids Research*, *47*(D1), D801–D806. https://doi.org/10.1093/nar/gky1056
Cao, C., Bai, S., Zhang, J., Sun, X., Meng, A., & Chen, H. (2022). Understanding recurrent pregnancy loss: Recent advances on its etiology, clinical diagnosis, and management. *Medical Review*, *2*(6), 570–589. https://doi.org/10.1515/mr-2022-0030
Chauhan, S., Sekher, T. V, Kumar, P., Srivastava, S., & Patel, R. (2020). Prevalence, determinants and socio-economic inequality of early marriage among men in India. *Children and Youth Services Review*, 105273.
Cheffi, K., Dahbi, N., El Khair, A., Stambouli, H., Elbouri, A., Talbi, J., Hilali, A., & El Ossmani, H. (2022). Consanguinity in the Chaouia population (Morocco): prevalence, trends, determinants, fertility, and spontaneous abortions. *Egyptian Journal of Medical Human Genetics*, *23*(1). https://doi.org/10.1186/s43042-022-00337-2
Dautaj, A., Krasi, G., Bushati, V., Precone, V., Gheza, M., Fioretti, F., Sartori, M., Costantini, A., Benedetti, S., Bertelli, M., & Paolacci, S. (2019). Hereditary thrombophilia. *Acta Bio Medica : Atenei Parmensis*, *90*(Suppl 10), 44. https://doi.org/10.23750/ABM.V90I10-S.8758
Doke, P. P., Palkar, S. H., Gothankar, J. S., Patil, A. V., Chutke, A. P., Pore, P. D., Deshpande, A. V., Bhuyan, K. K., Karnataki, M. V., & Shrotri, A. N. (2021). Association between adverse pregnancy outcomes and preceding risk factors: a cross-sectional study from Nashik District, India. *BMC Pregnancy and Childbirth*, *21*(1). https://doi.org/10.1186/s12884-021-04174-w
El-Kheshen, G., & Saadat, M. (2013). Prevalence of consanguineous marriages among Shi'a populations of Lebanon. *Journal of Biosocial Science*, *45*(5), 675–682.
El Mouzan, M. I., Al Salloum, A. A., Al Herbish, A. S., Qurachi, M. M., & Al Omar, A. A. (2008). Consanguinity and major genetic disorders in Saudi children: a community-based cross-sectional study. *Annals of Saudi Medicine*, *28*(3), 169–173.
El Sanharawi, M., & Naudet, F. (2013). Comprendre la régression logistique. *Journal Français d'ophtalmologie*, *36*(8), 710–715.
Fareed, M., Ahmad, M. K., Anwar, M. A., & Afzal, M. (2017). Impact of consanguineous marriages and degrees of inbreeding on fertility, child mortality, secondary sex ratio, selection intensity, and genetic load: a cross-sectional study from Northern India. *Pediatric Research*, *81*(1), 18–26.
Gordon, A., Raynes-Greenow, C., McGeechan, K., Morris, J., & Jeffery, H. (2013). Risk factors for antepartum stillbirth and the influence of maternal age in New South Wales Australia: a population based study. *BMC Pregnancy and Childbirth*, *13*(1), 12.
Hajjaji, M., Khadmaoui, A., & El Bakkali, M. (2020). Facteurs socioculturels influençant la transmission du mariage consanguin, en tant que rituel hérité, dans la province Tétouan (Maroc). *Antropo*, *44*, 13–24.
Hajjaji, M., Khadmaoui, A., & El Bakkali, M. (2021). L'effet cumulatif de la consanguinité, de l'hypertension et du court intervalle protogénésique sur la mortalité prénatale et le nombre

d'enfants survivants, dans la province Tétouan (Maroc). *Antropo*, *45*, 9–18.

Hajjaji, M., Khadmaoui, A., & El Bakkali, M. (2023). The practice of consanguineous marriage and the risk of diabetes among offspring in the province of Tetouan (Morocco). *Arab Gulf Journal of Scientific Research*.

Halim, N. Ben, Bouafif, N. B. A., Romdhane, L., Atig, R. K. Ben, Chouchane, I., Bouyacoub, Y., Arfa, I., Cherif, W., Nouira, S., & Talmoudi, F. (2013). Consanguinity, endogamy, and genetic disorders in Tunisia. *Journal of Community Genetics*, *4*(2), 273–284.

Hamamy, H., Antonarakis, S. E., Cavalli-Sforza, L. L., Temtamy, S., Romeo, G., Ten Kate, L. P., Bennett, R. L., Shaw, A., Megarbane, A., & van Duijn, C. (2011). Consanguineous marriages, pearls and perils: Geneva international consanguinity workshop report. *Genetics in Medicine*, *13*(9), 841–847.

Hardouz, H., Arfaoui, A., & Quyou, A. (2023). Impact of consanguinity on spontaneous pregnancy loss and descendants' health in north Morocco. *Arab Gulf Journal of Scientific Research*. https://doi.org/10.1108/AGJSR-01-2023-0027

Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (Vol. 398). John Wiley & Sons.

Hosseini-Chavoshi, M., Abbasi-Shavazi, M. J., & Bittles, A. H. (2014). Consanguineous marriage, reproductive behaviour and postnatal mortality in contemporary Iran. *Human Heredity*, *77*(1–4), 16–25.

Huang, L., Sauve, R., Birkett, N., Fergusson, D., & van Walraven, C. (2008). Maternal age and risk of stillbirth: a systematic review. *Cmaj*, *178*(2), 165–172.

Iddi, S., Kadengye, D. T., Kiwuwa-Muyingo, S., Mutua, M. K., & Asiki, G. (2020). Associated factors of pregnancy loss in two urban slums of Nairobi: A generalized estimation equations approach. *Global Epidemiology*, 100030.

Jabeen, N., & Malik, S. (2014). Consanguinity and its sociodemographic differentials in Bhimber district, Azad Jammu and Kashmir, Pakistan. *Journal of Health, Population, and Nutrition*, *32*(2), 301.

Jaouad, I. C., Elalaoui, S. C., Sbiti, A., Elkerh, F., Belmahi, L., & Sefiani, A. (2009). Consanguineous marriages in Morocco and the consequence for the incidence of autosomal recessive disorders. *Journal of Biosocial Science*, *41*(5), 575–581.

Khalife, S., & Geitani, R. (2022). Association of Inherited Thrombophilia with Recurrent Pregnancy Loss in A Population of Lebanese Women: A Case Control Study. *International Journal of Fertility and Sterility*, *16*(3), 247–251. https://doi.org/10.22074/ijfs.2022.540950.1205

Khamees, D. A., & Al-Ouqaili, M. T. S. (2022). Cross-sectional study of chromosomal aberrations and immunologic factors in Iraqi couples with recurrent pregnancy loss. *PeerJ*, *10*. https://doi.org/10.7717/peerj.12801

Kleinbaum, D. G., & Klein, M. (2002). Regression Logistic A self-learning text. *New York: Springer*, *21*, 22.

Kuntla, S., Goli, S., Sekher, T. V, & Doshi, R. (2013). Consanguineous marriages and their effects on pregnancy outcomes in India. *International Journal of Sociology and Social Policy*.

Lima, S. O. A., Farias, A. A., Albino, V. A., Marques-Alves, Y. K., Olinda, R., Santos-Silva, T. A., Alves, L. U., Zatz, M., & Santos, S. (2019). A population-based study of inter-generational attitudes towards consanguineous marriages in north-eastern Brazil. *Journal of Biosocial Science*, *51*(5), 683–697.

Long, J. S., & Freese, J. (2006). *Regression models for categorical dependent variables using Stata*. Stata press.

Lynch, M. T., Maloney, K. A., Pollin, T. I., Streeten, E. A., Puffenberger, E. G., Strauss, K. A., Shuldiner, A. R., & Mitchell, B. D. (2022). Impact of parental relatedness on reproductive outcomes among the Old Order Amish of Lancaster County. *American Journal of Medical Genetics, Part A*, *188*(7), 2119–2128. https://doi.org/10.1002/ajmg.a.62757

Magee, L. A., Singer, J., Lee, T., McManus, R. J., Lay-Flurrie, S., Rey, E., Chappell, L. C., Myers, J.,

Logan, A. G., & von Dadelszen, P. (2020). Are blood pressure level and variability related to pregnancy outcome? Analysis of control of hypertension in pregnancy study data. *Pregnancy Hypertension*, *19*, 87–93.

Maslowsky, J., Stritzel, H., Al-Hamoodah, L., Hendrick, C. E., Powers, D., Barrientos-Gutierrez, T., & Santelli, J. (2020). Health behaviors and prenatal health conditions in repeat versus first-time teenage mothers in the United States: 2015-2018. *Journal of Pediatric and Adolescent Gynecology*.

Melado, L., Lawrenz, B., Nogueira, D., Raberi, A., Patel, R., Bayram, A., Elkhatib, I., & Fatemi, H. (2023). Features of chromosomal abnormalities in relation to consanguinity: analysis of 10,556 blastocysts from IVF/ICSI cycles with PGT-A from consanguineous and non-consanguineous couples. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-36014-6

Mousa, B. A., Alqani, V. H. A., & Awadh, H. J. A. (2023). Consanguineous marriages and poor pregnancy outcomes. *Rawal Medical Journal*, *48*(3), 711–714. https://doi.org/10.5455/rmj.20230124065756

Moussouni, A., Aouar, A., Otmani, S., Chabni, N., & Sidiyekhlef, A. (2017). Etude de l'impact de la consanguinité sur l'avortement et la mortalité dans la population de Sabra (ouest algérien). *Antropo*, *37*, 149–160.

Najafi, K., Gholami, S., Moshtagh, A., Bazrgar, M., Sadatian, N., Abbasi, G., Rostami, P., Khalili, S., Babanejad, M., Nourmohammadi, B., Najmabadi, H., & Kariminejad, R. (2019). Chromosomal aberrations in pregnancy and fetal loss: Insight on the effect of consanguinity, review of 1625 cases. *Molecular Genetics and Genomic Medicine*, *7*(8). https://doi.org/10.1002/mgg3.820

Najafi, K., Mehrjoo, Z., Ardalani, F., Ghaderi-Sohi, S., Kariminejad, A., Kariminejad, R., & Najmabadi, H. (2021). Identifying the causes of recurrent pregnancy loss in consanguineous couples using whole exome sequencing on the products of miscarriage with no chromosomal abnormalities. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-86309-9

Nasab, L. H., Ranaei, F., Majidi, J., Zaheri, F., & Karime, R. (2021). Risk Factors Associated with Perinatal Mortality at Besat Hospital in Sanandaj: A Case-control Study. *Journal of Midwifery and Reproductive Health*, *9*(2), 2707–2717. https://doi.org/10.22038/jmrh.2021.50209.1624

Nassour-Mokhtari, I., Loukidi, B., Moussouni, A., Bettioui, R., Benhabib, R., Merzouk, H., Aouar, A., & Allal-Taouli, K. (2020). Inherited thrombophilia and recurrent pregnancy loss: a single-center case-control study in North-Western Algeria. *Egyptian Journal of Medical Human Genetics*, *21*(1). https://doi.org/10.1186/s43042-020-00077-1

Norton, E. C., Dowd, B. E., & Maciejewski, M. L. (2019). Marginal Effects - Quantifying the Effect of Changes in Risk Factors in Logistic Regression Models. In *JAMA - Journal of the American Medical Association* (Vol. 321, Issue 13, pp. 1304–1305). American Medical Association. https://doi.org/10.1001/jama.2019.1954

Oniya, O., Neves, K., Ahmed, B., & Konje, J. C. (2019). A review of the reproductive consequences of consanguinity. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *232*, 87–96.

Ossmani, H. E., Ouardani, M., Habibeddine, L., Amzazi, S., & Talbi, J. (2018). Study of consanguinity of the population of northern Morocco. *J Forensic Res*, *9*(406), 2.

Pandith, A. A., Manzoor, U., Amin, I., Dil-Afroze, Ahmad, A., Rashid, M., Zargar, M. H., Rah, S., Dar, F. A., Qasim, I., Qasim, I., & Sanadhya, D. (2022). High incidences of chromosomal aberrations and Y chromosome micro-deletions as prominent causes for recurrent pregnancy losses in highly ethnic and consanguineous population. *Archives of Gynecology and Obstetrics*, *305*(6), 1393–1408. https://doi.org/10.1007/s00404-021-06235-z

Poorolajal, J., Ameri, P., Soltanian, A., & Bahrami, M. (2017). Effect of Consanguinity on Low Birth Weight: A Meta-Analysis. *Archives of Iranian Medicine (AIM)*, *20*(3).

Preux, P. M., Odermatt, P., Perna, A., Marin, B., & Vergnenègre, A. (2005). Qu'est-ce qu'une régression logistique? *Revue Des Maladies Respiratoires*, *22*(1), 159–162.

Ranji, A. (2012). Induced abortion in Iran: prevalence, reasons, and consequences. *Journal of Midwifery & Women's Health*, *57*(5), 482–488.

Riaz, H. F., Mannan, S., & Malik, S. (2016). Consanguinity and its socio-biological parameters in Rahim yar Khan district, Southern Punjab, Pakistan. *Journal of Health, Population and Nutrition*, *35*(1), 14.

Saadat, M., Ansari-Lari, M., & Farhud, D. D. (2004). Short report consanguineous marriage in Iran. *Annals of Human Biology*, *31*(2), 263–269.

Shahbazian, H., Nouhjah, S., Shahbazian, N., Jahanfar, S., Latifi, S. M., Aleali, A., Shahbazian, N., & Saadati, N. (2016). Gestational diabetes mellitus in an Iranian pregnant population using IADPSG criteria: incidence, contributing factors and outcomes. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *10*(4), 242–246.

Shaker, M. M., Thomas, M. M., & Shalabi, T. A. (2021). Evaluating the role of inherited thrombophilia genes with recurrent pregnancy loss among Egyptian couples. *Gene Reports*, *25*. https://doi.org/10.1016/j.genrep.2021.101355

Shawky, R. M., & Sadik, D. I. (2011). Congenital malformations prevalent among Egyptian children and associated risk factors. *Egyptian Journal of Medical Human Genetics*, *12*(1).

Tadmouri, G. O., Nair, P., Obeid, T., Al Ali, M. T., Al Khaja, N., & Hamamy, H. A. (2009). Consanguinity and reproductive health among Arabs. *Reproductive Health*, *6*(1). https://doi.org/10.1186/1742-4755-6-17

Tiwari, D., Deka Bose, P., Das, S., Das, C. R., Datta, R., & Bose, S. (2015). *MTHFR (C677T) polymorphism and PR (PROGINS) mutation as genetic factors for preterm delivery, fetal death and low birth weight: A Northeast Indian population based study*. https://doi.org/10.1016/j.mgene.2014.12.002

Turki, R. F., Assidi, M., Banni, H. A., Zahed, H. A., Karim, S., Schulten, H.-J., Abu-Elmagd, M., Rouzi, A. A., Bajouh, O., & Jamal, H. S. (2016). Associations of recurrent miscarriages with chromosomal abnormalities, thrombophilia allelic polymorphisms and/or consanguinity in Saudi Arabia. *BMC Medical Genetics*, *17*(1), 69.

Warsy, A. S., Alkhuriji, A., Al-marry, B. A. A., Alraqibah, A. A., Alharbi, A. A., Babay, Z., Addar, M., & Daghestani, M. (2020). Consanguinity in unexplained recurrent pregnancy loss and preterm delivery among saudi females. *Journal of Nature and Science of Medicine*, *3*(1), 33–38. https://doi.org/10.4103/JNSM.JNSM_5_19

Wells, J. C. K. (2020). Could consanguineous marriage provide a cultural alleviation for the obstetric dilemma? *Medical Hypotheses*, *134*, 109424.

Williams, R. (2012). Using the margins command to estimate and interpret adjusted predictions and marginal effects. *Stata Journal*, *12*(2), 308–331. https://doi.org/10.1177/1536867x1201200209

YÜKSEL, Ş., KUTLUBAY, A., KARAOĞLU, L., & YOLOĞLU, S. (2009). The prevalence of consanguineous marriages in the city of Malatya, Turkey. *Turkish Journal of Medical Sciences*, *39*(1), 133–137.

Zhang, X., Fan, J., Chen, Y., Wang, J., Song, Z., Zhao, J., Li, Z., Wu, X., & Hu, Y. (2021). Cytogenetic Analysis of the Products of Conception after Spontaneous Abortion in the First Trimester. *Cytogenetic and Genome Research*, *161*(4), 120–131. https://doi.org/10.1159/000514088

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.18

Determinants of the desire for more children among women of reproductive age using TDHS data 2022

Nsajigwa Mwalupani[1], Christina Geoffrey Mandara[1], Mwajabu Mashinde[1]*

[1]Institute of Rural Development Planning, P. O. Box 138 Dodoma, Tanzania

Background: The desire for more children impacts a couple's fertility behaviors. It may serve as an early indication of real fertility performance. Globally, there are many places with lower fertility rates. In developing countries, the total fertility rate (TFR) is decreasing.
Objective: We aimed to evaluate the determinants of the desire for more children among women of reproductive age in Tanzania.
Methods: This study used TDHS data, the study analyzed descriptive statistics of the respondents' characteristics, followed by bivariate analysis to test the association between the dependent variable and each independent variable, and those variables that were statistically associated were included in the Binary Logistic Model to test their significance as determinants for the desire to have more children among women aged 15-49.
Results: The results of the multivariate logistic model, women aged 15-24 (OR=5.7, 95% CI:5.07-6.42, p<0.00) and 25-3 4 (OR=4.7, 95% CI:4.45-5.00, p<0.00) had higher odds to desire for more children, compared to women aged 35–49, those with secondary education (OR=1.8, 95% CI:1.62 -2.01, p<0.00) and higher education (OR=1.4, 95% CI:1.00 -2.03, p<0.04) had higher odds to desire for more children, compared to women with no education. Those whose partner/husband with primary education (OR=0.7, 95% CI: 0.73-0.84, p<0.00) and higher education (OR=0.69, 95% CI: 0.0.56-0.86, p<0.001) had lower odds to desire for more children compared to women whose partner had no education. Women using contraceptives (OR=0.87, 95% CI: 0.82-0.92, p<0.00) had lower odds of desiring more children compared to those who were not using contraceptives. Women who consider 4-5 (OR=2.52, 95% CI: 2.25-2.83, p<0.00) and 6+ (OR=6.17, 95% CI: 0.5.49-6.93, p<0.00) children as the ideal number had higher odds to desire more children compared to those who consider 0-3 as an ideal number.
Conclusion: The findings underscore the significance of age, education, partner's education, contraceptive use, ideal family size, number of living children, media influence, decision-making power, and wealth index in shaping the desire for additional children among women. The study recommends that the government implement comprehensive family planning education programs considering the complex interplay between education and fertility desires.
Keywords: *total fertility rate, desire for more children*

Introduction

The desire for more children impacts a couple's fertility behaviors. It may serve as an early indication of real fertility performance. Globally, there are many places with lower fertility rates. In developing countries, the total fertility rate (TFR) is decreasing. Between 1950–1954 and 2005–2010, the TFR declined from 4.97 to 2.53 children per woman and experiencing while recently the changes were more dramatic from a TFR of 6.08 to 2.69 (Bagheri & Saadati, 2019; Muluneh & Moyehodie, 2021; Wesley & Anuforo, 2023). In the last two decades, fertility rates in sub-Saharan Africa have decreased by approximately 0.5 children per decade on average. However, the pace of these changes varies significantly among different countries. Some nations, like Niger, Chad, and Mali, as well as larger ones

* **Corresponding Author:** *Nsajigwa Mwalupani; Email:* nmwalupani@gmail.com

like Nigeria and DR Congo, have experienced a recent and relatively modest decline in fertility. In these regions, fertility rates remain high, ranging between 5.0 and 6.0 children per woman, and the decline is progressing slowly (Atake, & Gnakou Ali, 2019). The deceleration in fertility waning in Sub-Saharan Africa is attributed to the spacing and delay of all birth orders (Lerch, 2019). Furthermore, Mburu et al., (2023) argue that the realization of fertility desires is connected to societal elements, including education, involvement in the workforce, patterns of sexual partnerships, age, gender equality, and the roles of women and men in child-rearing.

Several studies have been conducted to determine the determinants of the desire for more children among women. In sub-Saharan Africa, Ahinkorah et al., (2020) revealed that an increase in the wealth status and educational level of both women and their partners is likely to reduce women's desire for more children. Women without solo decision-making capacity were more likely to desire more children. Also, the study showed that The study also revealed that women with four or more living children were less likely to desire more children. Another study conducted in Ethiopia revealed that the odds of desire for more children among women 15–24 and 25–34 years age group was lower as compared to those women 35–49 years age group, higher education is associated with lower fertility desire. Also, the study showed that women's age at first marriage influenced their desire for more children. Women aged 15–24 years were more likely to desire more children compared to those women whose age group was 30–49 years. The study also found that women with four or fewer ideal numbers of children were less likely to desire more children (Muluneh & Moyehodie, 2021).

Yaya and Osanyintupin, (2018) revealed that the odd of women in Nigeria living in urban areas have a higher risk of having more than 2 children than in rural areas a ratio, the odd of women in Ghana and Nigeria with no education have a higher risk of having more than 2 children compared to women with primary education, secondary education and tertiary education. Also, the study showed that the odd of women in Ghana who are non-Catholic have a higher risk of having more than 2 children compared to women who are Catholic and Muslim. Moreover, In Ghana and Nigeria, the odd of women who gave birth to their first child at the age of less than 20 years have a higher risk of having more than 2 children compared to those at the age between 20 - 30 years and age greater than 30 years. Moreover, Kodzi et al., (2010) in their study of the time dynamics of individual fertility preferences among rural Ghanaian women, found that Women about 40 years old and older who had had five or more children or had borne their ideal number of children and wanted to stop childbearing showed the most stable preferences over the multiple rounds of interview, also the study revealed women who had attained their ideal parity generally held to their preference to cease childbearing, a substantial proportion of these women continued to bear children.

Furthermore, Withers and Pinatih, (2010) found that older women were found to be about half as likely as women in the middle age group to want more children, also postpartum women were found to be more likely to want more children than women who had not had a recent birth. The study also revealed that women who had regular access to health services were twice as likely to desire more children than women without regular access. Furthermore, numerous women communicated that they were afraid to 'risk another pregnancy' or to have more children because of the high rates of complications during childbirth and the lack of skilled birth attendants in their villages.

Even though there is considerable literature on the determinants of the desire for more children among women of Reproductive Age not much in the Tanzanian context (Withers & Pinatih, 2010; Kodzi et al., 2010; Yaya & Osanyintupin, 2018; Muluneh & Moyehodie, 2021; Ahinkorah et al., 2020), concerning the determinants of the desire for more children among women of reproductive age, little is known. Hence, this study will add to up understanding of the determinants that influence the desire for more children among women of reproductive age in several different ways, by examining the extent to which social-demographic and economic factors influence the desire for more

children among women of reproductive age. Achieving the objectives of this study will enable us to provide robust and viable recommendations that will assist policymakers in making decisions that will help to understand the desire for children and fertility as a whole.

The study objective was to investigate the motivating factors for the desire for more children among women of reproductive age in Tanzania. This study is important to policymakers as the results suggest that the desire for more children among women of reproductive age in Tanzania is influenced by age, education level. husband/partner's education level, marital status, use of contraceptive, the ideal number of children, number of living children, type of place of residence, frequency of listening to radio, frequency of watching television, frequency of reading a newspaper/magazine, wealth index combined, frequency of using the internet last month, and decision maker for using more child contraception.

Materials and Methods

Study design

The 2022 Tanzania Demographic and Health Survey and Malaria Indicator Survey (2022 TDHS-MIS) is the 7th DHS survey in Tanzania to be conducted through The DHS Program. Data was collected from February to July 2022. The survey was carried out across Tanzania's mainland and Zanzibar. The datasets were acquired through the DHS program measure, at https://www.dhsprogram.com.

Sampling design

The sample design for the 2022 TDHS-MIS had two stages and was intended to provide estimates for the entire country, for urban and rural areas in the mainland, and for Zanzibar. The first stage involved selecting sample points (clusters), consisting of enumeration areas (EAs) delineated for the 2012 Tanzania Population and Housing Census (PHC). A total of 629 clusters were selected. Among the 629 EAs, 211 EAs were from urban areas and 418 EAs were from rural areas. In the second stage, 26 households were to be systematically selected from each cluster, for a total anticipated sample size of 16,354 households for the 2022 TDHS-MIS. This method resulted in a probability sample of 40394 women ranging in age from 15 to 49 years. Only 32817 women aged 15-49 were included in the current study, taken from women's individual recode files (TZBR81DT).

Variables

Response variable

To identify the dependent variable, we used the question that was asked in a women's questionnaire to women aged 15-49 whether they wanted more children and if so, how long. Would they prefer to wait before the birth of the next child? The question had seven responses as follows "Wants within 2 years", "wants after 2+ years ", "Wants, unsure timing", "Undecided", "Want no more", "Sterilized", and "Declared infecund". We coded 1 if they responded that "wants within 2 years", "wants after 2+ years" or "wants, unsure timing" treating these responses as the desire to have more children while the rest of the responses were coded as 0 meaning they did not desire to have more children.

Independent variables

After a thorough review of the literature, the study used categorical independent variables namely; Age, education level, wealth index level, place of residence, the ideal number of children, marital status, number of living children, current use of contraceptive, frequency of reading newspapers, frequency of watching televisions, frequency of using the internet, frequency of listening to the radio.

Data analysis

Analysis began with a descriptive analysis of respondents' characteristics after we performed a univariate analysis of the dependent variable followed by bivariate analysis to test the association between the dependent variable and each independent variable for those variables that were statistically associated were included in the Binary Logistic Model to test their significance as determinants for the desire to have more children among women aged 15-49. We used Stata Version 16 to perform both processing and analysis.

Ethical considerations

This study followed ethical standards from the 1964 Declaration of Helsinki and its amendments. It did not involve experiments or interactions with human or animal subjects. The study used secondary data from the 2022 TDHS, which the ICF Ethical Review Board approved. Researchers obtained written permission from ICF to use the anonymous data.

Results

In the distribution of the women's responses to the question "If you wanted more children and if so, how long?" one-third (31%) of women responded "wants no more", followed by 27% of women who responded "wants after 2+ years" while the least ones (2.72%) wanted, but unsure of the timing (see Figure 1). Hence the desire for more children as shown in Table 1, more than half (53.10%) of women did not desire more children while only 46% desired. In descriptive characteristics of the respondents, more than half (59.15%) of respondents aged 35 to 49, most women had primary education, 56.25% of women's husbands/partners had primary education, three quarters (75.84%) of the participants were married, two third of women didn't use contraceptive, 63.8% women's ideal number of children were 6 and more, almost third quarters of women had 4+ living children, 46% didn't listen to radio, 62.44 did not watch television, and 81.3% did not read newspaper, 22.3% of women's wealth were categorized as middle, 92.1% did not use internet, and more than half of women make joint decision on using of contraception.

Also, Table 1 shows the association between the desire for more children (dependent variable) and with independent variables used in this study. Independent variables that were statistically significant and associated with the desire for more children at the 5% level were age, education, Husband/partner's education level, use of a contraceptive, the ideal number of children, number of living children, frequency of listening radio, frequency of watching television, frequency of reading a newspaper/magazine, wealth index combined, frequency of using the internet, and decision maker for using more children contraception. Independent variables that were not significantly associated with the desire for more children are marital status and type of residence.

Table 1. Distribution of socio-demographic factors by the desire for more children

Variable	The desire for more children		All N (%)	p-value
	No n (%)	Yes n (%)		
Overall	17427(53.10)	15390(46.90)	32817(100)	
Age				<0.001
15-24	504(1.54)	2326(7.09)	2830(8.62)	
25-34	3123(9.52)	7452(22.71)	10575(32.22)	
35-49	13800(42.05)	5162(17.10)	19412(59.15)	
Education level				
No education	4812(14.66)	3648(11.12)	8460(25.78)	<0.001
Primary	10603(32.31)	7857(23.94)	18460(56.25)	
secondary	1900(5.79)	3778(11.50)	5675(17.29)	

Higher	112(0.34)	110(0.34)	222(0.68)	
Husband/partner's education level				
No education	2791(8.50)	2411(7.35)	5202(15.85)	<0.001
Primary	11665(35.55)	8768(26.71)	20433(62.26)	
secondary	2416(7.36)	3535(10.77)	5951(18.31)	
Higher	297(0.91)	354(1.08)	651(1.98)	
Don't know	258(0.79)	322(0.98)	580(1.77)	
Marital status				0.178
married	13268(40.43)	11619(35.41)	24887(75.84)	
Living with partner	4159(12.67)	3771(11.49)	7930(24.16)	
Use of contraceptive				<0.001
Yes	6719(20.47)	5404(16.47)	12123(36.94)	
No	10708(32.63)	9986(30.43)	20694(63.06)	
The ideal number of children				<0.001
0-3	1682(5.13)	857(2.61)	2539(7.74)	
4-5	4764(14.52)	4580(13.96)	9344(28.47)	
6+	10981(33.46)	9953(30.33)	20934(63.79)	
Number of living children				
0	5(0.02)	66(0.20)	71(0.22)	<0.001
1-3	2759(8.41)	7621(23.22)	10.380(31.63)	
4+	14663(44.68)	7703(23.47)	22366(68.15)	
Type of place of residence				0.416
Urban	4562(13.90)	3968(12.09)	8530(25.99)	
Rural	12865(39.20)	11422(34.81)	24287(74.01)	
Frequency of listening to radio				
Not all	8523(25.97)	6787(20.68)	15310(46.65)	<0.001
Less than once a week	3838(11.70)	4014(12.23)	7852(23.93)	
At least once a week	5066(15.44)	4589(13.98)	9655(29.42)	
Frequency of watching television				
Not all	11206(34.15)	9285(28.29)	20491(62.44)	<0.001
Less than once a week	2420(7.37)	2387(7.27)	4807(14.65)	
At least once a week	3801(11.58)	3718(11.33)	7519(22.91)	
Frequency of reading a newspaper/magazine				<0.001
Not all	14234(43.37)	12460(37.97)	26694(81.34)	
Less than once a week	2206(6.72)	2165(6.60)	4371(13.32)	
At least once a week	987(3.01)	765(2.33)	1752(5.34)	

https://dx.doi.org/10.4314/thrb.v26i3.18

Wealth index combined				<0.001
Poorest	3224(9.82)	3118(9.5)	6342(19.33)	
Poorer	3710(11.31)	2941(8.96)	6651(2027)	
Middle	4169(12.70)	3152(9.60)	7321(22.31)	
Richer	3315(10.10)	3198(9.74)	6513(19.85)	
Richest	3009(9.17)	2981(9.08)	5990(18.25)	
Frequency of using the Internet last month				<0.001
Not all	16344(49.80)	13864(42.25)	30208(92.05)	
Less than once a week	145(0.44)	242(0.74)	387(1.18)	
At least once a week	389(1.19)	558(1.70)	947(2.89)	
Almost every day	549(1.67)	726(2.21	1275(3.89)	
decision maker for using more child contraception				<0.001
respondent	5822(17.74)	4671(14.23)	10493(31.97)	
husband/partner	2129(6.49)	2235(6.81)	4364(13.30)	
joint decision	9342(28.87)	8324(25.36)	17666(53.83)	
someone else	22(0.07)	35(0.11)	57(0.17)	
Other	112(0.34)	125(0.38)	237(0.72)	

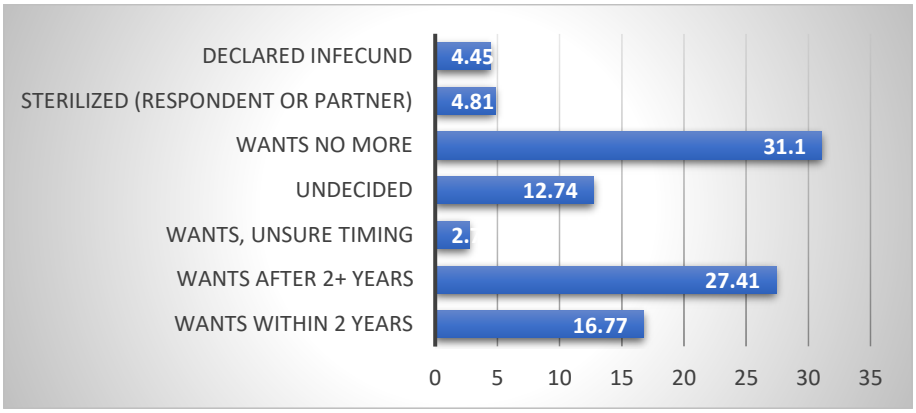


Figure 1. *Distribution of participants*

Binary logistic regression results on the predictors of desire for more children among women

The results of each predictor as shown in Table 2, women aged 15-24 (OR=5.7, 95% CI:5.07-6.42, p<0.00) and 25-24 (OR=4.7, 95% CI:4.45-5.00, p<0.00) had higher odds to desire for more children, compared to women aged 35–49, those with secondary education (OR=1.8, 95% CI:1.62 -2.01, p<0.00) and higher education (OR=1.4, 95% CI:1.00 -2.03, p<0.04) had higher odds to desire for more children, compared to women with no education.

Those whose partner/husband with primary education (OR=0.7, 95% CI:0.73-0.84, p<0.00) and higher education (OR=0.69, 95% CI:0.0.56-0.86, p<0.001) had lower odds to desire for more children compared to women whose partner had no education. Women using contraceptives (OR=0.87, 95% CI:0.82-0.92, p<0.00) had lower odds of desiring more children compared to those who were not using

contraceptives. Women who consider 4-5 (OR=2.52, 95% CI:2.25-2.83, p<0.00) and 6+ (OR=6.17, 95% CI:0.5.49-6.93, p<0.00) children as the ideal number had higher odds to desire more children compared to those who consider 0-3 as an ideal number.

Women with 1-3 (OR=0.11, 95% CI:0.04-0.29, p<0.00) and 4+ (OR=0.02, 95% CI:0.00-0.06, p<0.00 living children had lower odds of desiring more compared to those with no living child. Women who listen to the radio less than once a week (OR=1.38, 95% CI:1.29-1.48, p<0.00) and at least once a week (OR=1.08, 95% CI:1.00-1.15, p<0.02) had higher odds to desire more children compared to who not listen at all.

Women whose husband/partner (OR=1.13, 95% CI:1.04-1.23, p<0.002) or other (OR=1.63 95% CI:1.21-2.18, p<0.001) makes decisions have higher odds of desiring more children compared to when the respondent herself is the primary decision-maker. On the wealth index, poorer women (OR=0.88, 95% CI:0.81-0.95, p<0.002), middle (OR=0.88, 95% CI:0.81-0.96, p<0.007), and richest (OR=0.87, 95% CI:0.77-0.98, p<0.02) had lower odds of desiring more children compared to the poorest. Women who use the internet less than once a week (OR=1.5, 95% CI:1.18-1.92, p<0.00) and at least once a week (OR=1.2, 95% CI:1.06-1.49, p<0.00) had higher odd of desiring more children compared to those who not use at all.

Table 2. Binary logistic regression of desire to have more children

Variable	Odds ratio	Standard error	z	p-value	95% confidence interval	
Age						
15-24	5.70	0.34	29.01	<0.001	5.07	6.42
25-34	4.72	0.14	52.13	<0.001	4.45	5.00
35-49	**Reference**					
Husband/partner's education level						
No education	**Reference**					
Primary	0.78	0.03	-6.19	<0.001	0.731	0.849
secondary	0.96	0.050	-0.71	0.478	0.868	1.068
Higher	0.69	0.077	-3.22	0.001	0.562	0.869
Don't know	1.28	0.133	2.41	0.016	1.047	1.575
Education level						
No education	**Reference**					
Primary	0.937	0.031	-1.94	0.053	0.877	1.000
secondary	1.823	0.091	11.95	<0.001	1.652	2.012
Higher	1.434	0.257	2.01	0.044	1.009	2.038
Use of contraceptive						
Yes	0.876	0.024	-4.68	<0.001	0.829	0.926
No	**Reference**					
The ideal number of children						
0-3	**Reference**					

4-5	2.528	0.146	16.03	<0.001	2.257	2.832
6+	6.172	0.365	30.76	<0.001	5.496	6.931
Number of living children						
0	**Reference**					
1-3	0.113	0.055	-4.44	<0.001	0.043	0.297
4+	0.026	0.012	-7.44	<0.001	0.009	0.068
Frequency of listening to radio						
Not all	**Reference**					
Less than once a week	1.387	0.049	9.24	<0.001	1.294	1.487
At least once a week	1.080	0.037	2.23	0.026	1.009	1.156
Frequency of watching television						
Not all	**Reference**					
Less than once a week	0.966	0.040	-0.8	0.426	0.889	1.050
At least once a week	0.945	0.040	-1.31	0.191	0.868	1.028
Frequency of reading a newspaper/magazine						
Not all	**Reference**					
Less than once a week	0.964	0.039	-0.87	0.385	0.890	1.045
At least once a week	0.804	0.049	-3.53	<0.001	0.712	0.907
Wealth index combined						
Poorest	**Reference**					
Poorer	0.880	0.036	-3.05	0.002	0.811	0.955
Middle	0.889	0.038	-2.72	0.007	0.818	0.967
Richer	1.026	0.049	0.55	0.58	0.934	1.127
Richest	0.874	0.052	-2.23	0.026	0.777	0.983
Frequency of using the Internet last month						
Not all	**Reference**					
Less than once a week	1.508	0.187	3.31	0.001	1.182	1.925
At least once a week	1.264	0.108	2.72	0.006	1.067	1.496
Almost every day	1.102	0.089	1.19	0.232	0.939	1.292
Decision makers for using more child contraception						
respondent	**Reference**					

husband/partner	1.139	0.048	3.05	0.002	1.047	1.239
joint decision	1.028	0.030	0.94	0.345	0.970	1.088
someone else	1.733	0.563	1.69	0.09	0.916	3.277
other	1.630	0.242	3.29	0.001	1.218	2.180
cons	2.911	1.431	2.17	0.03	1.110	7.630

Discussion

This study evaluated the factors influencing Tanzanian women of reproductive age's desire for more children, among 32,817 women who participated. The study found that 47% of women desired more children. The study observed that younger women showed significantly higher odds of desiring more children than older women. The study conducted in Ethiopia found that the odds of desiring more children were higher in the 15-24 and 25-34 age groups compared to the 35-49 age group (Muluneh and Moyehodie, 2021). Another study in China found that as parity and age increase, the less likely it is for women to indicate that they desire more children (Eklund, 2016). This indicates that younger women are more likely to express a desire for additional children, highlighting the influence of age on fertility preferences.

On education, as the level of education increases, so does the likelihood of desiring more children. This finding is in line with the study by Muluneh and Moyehodie (2021), who found that women with higher levels of education had higher odds of desiring more children. However, Studies by Pradhan (2015), Kebede et al, (2022), OlaOlorun et al., (2016), and Withers et al., (2010) have highlighted the causal role of female education on fertility decline, with evidence supporting the impact of education reform on increased female educational attainment, delayed marriage, and fertility. More educated women may learn different ideas of desired family size through school, community, and exposure to global communication networks.

Additionally, education equips women with knowledge about prenatal care and child health, which may contribute to lower fertility due to greater confidence in child survival. This suggests that higher educational attainment is associated with an increased likelihood of desiring more children, reflecting the complex interplay of education and fertility desires. More on education, the study revealed that women whose partners/husbands had primary or higher education exhibit lower odds of desiring more children. This is in line with studies on the subject that higher socioeconomic status is associated with lower fertility desires (Götmark & Andersson, 2020; Akpa & Ikpotokin, 2012; Wolf & Mulder, 2019).

The lower odds of desiring more children among contraceptive users highlight the effectiveness of family planning methods. The study by Ahinkorah et al., (2020) found that the odds of desiring more children were higher among women who did not use contraceptives, while women who used contraceptives had lower odds of desiring more children. Other studies found that women who use contraceptives are less likely to desire more children (Babalola et al., 2017; Bulto et al., 2014; Adiri et al., 2010). Hence promoting and facilitating access to contraceptives could play a crucial role in shaping desired family size.

Women who consider 4-5 or 6+ children as the ideal number have higher odds of desiring more children. The study conducted in Ethiopia by Muluneh and Moyehodie, (2021), found that the odds of desiring more children were lower among women whose ideal number of children was four or fewer. Another study highlighted that the odds of desiring more children were high among women who considered six or more children as the ideal number (Ahinkorah et al, 2020). This aligns with the concept of family size preferences influencing reproductive choices.

We also found that the use of the internet and radio listening frequency had higher odds of desiring more children. These findings are supported by Mutumba, (2022), the study provides evidence of the influence of mass media, including radio, on reproductive behavior and family planning knowledge among women in sub-Saharan Africa. On the Internet, a study conducted in Kenya highlighted the importance of digital media, including websites and social media apps, in disseminating family planning information among young women and their social networks (Zinke-Allmang et al., 2022). This underscores the importance of considering media and the internet in designing public health campaigns.

The finding of this study also observed that women whose husbands/partners or someone else makes decisions have higher odds of desiring more children. This could signify a need for interventions that empower women in decision-making processes regarding family planning. Ahinkorah et al., (2020) found that the odds of desiring more children were high among women who did not make decisions alone, emphasizing the role of decision-making dynamics within relationships in shaping fertility desires. Another study highlighted the impact of husbands' larger ideal family size on fertility desires, indicating that couples in which the husband wants more children may be more likely to desire more children (Mcallister et al., 2012)

The study also revealed that the wealth index's influence on family size preferences implies that economic status plays a role in reproductive choices. Strategies addressing economic disparities could impact family planning decisions. Lastly, women with 1-3 or 4+ living children have lower odds of desiring more children. This finding suggests that women with more living children may be satisfied with their current family size.

Conclusion

In conclusion, the analysis of the paper titled "Determinants of the desire for more children among women of reproductive age using TDHS data" sheds light on various factors influencing women's fertility preferences. The findings underscore the significance of age, education, partner's education, contraceptive use, ideal family size, number of living children, media influence, decision-making power, and wealth index in shaping the desire for additional children among women.

The study recommends that the government implement comprehensive family planning education programs considering the complex interplay between education and fertility desires. These programs should not only focus on increasing education levels but also address the diverse influences that education can have on family planning decisions, strengthening efforts to promote and facilitate access to contraceptives, emphasizing their effectiveness in influencing desired family size.

Public health campaigns should continue to educate women and communities about the benefits of contraceptive use in enabling individuals to plan and achieve their desired family size, and public health campaigns that leverage mass media (radio) and digital platforms (internet) to disseminate accurate information about family planning.

References

Adiri, F., Ibrahim, H. I., Ajayi, V., Sulayman, H. U., Yafeh, A. M., & Ejembi, C. L. (2010). Fertility behaviour of men and women in three communities in Kaduna state, Nigeria. *African Journal of Reproductive Health*, *14*(3), 97-105.

Ahinkorah, B. O., Seidu, A. A., Armah-Ansah, E. K., Budu, E., Ameyaw, E. K., Agbaglo, E., & Yaya, S. (2020). Drivers of desire for more children among childbearing women in sub-Saharan Africa: implications for fertility control. *BMC Pregnancy and Childbirth*, *20*, 1-11.

Akpa, O. M., & Ikpotokin, O. (2012). Modeling the determinants of fertility among women of childbearing age in Nigeria: Analysis using generalized linear modeling approach. International Journal of Humanities and Social Science, 2(18), 106-107.

Atake, E. H., & Gnakou Ali, P. (2019). Women's empowerment and fertility preferences in high fertility countries in Sub-Saharan Africa. *BMC women's health*, *19*(1), 1-14.

Austin, P. C., & Merlo, J. (2017). Intermediate and advanced topics in multilevel logistic regression analysis. Statistics in medicine, 36(20), 3257-3277.

Babalola, S., Figueroa, M. E., & Krenn, S. (2017). Association of mass media communication with contraceptive use in Sub-Saharan Africa: a meta-analysis of Demographic and Health Surveys. *Journal of health communication*, *22*(11), 885-895.

Bagheri, A., & Saadati, M. (2019). Factors Affecting the Demand for a Third Child among Iranian Women. *Journal of Midwifery & Reproductive Health*, *7*(1).

Bulto, G. A., Zewdie, T. A., & Beyen, T. K. (2014). Demand for long acting and permanent contraceptive methods and associated factors among married women of reproductive age group in Debre Markos Town, North West Ethiopia. *BMC women's health*, *14*, 1-12.

Eklund, L. (2016). Preference or aversion? Exploring fertility desires among China's young urban elite. Intersections: Gender and Sexuality in Asia and the Pacific, 39, 1-16.

Garenne M (2014) Trends in marriage and contraception in sub-Saharan Africa: A longitudinal perspective on factors of fertility decline. ICF International

Götmark, F., & Andersson, M. (2020). Human fertility in relation to education, economy, religion, contraception, and family planning programs. BMC Public Health, 20(1), 1-17.

Kebede, E., Striessnig, E., & Goujon, A. (2022). The relative importance of women's education on fertility desires in sub-Saharan Africa: A multilevel analysis. Population Studies, 76(1), 137-156.

Khan, H. R., & Shaw, E. (2011). Multilevel logistic regression analysis applied to binary contraceptive prevalence data. Journal of Data Science, 9, 93-110.

Kodzi, I. A., Casterline, J. B., & Aglobitse, P. (2010). The time dynamics of individual fertility preferences among rural Ghanaian women. Studies in Family Planning, 41(1), 45-54.

Lerch, M. (2019). Regional variations in the rural-urban fertility gradient in the global South. PLoS One, 14(7), e0219624.

Mburu, G., Kamuyango, A., Kidula, N., Kabra, R., Thatte, N., Kiarie, J., & Allotey, P. (2023). Fulfilment of fertility desires for the attainment of Global Sustainable Development Goals. BMJ Global Health, 8(4), e012322.

Mcallister, L., Gurven, M., Kaplan, H., & Stieglitz, J. (2012). Why do women have more children than they want? Understanding differences in women's ideal and actual family size in a natural fertility population. American Journal of Human Biology, 24(6), 786-799.

Muluneh, M. W., & Moyehodie, Y. A. (2021). Determinants of desire for more children among women in Ethiopia. *BMC Women's Health*, *21*(1), 1-7.

Mutumba M. (2022). Mass media influences on family planning knowledge, attitudes and method choice among sexually active men in sub-Saharan Africa. PloS one, 17(1), e0261068. https://doi.org/10.1371/journal.pone.0261068

OlaOlorun, F., Seme, A., Otupiri, E., Ogunjuyigbe, P., & Tsui, A. (2016). Women's fertility desires and contraceptive behavior in three peri-urban communities in sub Saharan Africa. Reproductive health, 13, 1-6.

Pradhan, E. (2015, November 24). Female education and childbearing: A closer look at the data. World Bank Blogs. https://blogs.worldbank.org/health/female-education-and-childbearing-closer-look-data

Wesley, Y., Ekeh, A., & Anuforo, P. O. (2023). Correlates of desire for children among women. Global Journal of Fertility and Research, 8(1), 014-022.

Withers, M., Kano, M., & Pinatih, G. N. I. (2010). Desire for more children, contraceptive use and unmet need for family planning in a remote area of Bali, Indonesia. Journal of biosocial science, 42(4), 549-562.

Withers, M., Kano, M., & Pinatih, G. N. I. (2010). Desire for more children, contraceptive use and unmet need for family planning in a remote area of Bali, Indonesia. *Journal of biosocial science*, 42(4), 549-562.

Wolf, K., & Mulder, C. H. (2019). Comparing the fertility of Ghanaian migrants in Europe with nonmigrants in Ghana. Population, Space and Place, 25(2), e2171.

Wong, G. Y., & Mason, W. M. (1985). The hierarchical logistic regression model for multilevel analysis. Journal of the American Statistical Association, 80(391), 513-524.

Yaya, O. S., & Osanyintupin, O. D. (2018). Determinants of desired and actual number of children and the risk of having more than two children in Ghana and Nigeria. MPRA Paper

Zinke-Allmang, A., Hassan, R., Bhatia, A., Gorur, K., Shipow, A., Ogolla, C., ... & Cislaghi, B. (2022). Use of digital media for family planning information by women and their social networks in Kenya: A qualitative study in peri-urban Nairobi. *Frontiers in sociology*, *7*, 886548.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.19

The role of commodification of health care in Reproducing Health Care inequality in the Context of Neoliberalism in Amana Regional Referral Hospital

*Nassoro Rajabu Kitunda**

'Department of Sociology and Anthropology, College of Social Sciences, University of Dar es Salaam, P. O. Box 35043, Dar es Salaam, United Republic of Tanzania

Abstract

Background: This article examines how the commodification of healthcare contributes to the perpetuation of healthcare inequality. It focuses on how this process operates through money, the distinction between exchange value and use value, marketization, and the continuation of user fees.

Method: A critical ethnography approach was used. which included in-depth interviews, focus group discussions, and observations.

Theories: The study draws on two key theoretical frameworks: Marxian Political Economy (MPE), as explained by Harvey (2014), to explore the contradiction between use-value and exchange-value, and Farmer's concept of Structural Violence (SV) (2003) to analyze the role of commodification in healthcare inequality. This perspective looks beyond the visible factors of inequality, such as education, poverty, and geography.

Results: The findings indicate that the commodification of healthcare plays a central role in driving healthcare inequality within hospitals.

Conclusion: The study concludes that the commodification of healthcare should not be overlooked in discussions about healthcare inequality, as it leads to significant harm, including death and poor health outcomes for many people.

Keywords: Commodification of health care, Neoliberalism, health care inequality, use-value, exchange-value, money.

Background

Health care inequality has been very normal feature within the health care system in the world, millions of people in the world never get the necessary health services they need (Kitunda,2022:WHO, 2018), although there are international and national agenda for universal health coverage. The debate on why and how to address health inequality is still ongoing amongst scholars, policy planners, citizens, Non-governmental organizations and politicians about whether or not universal health coverage can be achieved (URT.,2007; WHO.,2018).

Some attribute health inequality to processes of privatization and commercialization of the health care system (Ellison.,2014: Farmer,1992.,1999.,2003: Navarro.,1993). Others claim that health inequality is a product of social inequalities in income, education, and cultural factors (Akazil et al., 2011: WHO., 2018). On their part, feminist's scholars link health inequalities to gender inequality which affect more women than men due to the patriarchal system (TGNP., 2003: Tong.,2009). A numbers of studies have tried to explain the causes of health inequality, how it is produced and reproduced within a society across social groups, because inequality in health care affect more poor people compared to rich people. (Kinyeshi., 2017: Conrad et al 2000: Navarro.,1993).

* **Corresponding author:** Nassoro Kitunda, Email: nassorokitunda@gmail.com

The dominant explanation for health care inequality has been one dominated by different forms of positivist thinking and conceptualization (Mugisha and Sigalla., 2018). It is also one which views income inequalities as a product of individual disparities in education, status, entrepreneurship skills, capital formation, business acumen, etc. On the other hand, however, from a Marxist point of view, commodification and/or privatization under capitalism are singled out as the underlying forces for the health inequality in health care system rather than harping the observable/descriptive factors of health inequality like income or level of education. Therefore, the proposed study was focused on the urban social context of Dar es Salaam as a social formation using a Marxian political economy of health.

In Tanzania, the nature of health inequality in the health care system has, increased tremendously as there are already a lot of signs and symptoms of health inequality (TDHS., 2015-2016). Health care inequality is injustice in health between groups of people occupying different positions in society (Akazil et al., 2011).

Literature have suggested that health systems as whole are organized in such a way that they are unable and hence unsuccessful to make sure that all citizens should receive health care, as well as the ability to control and prevent the diseases. Inequality of attaining vaccination between poor and rich, and issues of combating malaria is more likely to the rich rather than poor. Malaria increase with poor status (TDHS., 2015-2016).

Kitunda (2020) revealed that there are forms of health care inequality in Tanzania. In his study showed the forms in health insurances (there are many categories of health insurance schemes), wards within hospitals (there is private and public wards), doctor consultation between the doctors and specialists, and mechanism of receiving health (those pay cash and use insurance card). These forms of health are found in our hospitals in Tanzania, continue to justify that Tanzania has health care inequality, and mean that there is inequality among the social groups in access health care services.

Conceptual Tool

This study used two conceptual tool such as Marxian Political Economy (MPE) and Farmers concept of Structural Violence (SV). Marxian Political Economy is a grand theory which constitutes many concepts. In this theory study used the concept of use-value and exchange-value continued by Harvey (2014) in his seventeen foundation of contradictions of capitalism. Health instead to cure people, tend to create space for business. This occur when exchange-value dominates the use-value. Hence, lead the crises of health care inequality.

> *"Capital never solve these crises. Crises are always reflection and/or manifestation of underlying foundation of contradictions of capitalism". (Harvey.,2014:18)*

Also, Paul Farmer on Structural Violence (SV) explained the damage of this process of commodification in health care to the poor people who seek care in hospital (Farmer,2001). The effect of commodification of health care is invisible and very subtle, due to institutionally legalized and routinized in daily life.

> *"Structural violence is the social arrangements that puts individuals and populations in harm's way…. The arrangements are structural because they are embedded in the political and economic organizations of our social world, they are violent because they cause injury to people"(Farmer.,2001)*

Method

This study used a Critical Ethnography design (Madison, 2004; Mugisha, 2018). It advocates for the empowerment of marginalized groups in society (Carspecken, 1996). This study used four data

collection methods, namely in-depth interviews with 31 patients, healthcare providers, and hospital administrators (medical in charge); a focus group discussion was held with five healthcare providers; observation of the hospital environment, healthcare organization, and services provided; and review of documents related to healthcare inequality. The data was analyzed using thematic analysis, after transcribing the interviews verbatim from audio to Kiswahili, and then translating them into English.

Ethical consideration

The research was granted ethical approval by the University of Dar es Salaam, with reference number AB3/12(B), and granted permission from the administration of Amana Hospital, with reference number MOHCDGEC/ARRH/R.I/X/. The President's Office of Regional Administration and Local Government (PORALG) provided permission to conduct this study in the respective regions and districts. Before data collection, informed written consent was obtained from all respondents, who were assured that their participation was voluntary and that any information collected would be kept confidential.

Results and Discussion

This study examined the process through which commodification operates and how it contributes to healthcare inequality in hospitals. The processes involved continue to normalize and legitimize commodification within the healthcare system. Key processes identified include the monetization of hospitals, marketization, the distinction between use value and exchange value, and the implementation of user fees.

Monetization of Hospitals

The study found that money plays a significant role in healthcare provision at Amana Regional Referral Hospital. Payments are required for doctor consultations, specialist visits, laboratory tests, medications, and even for bed use in the wards and surgeries. All these services are priced based on monetary exchange. In the context of neoliberalism, money has become the primary measure of exchange value in healthcare services (Harvey, 2014). Under neoliberalism, healthcare has transformed into a commodity, and money is necessary to assign its value (Harvey, 2014). Money is, therefore, a central feature of commodification, as it enables the process to function.

Shivji (2009) explains that capitalism is centered around capital accumulation, and previously, the focus was on tangible goods produced through commodity production. However, now even intangible services that were once provided freely, such as healthcare, have been turned into commodities in the pursuit of capital accumulation (Magufuli, 2013).

Through observations, the study noted that at Amana Regional Referral Hospital, all services are governed by money through the process of commodification. This creates inequality among social groups, particularly hindering access for those without sufficient funds. The hospital operates similarly to a shopping mall, where prices are clearly displayed on the shelves of commodities. In the same way, healthcare services at Amana are priced and displayed, including on a price list observed within the hospital. For example, the price of ultrasound services was prominently listed, reflecting the commodification of healthcare services.

Table 1: Amana Regional Referral Hospital (Ultrasound Examination and Prices)

NO	TYPE OF TEST	PRICES
1.	ABDOMINAL PELVIC ULTRASOUND	30,000/=

2.	KUB/RENAL ULTRASOUND	30,000/=
3.	KUB-P ULTRASOUND	30.000/=
4.	THYROID/NECK ULTRASOUND	30/000/=
5.	SCROTAL ULTRASOUND	30,000/=
6.	BREAST ULTRASOUND	30,000/=
7.	MUSCULOSKELETAL ULTRASOUND /SWELLING	30,000/=
8.	VENOUS DOPPLER ULTRASOUND (Rt/Lt upper or lower limb)	80,000/=
9.	ARTERIAL DOPPLER ULTRASOUND (Rt/Lt upper or lower limb	80,000/=
10.	RENNAL DOPPLER ULTRASOUND	80,000/=
11.	CAROTID DOPPLER ULTRASOUND	80,000/=
12.	ULTRASOUND GUIDED BIOPSY	50,000/=
13.	ECHOCARDIOGRAPHY	50,000/=

Source: Field data: October., 2019

The evidence from the observation above, can be seen from the evidence of the patient who were admitted in the male medical and surgical ward. During the in-depth interview he had explained that

> *"Yesterday I came here, in the reception, they told me that I needed to pay 35,000/= Tshs, but here in this ward told me that they owe me 120,000/=, I don't understand, and see these medical bills for my debts. And also, today they wanted to chase me here hospital, they said because I have no money to pay, but I calmed them by telling that my relatives whether they find money there, maybe they will come to pay this bill"* ***(IDIs, Patient; October,2019)***

From the above in-depth interview with a patient, can be more seen from the extract of focus group discussion, from one of the health provider who had a following to say on the position of money on creating inequalities.

> *Here everything is money, everywhere is involves transaction. In addition, also, money save people life. Means that, you prescribed the relatives of patients to go to buy medicine, if you have money you will send medicine on time, but we observed two days left no medicine for a patient, because of no money. So, a patient miss drugs because of money* ***(FDGs, health provider/ Woman)***
>
> *"Young brother, find money, in order to escape these public words (kwa Mtogole). Here the way you see is not good place. Find money*

young brother if you come here you will go to private ward (oyster bay). ***(FGD/Health Provider/2019)***

This situation, reflected above forms of health care inequality for those have money can facilitate to buy all important services for his/her patient and will save life, while those they have no money automatically fail to do that and expect the patient to loss life. And study observed that the death of the patient is something normal to the nurses and doctors, just say so sorry or very sorry to the relatives. This conditions within hospital is just business as usual, pays money to save your life.

Also, there is a case study provided by the one of the patient in the outpatient building, who came to seek care at Amana referral hospital. This case also, showed the way money continued to dominates the health care services in hospital. He had a following experience,

> A man from Tabata liwiti, who sought care in Amana hospital, He is just small entrepreneur and his income is below 10,000/= per day. He tells the story of his wife who had a pregnancy, and unfortunately she delivery at home. He took action to rent taxi in order to send his wife as soon as possible to Amana hospital. He achieved to arrive Amana hospital and received in reception. But the problem came, the time hospital need money for treatment. He had no money. All money he used to pay Taxi. And the doctors needed money for laboratory test for the blood test. Because his wife needed to take blood test.
>
> He said, we took more time to discuss with doctors and nurses with shouting, because he had no money, and hospital need money in order to take action for treatment. But at the end he tried to promise the hospital that in the morning he will pays money for laboratory test for his wife. He said it means if I failed to pay the bill, my wife would be difficult to be allowed to return home. Without paying bills you won't go home. First should pay and then allow you to go.
>
> He continued to say that if you have no money in hospital you will dies. These hospitals are not ours, are already privatized. Are not belong to us, are belong to those have money. Is like Muhimbili National Hospital. Money derived all things in these hospitals.

Source: Field Data., 2019

Use values vs Exchange value

Hitherto health was provided free of charge, as right to everyone and this should be provided in any society. (Harvey.,2014). But, the way system of capitalism under neo liberalism continue extending the exchange value character in the health care services, distort this use value in health system (Ibid,2014). The health takes financial motives, financial capital and financial market rather for use value. The study discovered that, health services took new face of financial and commercial aspect, this process Harvey (2014) called Financialization. Financialization create new forms of capital formation (Hunter and Murray.,2019). Health no longer as use value for curing people, but rather took the financial and/or commercial calculation as an exchange value. This is the exchange value character add cost plus profit of the commodity (Harvey., 2014)

This can be seen in the one of the case study of the woman who brought her children in Amana regional referral hospital for treatment (use value), but she had a burden of exchange value to pays for every services she got in the hospital. And this is not guarantee that your patient will be treated and a live. Money will go and even your patient also goes (Means dies)

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.19

Case study of Patient in Amana Regional Referral Hospital

Study observed a woman from Buguruni, Ilala in Amana regional referral hospital, who brought her son for the getting treatment. She was poor, she does not do anything just a mother house. Her son has problem of stomach, and her son got first operation but went bad, they returned hospital for checkup. The son is 14 years old and is orphans, his real parents were already died. But she had a debt of 220,000/= for the previous operation and bill for a bed. She was cry, she had no money for paying this medical and surgical bill. She gone home sold the furniture's and same stuffs in order to repay the bill. She said no help from health providers, every health provider told her to pays for health services, no one listens her in the ward.

Additional, her son went another surgery and she paid 100,000/= Tshs for the medicine. This time she sold a television in order to pay bill. She said I went to department of social welfare, but no any help just they told her should apply the pardon after her son to be allowed in the ward. But, in the ward still health providers gave her medical bills for a treatment. She did not understand this situation. She was cries any time. She said no any services were got free of charge.

The last day, the study never found her, but according to the report from one of the health provider, she said, her and son were got a referral to Muhimbili National Hospital, because the son problem become more serious. The study never know what will happen in Muhimbili National Hospital[1].

Source: Field data, October 2019

This case study still proved that, health care system procured the exchange-value side rather a use-value, health care become a commercial rather than a right to everyone. In order to get use value which is cure, you need quantities of exchange value to get it (Harvey.,2014). Hence, the process of paying these medical and surgical bills this create obstacle for the poor to receive health, means inequality. And has left many people into loss the important health care services. Also, this case study endorsed by the words of the patient, who were admitted in the ward, who talked with feeling and shocked, he had a following to demonstrates

> *"No free services, I didn't see. Here in this ward without money the custom of your disease decrease. Also, the language of naming patient to be custom, this changed the face of health care system from services into business. And, this is when you put in measurement between health services and business, still business remains in the highest rank than services in health system.* ***(IDIs/Inpatient/2019)***

From the Marxian concept of use and exchange value justify the above quotation from the participant, that the way use value of health care changed into the exchange value like a business, no free service for the citizens, but should to pay money for the buying the health care services within our hospitals. And this, for the Farmers concept of Structural violence it creates a problem for the poor to access the heath service if someone he/she has no money to buy.

[1] This is the story told by the one of the relative of the patient, the way health care provided in Amana regional referral hospital. This is a sign that health took new form of exchange. The same to hospital which responsible to provides health services, also, its more provide services because of profit oriented than free of charge.

Navarro (1993) demonstrates that the economic and political order of capitalism governs the financing and delivery of our health care services. Indeed, it is business "Entrepreneurship" that is the moving force behind our medical institutions. Here lies the root of human tragedy behind death and suffering of millions. Hence, the tragedy like health care inequality is the product of this moving force.

Marketization.

This is the central aspect of commodification process; commodification also require market to operate (Harvey., 2005). Every social services which turned into commodity, took the character of market value. Like health care under the social forces and processes of neoliberalism through commodification has value in the market system (Hunter and Murray.,2019). This goes together with the reifying of individual choice in the market and the one who responsible. Market operate under competition that why there are different health insurances with higher cost and lower cost, different wards with higher and lower quality, so individual has choice to choose. Haroub (2014) explained the government withdraw to finance social welfare services and putted this duty to individual under the power of market. (Mukono., 2012)

Findings revealed that, health marketed in the market and the price tend to fluctuate, by increased day after day. And this proved the section one on money and section two on health no longer as use value, but business. Because a market needs money to run the business. (Bought and sold (Harvey.,2014). That why you will see the prices changes in hospital. This can be seen from the one of the observation which conducted in Amana regional referral hospital. The way prices of services never being the same for a year. Most of the health providers seemed to endorsed the prices changes, because of the running costs of health care services in the market.

The evidence from observation, demonstrates that, in Amana hospital, the prices of services tend to change, due to the value of the market of that services. A good example, study discovered that, previous the bill of bed in ward was 15,000/= Tshs and patient pay once, but the time research a conducted the bill of bed was 20,000/= and patient pay this per week for those admitted in the public wards. Also, study observed changes in the price of x-rays through patient claimed that "*I see price of X-rays increased, it was 15,000/=, but now is 30,000/=*" the same to the price for delivery in Amana hospital is 75,000/= for normal and 250,000/= for operation. And the words of one of the health provider he said "*we should contribute the money for drip and other equipment's, because this hospital also buy these in the market*" He tried to justify why they increased the prices of health services.

Although the services for the pregnant mother are supposed to be free, but due to this market forces in health care caused the service to be charged by the hospital. Mwananchi (2019) and ITV (2019) shows the claims of the relatives of pregnant mothers in Mwananyamala hospital after charged money for delivery, its 75,000/= for the normal and 250000/= for operation to the ministry of health. And the reason mentioned was about hospital need this money to operate, means in the market of health care, for buying health equipment's. This also gives some meaning that, health has market value in term of medicine and medical services. This market process hinders the poor to access the service due to barrier of paying.

This is because of the marketization of health care system, because commodification puts costs in buying and selling the health facilities and equipment's and sometime to repair the wards which automatically increased the prices of services to the patient (Marton and Sullivan., 2019). Hence, the market value replaced the social value. So, this process also, normalized and routinized health care inequality. Because under neoliberal capitalism everything is commodified and has market value (Harvey., 2014). This is kind of another form of structural violence which existed to deprived the poor people. Because marketization is structural product, the structure who responsible for this process which destroy the people to access health care services (Farmer., 1999)

User-fee in health care

This has mentioned as one of the feature of structural adjustment programs of 1980s in Tanzania (Haroub.,2014). The government has changed his role in financing the social welfare services, depart from governing. And put this duty to the individual. Individual has responsible to make sure his/her health is good and once get health problem should make sure pays for his/her treatment. This policy led more burden of the individual to affords the price of health care services (Mukono.,2012: Tibeijuka.,1998). User fee and/or cost shearing this emanate from the process of commodification and privatization, from turned health care services into a thing or object., the same turned the collective service into private (Marten and Sullivan.,2019).

Basically, the issue of government withdraw / reduce its contribution to the provision of services to the population in the hospital, and provide small grants for hospital operation (Navarro.,2009). This have been also justification for those who buy the neoliberal policies of commodification within the hospital to increase the commodification and even prices for the reason that hospital should find money for the running. This evidently explained by the one of the hospital administrator who had follows to say,

> *"You know that the all regional referral hospitals took full supervision for their governed and received very small grants from the government purposely for running the hospital. So, most of time we try to invent new alternative source of revenue for running. Government give us 64 million as a grant, this is pea nut. We need to pay cleaners, to buy medicine and to repair hospital. So, important patient to contribute as cost shearing. Hence, things like private wards and adding the prices of same services purpose to get money, we do that because we need to run the hospital, without that will no hospital.* ***(IDs/Health provider/2019)***

In nutshell, this resulted increased user fee in the hospital environment, then the inequality still takes new forms, because the things like private wards, private doctor and special services is because of the government escape his duty of running the health of the population[2]. Due to this fact, the commodification continues to produce and reproduce health care inequality (Ellison.,2014). Because, this process create disparity among people and extend the damages to those who will not afford these reforms in hospital.

Marten, et al (2019) demonstrates that this situation of government to depart to public funding, resulted publicly-funded hospitals to be a "side hustles" for address conundrums derives from perverse incentives. While these strategies are supposed to generate revenues to sustain services to poor clients. In practice these market based approaches erode the ability of publicly funded hospitals to meet their obligation on to the poorest. This conditions always undermine the equality of health care system and/or universal health coverage. Hence, health care inequality in hospital have been produced and reproduced, due to this called side hustles under neoliberal process of commodification of health care.

This process produced more damages to the poor people who always failed to afford the prices of health care (Magufuli.,2013). Farmer (2001,2003) contend that this cost shearing just an indicator of structural violence, which always harms people. Because everyday people suffocate to pays for a medical bill, they can't afford, this mean that, lead death inequality among the social group,

[2] This is the continuation of the cruel structural adjustment policies. Because SAP provided a condition for government to withdraw to finance the social services include health care services.

of poor and rich. Due to this political and economic structure which invisible, but cost the life of many people in the world, especially poor.

The findings from the study, discovered that, the issue of higher price of health care in Amana hospital is the thing which hinder the patients and his/her relatives for afford the health care. This cause relative to take more responsibility to find alternative means of receive money in order to pay for health care services. This under the fact that, this user fee acted as a curtain for the poor people who are majority to access health care. The observation of the study also, observed the way patient claimed the prices of health services under the umbrella of user fee and/or cost shearing. This observation can be seen from the Focus Group Discussion with health providers, one of health provider had a following to say

> *"The price of health care services, frankly speaking is higher, not affordable to the patients. You write a medical and surgical bill to the relatives of the patient, you see relatives crying when they see this bill. This, means that, the price of health care is higher. The user fee is not a good thing, this is very dangerous for the poor people, because of this affect many people who are poor to receive health care services."* ***(FDG/Health Provider/2019)***

And also, another extract from the focus group discussion with health provider who spoke about how the higher price of health care services tend to produced challenges to the patients and relatives in the process of paying. This health provider had a following to say,

> *The issue of relatives to chases his/her patients in this hospital is normal. I am looked these events seven (7) times. Mmmh! And this because of price of health care (Medical Bill)). The price of health care is a major reason, although there are other reasons, like mental problem, those have addicted with drugs abuse, but the major reason is issues of price of health care (Medical Bill).* ***(FDG/Health Provider/2019)***

These above quotations, focus groups discussion corresponds the work of Magufuli (2013) and Tibaijuka (1998) who explained the user fee is not here to assist people, but rather is the new form of profit maximization from the poor people. Poor people always pick the cargo of this cost shearing. So, it has left poor people out of the position to get good and quality health care services. And this, is not only health care also, housing, education, water, information and others services. Hence, put poor people under the pressure of getting the social services which are important for their life and would be provided free to everyone.

Conclusion

This study came to debunk on essence or origin of health care inequality in the context of neoliberalism. Because there is positivistic thinking, that health care inequality is because of descriptive and/or observables factors like education, poverty, geographical location and income. And deny the moving force of commodification in produce and reproduce health care inequality. The way commodification operate in health care, is the same way creating death and injury to the poor people who are seeking health care services in hospitals.

References

Akazil, J., Ataguba, J., and McIntyre, D. (2011). Socio economic-related health inequality in South Africa: Evidence from general household survey. International journal for equity in health.

Carspecken, P and Apple, M. (1992). *Critical qualitative research. In M. LeComple*, W. Millroy, and J, Preissley (Eds). Handbook of critical research in education (pp. 507- 554). San Diego: Academic Press

Carspecken, P. (1996). *Critical Ethnography in Educational Research*. A theoretical practical Guide: New York. Routledge.

Conrad, M., Juma, Z., Kasale, H., Masanja, H., Momburi, D., Mkilindi, Y., Mwangeni, E., Reid, G., and Savingny, D. (2000), Health Inequality in Rural Tanzania: Evidence from the Rufiji Demographic Surveillance System

Ellison, J. (2014). First-Class Health: Amenity Wards, Health Insurance, and Normalizing Health Care Inequalities in Tanzania. Medical Anthropology Quarterly, Vol. 28, Issue 2, pp. 162–181,

Farmer, P. (2003), Pathology of power. Health, Human rights and the new war on the poor, with a foreword by Amartya Sen. University of California Pres, Berkeley and Los Angeles,402p

Farmer, P. (2001). Anthropology of Structural Violence: Current Anthropology. University of Chicago Press

Farmer, P. (1999). Infectious and Inequalities. The Modern Plague. University of California Press: Berkeley

Farmer, P. (1992). AIDS and accusation: Haiti and the Geography of Blame.
University of California Press. Berkeley

Farmer, P. (1999). Infectious and Inequality. The Modern Plague

Harvey (2014). The Seventeen Contradiction and Demise of Capitalism.

Harvey, D. (2005), *A Brief History of Neoliberalism, Oxford*: Oxford University Press

Independent Television. (2019). Msiwatoze Fedha za Huduma ya Uzazi Wakina Mama wajawazito. [27/12/2019]

Kinyeshi, O. (2017), Factors Determining Access to and Utilisation of Maternal Health Care Services in Urban Slums. The case of Kinondoni Municipality. A dissertation submitted in department of Sociology and Anthropology at University of Dar Es Salaam

Kitunda, N. (2020). Health Care Inequality in the Context of neoliberalism: The case of Amana Regional Referral Hospital. Master's thesis. University of Dar es Salaam

Madison, D. S. (2005). *Critical ethnography: Method, ethics, and performance.* Thousand Oaks, CA: Sage

Magufuli, M. (2013). Microfinance Credits and the Poor in the Neoliberal Era: The case PRIDE Tanzania. Kinondoni Municipality

Marten, M and Sullivan, N. (2019). Hospital Side Hustlers: Funding Conundrums and Perverse Incentives in Tanzania's Publicly Funded Health Sector.

Mugisha, L and Sigalla, H. (2018). Critiquing Expert' Struggles to Amplify the Concept of Nutrition' among Under-five Children in Southern Coastal Tanzania. Tanzania Journal of Sociology. Vol.4, June 2018: 47-64

Mukono, D. (2012). Social Insecurity and Vulnerability Among Causal Laborers in the Context of Neoliberalism: A case Study of Causal Cleaners in Cleaning Companies at University of Dar Es salaam

Mwananchi. (2019). Waziri Ummy aeleza kwa nini wajawazito wanatoa Fedha [27/12/2019]

Navarro, V. (2009). What We Mean by Social Determinants of Health: International Journal of Health Services, Volume 39, Number 3, Pages 423–441, 2009 doi: 10.2190/HS.39.3. a

Navarro, V. (1993), Dangerous to Your Health: Capitalism in Health Care. New York: Cornerstone Bokk

Shivji, I. (2009). Accumulation in an African Periphery: A Theoretical Framework. Dar Es Salaam. Mkuki Na Nyota

Tibaijuka, K.A. (1998), *The Social Services Crisis of the 1990s: Strategies for Sustainable Systems in Tanzania*, Aldershot, Ashgate Publishing Ltd

Tong, M. (2009). Feminist thought. A more comprehensive introduction. (3rd Ed.). United States of America: Westview.

United Republic of Tanzania. (2015). Tanzania Demographic Health and Malaria Indicators Survey 2015-2016

United Republic of Tanzania. (2007). National Health Policy of Tanzania

WHO. (2018), Tracing Universal Coverage, Global Monitoring Report

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.20

Factors associated with postpartum depression among adolescent mothers in Kigamboni municipality, Dar es Salaam: A cross-sectional study

Beatrice Mungi Matondo[1], Peter Joseph Wangwe[1,2], Ester Steven Mzilangwe[3]*

[1]Muhimbili University of Health and Allied Sciences, Campus College of Medicine, School of Clinical Medicine, [2]Muhimbili National Hospital, Department of Obstetrics and Gynecology, [3]Muhimbili University of Health and Allied Sciences, Campus College of Medicine, School of Clinical Medicine.

Abstract

Background: Postpartum depression(PPD)has been described as "a thief that steals motherhood". Maternal depression is a major public health concern as it affects both mothers and their children. PPD is often underdiagnosed and has been associated with child abundance, malnutrition and suicidal or suicidal ideation. It is associated with mother-infant bonding impairment, child abuse, child neglect, maternal abuse and self-harm. This study aimed to determine the prevalence of PPD and its associated factors among Adolescent mothers attending postnatal and under-five clinics in a Peri-urban area (Kigamboni) Dar-es-salaam.

Methods: A cross-sectional analytical study was conducted in two Health Centers located at Kigamboni, Dar es Salaam. A consecutive sampling technique was used to select 380 adolescent mothers accessing postnatal and under-five clinics. A structured questionnaire and review of the ANC card were used to collect information on social demographics and bio-psychosocial factors contributing to PPD. Edinburg Postpartum Depression Scoring scale with a score of ≥13 was used to assess the level of depression. Data were analyzed using SPSS software version 23 where Bivariate and multivariate logistic regression were used to identify the associated factors with PPD. A p-value of <0.05 was considered to be statistically significant.

Results: Forty -four per cent of adolescent mothers were found to have signs of depression. PPD was significantly associated with an unplanned pregnancy (AOR=7.40, 95% CI=3.16 -17.38). On the other hand, being married (AOR=0.92, 95% CI=0.12-0.69); having family support (AOR=0.42, 95% CI=0.22-0.81) and partner support (AOR=0.13, CI=0.28-0.60) had less likelihood of being associated with postpartum depression.

Conclusion: Adolescent mothers attending postnatal services and under-five clinics are at risk of developing PPD. Unplanned pregnancy, unmarried, poor family and partner support are among the identified common risk factors for PPD. Prevention of adolescent pregnancy by advocating sexual education and family planning in youth-friendly service clinics at every health facility is highly recommended.

Keywords: Postpartum Depression, Adolescent mothers

Introduction

Postpartum depression (PPD) is defined in the psychiatric nomenclature as a major depressive episode occurring within the first four weeks after childbirth and lasting for at least two consecutive weeks. PPD has been described as a "thief that steals motherhood" (Beck, 1999). Globally, about 13% of women who give birth suffer from mental health problems. The prevalence is higher in developing countries, where 19.8% of women develop mental health issues after childbirth. According to the WHO, adolescent pregnancies and motherhood are

* **Corresponding author:** Dr Peter Joseph Wangwe; Email:drwangwe@yahoo.com

causes of concern due to their significant impacts on both mothers and their offspring (Adeyemo, 2020). A Medline literature search conducted in the USA between 1996 and 2015 reported a prevalence of 25%. Similarly, a systematic review and meta-analysis conducted in Africa between 2007 and 2018 reported a pooled prevalence of 17.8% in African countries (Dinwiddie, 2018).

In sub-Saharan Africa, studies show varying prevalence rates, ranging from single to double digits in Eswatini, Ghana, the Democratic Republic of Congo, and Uganda, with prevalence rates of 47.4%, 33.3%, 50.8%, and 6.6%, respectively (Dlamini, 2019; Koutra, 2013; Gladys Ibanez, 2015).

PPD is a common complication affecting approximately 10-15% of women of childbearing age, representing a considerable public health issue. Depressed mothers may prematurely discontinue breastfeeding due to a reduction in breast milk production (Eastwood, 2017). This clinical condition is rarely assessed or understood in routine antenatal and postnatal care. Additionally, PPD is associated with abnormal development, cognitive impairment, and depression in infants (Hymas, 2019; Mohammad, 2020).

The etiology of PPD has complex pathophysiology and is likely the result of the interplay of genetic, neuroendocrine, and psychosocial factors (Wall, 2018). These factors include a history of mood disorders, a family history of psychiatric disorders, negative life events, poor marital relationships, lack of social support, drug abuse, maternal perfectionism, and antenatal depression or anxiety (Hymas, 2019; Stellenberg, 2015; Mbarak, 2019; Mohammad, 2020).

Tanzania is among the developing countries facing major public health challenges related to sexual and reproductive health for adolescents. The majority of adolescents in Tanzania are at risk for a broad range of health problems, including mental health issues. This is not exceptional, as reported by Dadi et al. (Dadi, 2020). Studies have been conducted extensively in adults, but less so in adolescent mothers (Getinet, 2018).

In Tanzania, the prevalence of postpartum depression in adolescents is not well-known. Despite several studies assessing PPD, adolescents are typically included as part of women of reproductive age. This study aims to determine the magnitude and associated factors of PPD in adolescent mothers attending postnatal and under-five clinics in Kigamboni, Dar-es-Salaam.

Materials and Methods

Study Design

This was a cross-sectional study involving women attending postnatal clinics at Kigamboni Municipality, Dar-es-Salaam, Tanzania. The study was conducted from October 2020 to January 2021. The council has five wards: Kigamboni, Maweni, Mjimwema, Somangila, and Kibada. It has two hospitals that receive referrals from all five wards. The study was conducted at Vijibweni Hospital and Kigamboni Health Centre.

Study Population

The study included all adolescent mothers aged ≤19 years who were attending postnatal and under-five clinics. It included women who were more than two weeks but less than six weeks post-delivery.

Sample Size and Sampling

The sample size was calculated using the formula: n=Z2·p(100−p)E2n = \frac{Z^2 \cdot p(100 - p)}{E^2}n=E2Z2·p(100−p) Proportion (P) was 8.8%, which was the prevalence according to a study conducted in Kwazulu-Natal, South Africa. With assumptions of a 95% confidence interval and a 3% margin of error, the minimum sample size was estimated to be 342. After adjusting for a non-response rate of 10%, the final sample size was 380. All adolescent mothers with children aged more than two weeks but less than six weeks, who were eligible to participate in the study, were informed about the study and asked for their assent. A random sampling technique was used to select the first participant, and subsequent participants were selected systematically using the calculated sampling interval based on the sample size. All adolescent mothers who had experienced early neonatal death and were attending the postnatal clinic were excluded from the study. Recruitment of participants was done at the clinics by research assistants who were nurse midwives.

Training of Research Assistants and Pretesting of the Questionnaire

The questionnaire was pretested at the same health facility before the initiation of data collection, and no changes to the questionnaire were deemed necessary. Two research assistants (nurse midwives), one from each health facility, were trained on the purpose of the study, the meaning of each question in the questionnaire, and professional conduct when approaching women during data collection. The questionnaires used were validated in a study conducted in Kenya by Manasi et al. (2015), where the English version of the Edinburgh Postnatal Depression Scale (EPDS) screening tool was successfully translated into Kiswahili. The Kiswahili version was used in this study (Linnet Ongeri, 2015).

Data Collection

The outcome of interest was postpartum depression, measured using the EPDS. The 10-item EPDS explores events that occurred in the seven days immediately post-delivery. Each item has four choices scored from 0 to 3, from the first to the last choice for items 1, 2, and 4. The scores are reversed from items 3 to 10 for questions 3, 5, 6, 7, 8, 9, and 10. Adolescents were interviewed, and their scores were recorded and summed up, where the total score ranged from 0 to 30. Mothers who scored 13 and above are likely to be suffering from depressive illnesses of varying severity (Orbach, 2013; Atuhaire, 2018; Niyonsenga, 2021). Mothers with such scores were counselled and referred for further care.

Independent variables included bio-psychosocial etiological factors for depression, demographic, and obstetric characteristics. These factors included maternal age, marital status, level of education, occupation, history of mental illness or depression in the family, unplanned pregnancy, school dropout, poor family support, partner support, intimate partner violence, drug or substance use, parity, gestational age at delivery, mode of delivery, baby's condition, mode of feeding, hypertensive disorders during pregnancy, and HIV status. Details on obstetric information and HIV status were obtained from the maternal antenatal card.

Data on family support were obtained by asking participants how they perceived assistance from their family, including informational, material, and emotional support. The quality of the relationship with a partner was assessed with three responses: very good, good, or poor. Regarding partner support, participants were asked how they perceived assistance from the partner or father of the child, with three responses: not at all, somewhat supportive, or yes. A history of mental illness was obtained by asking participants if anyone in the family had a history of mental illness, with responses of yes or no, specifying the relationship of that person to the participant. Hypertensive disorders were

assessed by asking participants if they had been informed of hypertensive disorders during pregnancy, with responses of yes or no, and medication use was verified. Data were collected using face-to-face interviews after obtaining signed informed assent.

Data Analysis

Data coding, entry, and analysis were done using descriptive methods through the Statistical Package for Social Sciences (SPSS) version 23. Results were expressed as frequencies and proportions for categorical variables and standard deviation for continuous variables. The prevalence of PPD was obtained as a percentage of women who scored ≥13 on the EPDS. Bivariate analysis was done, and the Chi-square test was used to find differences in the proportion of PPD across all variables for socio-demographic, bio-psychosocial, and obstetric factors. Crude odds ratios (OR) with 95% confidence intervals were calculated for all study variables. Multivariate logistic regression was then run to compute adjusted odds ratios (AOR) for variables with significant associations to the dependent variable ($p < 0.05$) to determine the independent risk factors for PPD.

Ethical Considerations

The study was approved by the Research and Ethics Committee of Muhimbili University of Health and Allied Sciences (MUHAS). Permission to conduct the study was obtained from the Kigamboni district medical officer and the medical officers in charge at Vijibweni Hospital and Kigamboni Health Centre. Participation was voluntary, and signed informed assent was obtained before data collection. Confidentiality was maintained throughout by ensuring that no names were used. Participants who were found to be at risk of PPD or had suicidal thoughts were counselled and referred to a doctor for further evaluation and treatment.

Results

One hundred and sixty-six out of 380 participants had an EPDS score of ≥13. This category was considered as having PPD with a prevalence of 44% (*Table 2*). Unplanned pregnancy had higher chances of having PPD compared to planned pregnancy. Being married, and having family and partner support were protective for PPD compared to their counterpart.

Table 1: Social demographic characteristics of adolescent mothers (N=380).

Variable	Frequency n(%)
Marital status	
Single	201(52.9)
Married	165 (43.4)
Separated	12(3.2)
Widow	2(0.5)
Level of education	
Not completed primary education	35 (9.2)
Completed primary education	178 (46.8)
Secondary education	146 (38.4)
College education	21(5.5)
Occupation	
Housewife or unemployed	295 (77.6)
Self-employed	58 (15.3)
Employed	27 (7.1)

Age group	
≤17	61(16.1)
18- 19	319 (83.9)
Parity	
One	332(87.4)
Two	48(12.6)
Gestation age	
≥37 weeks	371(97.6)
< 37 weeks	9(2.4)

The mean age for the study participant was 18.3 ± 0.8 years. Less than half of the participants were married and had primary school education levels 165 (43.4%) and 178 (46.84%) respectively.

Table 2. Descriptive statistics on Postpartum Depression (PPD), Overall and intergroup prevalence among studied adolescent mothers (N=380).

Variable	Non-depressed Frequency (56%) (n= 214)	Depressed Frequency (44%) (n=166)
Age		
≤17	20(32.8)	41(67.2)
18-19	123(38.7)	196(61.3)
Level of education		
No formal education	4(50.0)	4(50.0)
Drop out primary education	15(55.6)	12(44.4)
Completed primary education	82(46.1)	96(53.9)
Secondary education	100(68.5)	46(31.5)
College education	15(71.4)	6(28.6)
Marital status		
Single	64(31.8)	137(68.2)
Married	150(90.9)	15(9.1)
Divorced/separated	2(16.7)	10(83.3)
Widow	0(0)	2(100)
Parity		
One	180(54.2)	152(45.8)
Two	36(75.00)	12(25.00)
Planned pregnancy		
Yes	162(85.7)	27(14.3)
No	54(28.3)	137(71.7)
Gestation age		
≥37 weeks	212(57.1)	159(42.9)
< 37weeks	4(44.4)	5(55.6)
Mode delivery		

Vaginal delivery	192(59.6)	130(40.4)
C/S	24(41.4)	34(58.6)
Weight of the baby		
<2kg	1(20.0)	4(80.0)
2kg -2.5kg	11(47.8)	12(52.2)
≥2.6k	203(57.8)	148(42.2)
Baby's condition		
Stable	213(56.5)	164(43.5)
Unstable	1(33.3)	2(66.7)
Hypertensive disorders during pregnancy		
Yes	11(37.9)	18(62.1)
No	205(58.4)	146(41.6)
HIV status		
Positive	1(100)	0(0)
Negative	213(56.2)	166(43.7)
Use of any illicit drugs		
Yes	61(45.9)	72(54.1)
No	155(62.8)	92(37.2)

The overall proportion of PPD among participants was found to be 44%. Several factors were related to PPD including age, planned pregnancy, mode of delivery and marital status.

Table 3: Biological factors associated with depression status among participants using chi-square test. (N=380)

Variable	Non depressed Frequency (%) (n= 214)	Depressed Frequency (%) (n=166)	P value
Parity			
One	178(53.61)	154(46.39)	0.005
Two	36(75.00)	12(25.00)	
Gestation age			
≥37 weeks	210(56.60)	161(43.40)	0.512*
< weeks	4(44.44)	5(55.56)	
Mode of delivery			
Vaginal delivery	189(58.70)	133(41.30)	0.028
C/S	25(43.10)	33(56.90)	
Baby's condition			
Stable	213(56.50)	164(43.50)	0.583*
Unstable	1(33.33)	2(66.67)	
Mode of feeding			
Not breastfeeding	1(25.00)	3(75.00)	0.322*
Breastfeeding	213(56.65)	163(43.35)	

Hypertensive disorders during pregnancy			
Yes	11(37.93)	18(62.07)	0.038
No	203(57.83)	148(42.17)	
HIV status			
Positive	1(100.00)	0(0.00)	1*
Negative	213(56.20)	166(43.68)	

Variables put for logistic regression, p-value<0.2 and *fisher exact. Adolescent mothers who were para one, delivered by C/S and had hypertensive disorders were found to be more depressed compared to their counterparts in the group.

Table 4: Psychosocial factors associated with depression status among participants using the chi-square test (N=380)

Categories	None depressed Frequency (%) (n=214)	Depressed Frequency (%) n= 166)	P Value
Marital status			
Single	61(30.35)	140(69.65)	<0.001*
Married	151(91.52)	14(8.48)	
Divorced/separated	2(16.67)	10(83.33)	
Widow	0(0.00)	2(100.00)	
Level of education			
Not completed primary education	15(42.86)	20(57.14)	<0.001
Completed Primary education	84(47.19)	94(52.81)	
Secondary education	99(67.81)	47(32.19)	
College	16(76.19)	5(23.81)	
Pregnancy planned			
Yes	161(85.19)	28(14.81)	<0.001
No	53(27.75)	138(72.25)	
Satisfied with the level of family support			
Not satisfied	47(38.84)	74(61.16)	<0.001
Satisfied	167(64.48)	92(35.52)	
Partner of the child support			
No, not at all	50(25.25)	148(74.75)	<0.001
Yes, supportive	164(90.11)	18(9.89)	
Used any illicit drugs			
Yes	63(47.37)	70(52.63)	0.01
No	151(61.13)	96(38.87)	
Past 6 months your partner hurt you			
Yes	40(38.83)	63(61.17)	<0.001
No	174(62.82)	103(37.18)	
Past 6 months forced into a sexual act by your partner			
Yes	27(38.03)	44(61.67)	0.001
No	187(60.52)	122(39.48)	

The studied psychosocial factors were found to be statistically significant (p-value <0.05) associated with PPD.

 https://dx.doi.org/10.4314/thrb.v26i3.20

Table 5: The factors associated with PPD among participant's Multivariate logistic regression model (N=380)

	Bivariate		Multivariate	
Variable	COR (95% CI)	P-value	AOR (95%)	p- value
Parity				
2	1	1	1	1
1	2.60(1.30-5.16)	0.007	0.69(0.30-1.59)	0.39
Mode delivery				
Vaginal delivery	1	1	1	1
C/S	1.88(1.07-3.30)	0.029	0.95(0.48-1.90)	0.906
Hypertensive disorder during pregnancy				
No	1	1	1	1
Yes	2.24(1.02-4.89)	0.042	1.87(0.72-4.84)	0.196
Marital status				
Separated	1	1	1	1
Single	0.45(0.09-2.15)	0.324	0.15(0.22-1.06)	0.057
Married	0.01(0.00-0.09)	<0.001	0.92(0.12-0.69)	0.02
Education				
Not completed primary education	1	1	1	1
Completed Primary education	0.83(0.40-1.74)	0.639	0.91(0.31-2.64)	0.863
Secondary education	0.36(0.16-0.75)	0.007	0.57(0.19-1.72)	0.319
College	0.23(0.70-0.78)	0.018	0.45(0.06-3.56)	0.449
Pregnancy planned				
Yes	1	1	1	1
No	14.97(8.97-24.96)	<0.001	7.40(3.16-17.38)	<0.001
Satisfied with the level of family support				
Not satisfied	1	1	1	1
Satisfied	0.34(0.22-0.54)	<0.001	0.42(0.22-0.81)	0.009
Partner of the child support				
No, not at all	1	1	1	1
Yes, supportive	0.37(0.20-0.66)	<0.001	0.13(0.60-0.28)	<0.001
Used any illicit drugs				
Yes	1	1	1	1
No	0.57(0.37-0.87)	0.01	0.60(0.30-1.21)	0.156
Past 6 months your partner hurt you	1	1	1	1
Yes				
No	0.37(0.23-0.59)	<0.001	0.99(0.48-2.06)	0.99
Forced into a sexual act by your partner				
No	1	1	1	1
Yes	2.66(1.67-4.24)	<0.001	0.95(0.452.058)	0.915

COR-Crude Odds Ratio **AOR**-Adjusted Odds ratio. Statistically significant at p<0.05,

Discussion

The prevalence of postpartum depression (PPD) was found to be higher (44%) and was related to the mother's age, gestational age at delivery, and mode of delivery. Medical disorders during pregnancy were among the factors associated with PPD in adolescent mothers. The use of illicit drugs among adolescent mothers was directly related to PPD when compared to their counterparts in the same group. PPD was significantly associated with unplanned pregnancy, marital status, education level, and family and partner support.

Biological factors like parity, mode of delivery, and medical disorders during pregnancy, such as hypertensive disorders, were clinically important when considering the outcome of adolescent mothers, although they did not have a statistically significant effect on PPD. The study area, being peri-urban with good antenatal services where mothers at risk are identified and referred to higher health facilities, could explain the differences when compared to other studies. A study conducted in Tanzania at Muhimbili National Hospital by Mbaraka et al. (2019) noted that medical disorders during pregnancy were a determinant of PPD, with pre-eclampsia showing a high association with postpartum depression, and a stronger association was found in adolescents compared to adults (Mbarak, 2019; Mohammad, 2020; Dadi, 2020).

Unplanned pregnancy was more strongly associated with PPD than other factors. The majority of adolescent mothers in our study had unplanned pregnancies and had primary education levels, which were identified as risk factors for adolescent PPD. A similar finding was observed in a meta-analysis in Ethiopia by Getinet et al. (2018), which reported that women with unplanned pregnancies were 4.49 times more likely to develop PPD than women with planned pregnancies (Getinet, 2018; Niyonsenga, 2021; Atuhaire, 2018). Mbawa et al. (2018) in Zimbabwe also found similar results, with unplanned pregnancies and lack of information about contraception being associated with PPD. Other factors, such as first pregnancy, previous prenatal depression, and negative relationships with guardians or parents, were also associated with postpartum depression (Orbach, 2013).

Adolescent mothers who were married had higher education levels, and received family and partner support were less likely to develop PPD compared to other groups. This is because they believed in having a stable home and the basic needs to sustain themselves and their babies (Dlamini, 2019; Atuhaire, 2018; Niyonsenga, 2021; Sangsawang, 2022).

The use of illicit drugs in adolescent mothers was identified as one of the risk factors for developing depression, although it was not statistically significant. This is contrary to a study by Kambui et al., which assessed depression with comorbid substance use in antepartum women, where about 60.4% had depression (Kambui, 2018). This raises concerns about the accuracy of using the EPDS score ≥13 to detect PPD in adolescents, as it was found to be more accurate compared to other scales with a cutoff point of less than 9 (Venkatesh, 2014; Sangsawang, 2022).

Even though the prevalence of PPD was found to be higher than the worldwide prevalence rate of 12%-15%, the results are comparable to those from previous studies. A study conducted in Eswatini by Dlamini et al. (2019) reported a prevalence of 47.4%, which was higher compared to our findings. This could be due to differences in the socio-demographic characteristics of the study participants, where the majority were older than 24 years (Fantahun, 2018). This study highlights the extent to which adolescent mothers suffer compared to non-adolescent mothers and emphasizes the need for special attention during the antenatal and postpartum periods (Oladeji, 2019; Sangsawang, 2019).

Literature shows variations in PPD depending on whether the study was conducted in developing or developed countries. A Medline literature search and meta-analysis conducted in the USA and Africa reported a prevalence of 25% and 6.6% to 33.3%, respectively (Kambui, 2018). The differences in prevalence rates between regions were attributed to variations in study designs, measurements of PPD, study population characteristics, and contextual risk factors for maternal mental health disorders in different settings.

Limitations of the Study

Despite the reported results, this study had some limitations. It did not account for antenatal factors that could also influence PPD. As a hospital-based study, it excluded mothers with mental illness, those who were seriously ill, and those adolescent mothers who had lost their babies. A community-based cohort design could have further solidified the results observed. However, the results are valid and form a stepping stone toward improving adolescent services. More studies are needed, particularly in rural areas where early marriage and teenage pregnancies are common. Intimate partner violence should also be investigated further.

Conclusion

Adolescent mothers attending postnatal services and under-five clinics are at risk of developing PPD. Unplanned pregnancy, unmarried status, and poor family and partner support are among the most common risk factors for PPD. Adolescent-friendly services should be advocated to address PPD. Prevention of adolescent pregnancy through the promotion of sexual education and family planning in youth-friendly service clinics at every health facility is highly recommended. More research concerning adolescents should be done in the country, especially in rural areas.

Acknowledgements

We convey heartfelt gratitude to the participants and field staff (midwives). We are also thankful to Vijibweni Hospital and Kigamboni Health Centre for granting permission to conduct this study.

Authors' Contributions

Conceptualization: BMM, PJW and EM
Data collection: BMM and PJW
Data analysis: BMM, PJW and EM
Funding acquisition: BMM

References

Addishiwet, F., Amsale, C.& Leul, D. (2018). Prevalence and Factors Associated with Postpartum Depression Among Mothers Attending Public Health Centers of Addis Ababa, Ethiopia,2016. *Clinical Practice & Epidemiology in Mental Health,14(1),196-206. DOI: 10.2174/1745017901814010196,*

Adeyemo, E.O., Oluwole, E.O., Kanma-Okafor, O.J., Izuka,O.M.& Odeyemi, K.A. (2020). Prevalence and predictors of postpartum depression among postnatal women in Lagos, Nigeria. *African Health Sciences, 20*(4), 1943-1954. doi:10.4314/ahs.v20i4.53

Atuhaire, C. & Samuel, N.C. (2018). Factors associated with postpartum depression among adolescents in Uganda. *Pan African Medical Journal, 30*. doi:10.11604/pamj.2018.30.170.15333

Beck, C. T. (1999). Postpartum Depression Stopping the Thief That Steals Motherhood. *Nursing for Women Health(NWH) LIBERTY*| , , 3(4), 41-44. doi:DOI:https://doi.org/10.1111/j.1552-6356.1999.tb01115.x

Dadi, A.F, Temesgen, Y. A., Adhanom, G.B. & Haileab F. W. (2020). Epidemiology of postnatal depression and its associated factors in Africa: A systematic review and meta-analysis. *PLoS ONE, 15*(4). doi:10.1371/journal.pone.0231940

Dinwiddie, K.J., Tracy, L.S. & Jason, E.S. (2018). Postpartum depression in adolescent mothers. *39*(3), 168-175. doi:10.1080/0167482X.2017.1334051

Dlamini, L.P., Mahanya, S, S., Dlamini, S.D& Mduduzi, C.S. (2019). Prevalence and factors associated with postpartum depression at a primary healthcare facility in Eswatini. *South African Journal of Psychiatry*. doi:10.4102/sajpsychiatry

Eastwood, J., Felix, A. O., Alexandra, H., Justine, N., Andrew, P.& Early Years Research Group (EYRG) (2017). The impact of antenatal depression on perinatal outcomes in Australian women. *PLoS ONE, 12*(1). doi:10.1371/journal.pone.0169907

Fantahun, A., Amsale, C.&Leul D. (2018). Prevalence and Factors Associated with Postpartum Depression Among Mothers Attending Public Health Centers of Addis Ababa, Ethiopia, 2016. *Clinical Practice & Epidemiology in Mental Health*, 196-206. doi:10.2174/1745017901814010196, 2018, 14, 196-206

Getinet, W., Tadele,A, A, A., Berhanu, B., Shegaye, S., Wubet,W.,& Telake,A. (2018). Prevalence and Risk Factors for Antenatal Depression in Ethiopia: Systematic Review. *Depression Research and Treatment, 2018*. doi:10.1155/2018/3649269

Gladys I., Jonathan, Y.B., Claire, R., Hugo, P., Anne, F.,Monique, K., Marie-Josèphe, S.& EDEN Mother-Child Cohort Study Group (2015). Effects of antenatal maternal depression and anxiety on children's early cognitive development: A prospective Cohort study. *PLoS ONE, 10*(8). doi:10.1371/journal.pone.0135849

Hymas, R.&, Lisa-Christine, G. (2019). Predicting postpartum depression among adolescent mothers:Asystematic reviewofrisk. *Journal of Affective Disorders, 246*, 873-885. doi:10.1016/j.jad.2018.12.041

Kimbui, E., Mary, K., Obadia, Y.& Manasi, K. (2018). A cross-sectional study of depression with comorbid substance use dependency in pregnant adolescents from an informal settlement of Nairobi: Drawing implications for treatment and prevention work. *Annals of General Psychiatry, 17*(1). doi:10.1186/s12991-018-0222-2

Koutra, K., Leda, C., Manolis, B., Maria,V., Panos,B.& Manolis, K.(2013). Antenatal and postnatal maternal mental health as determinants of infant neurodevelopment at 18 months of age in a mother-child cohort (Rhea Study) in Crete, Greece. *Social Psychiatry and Psychiatric Epidemiology, 48*(8), 135-145. doi:10.1007/s00127-012-0636-0

Linnet, O., Manasi, K., Muthoni, M.& Anne,M. (2015). Translation of EPDS Questionnaire into iswahili: Understanding the Cross-Cultural and Translation Issues in Mental Health Research. *Journal of Pregnancy and Child Health, 02*(01). doi:10.4172/2376-127x.1000134

Mbarak, B., Charles, K., Saidi,K.& Bruno, F.S. (2019). Postpartum depression among women with pre-eclampsia and eclampsia in Tanzania; A call for integrative intervention. *19*(1). doi:10.1186/s12884-019-2395-3

Mohammad, R.S.A., Priyasini, S., Thenmoli, P., Venotha, G.,Puteri, N.M.A.,Paream,K.,Lili, Z. M.,Subashini,A.,Paranthaman,V& Boon, H.C. (2020). Prevalence and risk factors of postpartum depression, general depressive symptoms, anxiety and stress (PODSAS) among mothers during their 4-week postnatal follow-up in five public health clinics in Perak: A study protocol for a cross-sectional study. *BMJ OPEN, 10*(6). doi:10.1136/bmjopen-2019-034458

Niyonsenga, J. & Jean M. J. J. (2021). Factors of postpartum depression among teen mothers in Rwanda: a cross- sectional study. *Journal of Psychosomatic Obstetrics and Gynecology*, 356-360. doi:10.1080/0167482X.2020.1735340

Oladeji, B.D, Toyin, B., Lola,K., Ricardo, A., Oye, G.& Phyllis. (2019). Exploring differences between adolescents and adults with perinatal depression—data from the expanding care for perinatal women with depression trial in nigeria. *Frontiers in Psychiatry, 10*. doi:10.3389/fpsyt.2019.00761

Orbach, H., Ilan, M., Rafael, G., Eyal, S., Sharon, D., Arnon, W. Gideon, K.& Amalia,L. (2013). Hypertension and antihypertensive drugs in pregnancy and perinatal outcomes. *American Journal of Obstetrics and Gynecology, 208*(4), 301.e1-301.e6. doi:10.1016/j.ajog.2012.11.011

Sangsawang, B., Chintana,W.& Nucharee, S. (2019). Interventions for the prevention of postpartum depression in adolescent mothers: a systematic review. *Archives of Women's Mental Health, 22*(2), 215-228. doi:10.1007/s00737-018-0901-7

Sangsawang, B., Wannee, D., Pornpat, H.&Nucharee, S. (2022). Effectiveness of psychosocial support provided by midwives and family on preventing postpartum depression among first-time adolescent mothers at 3-month follow-up: A randomised controlled trial. *Journal of Clinical Nursing, 31*(5-6), 687-702. doi:10.1111/jocn.15928

Stellenberg, E. L.&Johanna M. A. (2015). Prevalence of and factors influencing postnatal depression in a rural community in South Africa. *African Journal of Primary Health Care and Family Medicine, 7*(1). doi:10.4102/phcfm.v7i1.874

VenkateshK,. K., Caron, Z., Elizabeth, W. T., Crystal. & Maureen,G.P.(2014). Accuracy of brief screening tools for identifying postpartum depression among adolescent mothers. *Pediatrics, 133*(1). doi:10.1542/peds.2013-1628

Wall, V., Shahirose, S.P., Nicole, L. Graham, Mc.& Elias,C.N, C.N, C.N. (2018). Factors associated with pregnancy-related anxiety in Tanzanian women: A cross-sectional study. *BMJ Open, 8*(6). doi:10.1136/bmjopen-2017-020056

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.21

Factors contributing to errors during radiotherapy in a resource-constrained setting: Experience from Ocean Road Cancer Institute in Tanzania

Polikalipo Simon Kagina[1*], *Furahini Yoram*[1]

[1]Department of Clinical Oncology, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania

Abstract

Background: Various factors have been identified as contributing to errors during radiotherapy. However, there is limited data on these factors in Tanzania's radiotherapy settings. Understanding these factors is essential for developing strategies to reduce errors in radiotherapy.

Objective: To investigate staff experiences with factors that contribute to errors during radiotherapy at the Ocean Road Cancer Institute.

Methods: In-depth interviews were conducted with 10 staff members involved in radiotherapy planning and delivery at the Ocean Road Cancer Institute from June to July 2023. The data was analyzed using qualitative content analysis.

Results: Five key categories emerged from the data, highlighting staff experiences with factors leading to errors in radiotherapy. These categories were: the use of outdated and malfunctioning equipment, negligence, a stressful working environment, the absence of an error monitoring system, and communication breakdowns.

Conclusion: This study identifies several factors contributing to errors during radiotherapy. The findings emphasize the need for accurate and reliable equipment, improved staff practices, better working conditions, and the establishment of a robust error-monitoring system.

Keywords: Radiotherapy, Errors, Ocean Road Cancer Institute, Qualitative study

Introduction

With the rise of cancer incidence globally, radiotherapy is becoming increasingly needed as one of the treatment modalities for different cancers. It is an essential treatment modality that uses ionizing radiation to kill malignant cells (Connell & Hellman, 2009). To ensure the safety of the normal structures, a maximum radiation dose is delivered to the tumor (malignant cells) while at the same time minimizing the radiation dose to the surrounding normal tissues (Burnet et al., 2004). Approximately, 60% of cancer patients require radiotherapy during their course of treatment either for curative or palliative treatment (Chierchini et al., 2019).

Radiotherapy is delivered using different techniques from conventional to more advanced techniques (Baskar et al., 2012), which use complex equipment, require several steps, and involve different professionals (Jaffray & Gospodarowicz, 2015). These techniques need an effective linkage of different systems and professionals to attain better treatment outcomes. It is therefore required to conduct quality assurance in every step of the radiotherapy process to minimize the possibility of error occurrence (STUK, 2003).

Despite being uncommon due to quality management measures used in radiotherapy practice, errors occur in each radiotherapy process affecting patients' quality of life (Errifai et al., 2022; Xu et al., 2017). Several factors contribute to these errors at some stage of the radiotherapy workflow. As reported in previous studies, incorrect patient setups and dose calculation, communication failure, oversight, shortage of proper equipment, stressful working environment and use of old systems or poor maintenance are some of the factors contributing to errors during

* **Corresponding author**: polikalipokagina@gmail.com

radiotherapy (Hosseini-Ashrafi & Robinson, n.d.; Ishiyama et al., 2019; Portaluri et al., 2010; Xu et al., 2017).
However, variations exist between institutions depending on their workload, staff experiences and training, and other individual factors (Malicki et al., 2018). Limited data exist on the factors contributing to radiotherapy errors in Tanzania. Understanding the contributing factors to errors during radiotherapy will help to develop a more effective way of mitigating these errors in a study setting. This study explored staff experiences on factors contributing to errors during radiotherapy at Ocean Road Cancer Institute in Tanzania.

Materials and Methods

Design and Setting

An exploratory qualitative study was conducted to understand factors contributing to errors during radiotherapy. The study was conducted at Ocean Road Cancer Institute in Dar es Salaam, Tanzania. The institute offers in-patient and outpatient services, including laboratory services, diagnostic imaging, chemotherapy, radiotherapy, palliative care services, cancer screening and cancer vaccination. Ocean Road Cancer Institute is equipped with two Cobalt machines, two linear accelerator machines and One CT Simulator machine. Radiotherapy treatment at Ocean Road Cancer Institute involves a multidisciplinary team including Radiation therapists, Radiation and Clinical Oncologists, Medical Physicists, and nurses. The radiation therapy process follows the following steps: Consultation, simulation, contouring, treatment planning, treatment delivery, and follow-up (Figure 1).

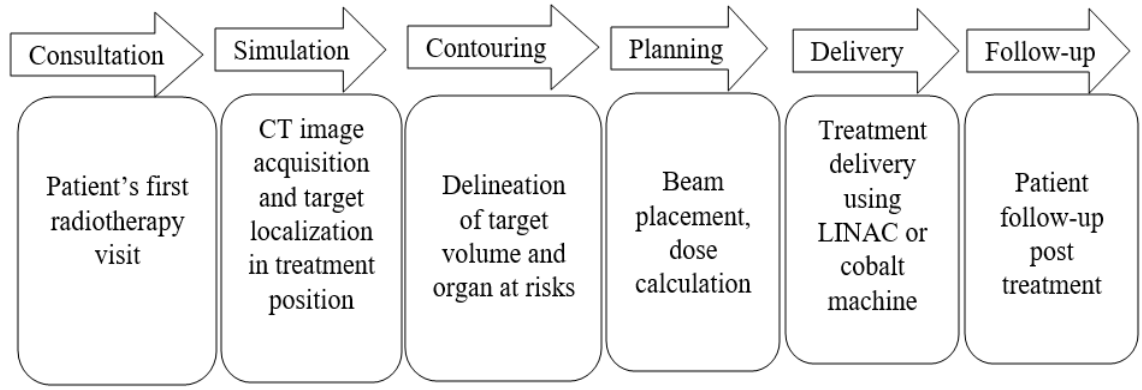


Figure 1: Radiotherapy workflow at Ocean Road Cancer Institute

Participants

This study included radiotherapy staff (Oncologist, Radiation therapists and Medical Physicist) working in radiotherapy section at Ocean Road Cancer Institute. They were selected due to their direct involvement in radiotherapy workflow.

Interviews

Ten (10) In-depth interviews were conducted using a semi-structured interview guide developed by researchers based on a literature review and clinical experience of working in the radiotherapy section. The guide was pre-tested before data collection and revised during data collection to include issues that were arising. The guide included questions that asked about the factors contributing to errors in the radiotherapy process, followed by probing questions. Interviews were conducted in the Kiswahili language, Tanzania's national language, until saturation was attained (Francis et al., 2010). All interviews were audio recorded, and a notebook was used to capture nonverbal responses.

Data analysis

Interviews were analyzed using a qualitative content analysis approach (Graneheim & Lundman, 2004). Recorded interviews were transcribed verbatim by the first author and reviewed by the second author. The Kiswahili transcripts were used for analysis where each transcript was carefully read by all authors line by line to get the whole content narrated by the participants. Phrases and sentences related to factors contributing to errors during the process of radiotherapy were coded together by all authors. Codes were discussed several times, and the agreed codes were sorted out based on their similarities and differences. Similar codes were grouped to form categories. The agreed codes and categories by all authors were presented with the support of succinct quotes. The codes, categories and quotes were translated into English language (Table 1).

Table 1: Example of qualitative content analysis to come up with a stressful working environment category.

Quote	Code	Category
"…… .among the three staff, only one comes on time and works alone…..you position the patient yourself, be on the console, and again provide instructions to the patient yourself. It is difficult to work in that environment... there is a possibility of errors occurring when you are exhausted"	Working alone during treatment delivery	Stressful working environment

Ethical clearance

Ethical approval for the study was obtained from the Institutional Review Board of the Muhimbili University of Health and Allied Sciences (Ref. No.DA.282/298/01L/129). Permission to conduct this study was acquired from Ocean Road Cancer Institute (Ref: 10/VOL.XXI/149B). After a detailed explanation of the study objective, informed consent was obtained from each study participant. All the interviews were conducted in a private room to keep the participants' privacy their records were also kept confidential.

Results

Participants' characteristics

Table 2 below summarizes the participants' characteristics regarding their age, gender, profession and years of experience in radiotherapy practice.

Table 2: Participants' characteristics

Characteristics	Number
Age	
Median age (range) in years	35.5 (30 - 50)
Gender	
Male	7
Female	3
Profession	
Radiation Therapist	8
Oncologist	1
Medical physicist	1
Years of experience in radiotherapy	
0-5 years	4
6-10 years	3
>11 years	3

Categories

Five categories emerged from interviews with staff working at the Radiotherapy section at Ocean Road Cancer Institute (Table 3). These are the use of impaired and old devices, negligence, stressful working environment, lack of error monitoring system and miscommunication.

Table 3: Summary of findings

Selected codes	Categories
Using impaired equipment and devices	Use of impaired and old devices
Using old devices	
Not paying attention to patients' details	Negligence
No cross-checking of patient details	
Staff being exhausted due to workload	Stressful working environment
Work pressure on staff to meet goals	
Working alone during treatment delivery	
No cross-checking of treatment plans	Lack of error monitoring system
Lack of continuous error reporting system	
Improper communication among professionals	Communication failure
Staff failure to adequately communicate information to patients	

Impaired and Outdated Devices

Participants highlighted the use of faulty and outdated devices as a significant source of errors. For example, informants pointed to the malfunctioning of a laser in the facility as a contributing factor. One participant explained that if one of the lasers is not working, it becomes difficult to align the patient properly, which can affect the reproducibility of the patient's position. One participant shared the following:

> *"There was a time when one laser was not working (with two still functioning), so when using two lasers for patient positioning, it becomes difficult to achieve the intended reproducibility" (Participant 04).*

Additionally, the movement of the treatment couch was cited as a source of errors, especially when the couch is old and lacks regular quality assurance checks. As one respondent explained:

> *"…In this cobalt machine, sometimes, when you position the patient on the couch, while outside the treatment room, the couch starts to move. We've observed this, and if you're not careful, you could end up treating unintended areas" (Participant 06).*

Several informants also mentioned that the equipment and devices used in the facility are very old, and as a result, they are not effective in ensuring accurate patient positioning.

> *"The devices being used are very old, and they are not effective in positioning a patient as planned…" (Participant 01).*

Negligence

Study participants explained that some staff members fail to pay attention to patient details, such as treatment parameters, during the radiotherapy delivery process. Additionally, some staff do not cross-check patient information before positioning and treatment delivery, leading to errors such as treating patients with the wrong treatment plans or incorrect setups.

> *"During treatment delivery, the issue can stem from the staff themselves. Honestly, not all staff pay attention to patient details, and some fail to cross-check patient information" (Participant 01).*

Stressful Working Environment

Participants reported that the high volume of cancer patients visiting the facility makes it difficult to follow all treatment protocols, which increases the likelihood of errors. The overwhelming workload contributes to staff fatigue, as described by one respondent:

> *"…The workload at our institute is very high. It predisposes us to more errors because we don't have enough time to adhere to all the protocols during radiotherapy simulation and treatment. We're overwhelmed with a large number of patients, which makes us exhausted" (Participant 09).*

Moreover, the pressure to meet work goals adds stress and increases the potential for errors. One informant explained:

> *"…The main factor is the pressure. Work pressure causes a lot of errors. Practitioners become insecure, unable to tolerate the pressure, and attempt to meet goals that are difficult to achieve, such as accommodating the large number of patients we have. With that pressure, many errors occur…" (Participant 08).*

Some participants also reported that working alone during treatment delivery contributes to errors. One staff member described the challenges of managing multiple tasks, such as providing instructions, positioning the patient, and monitoring the treatment console, which creates a difficult working environment:

> *"…Among the three staff members, only one comes on time and works alone. You position the patient yourself, manage the console, and provide instructions to the patient. It's difficult to work in such an environment, and there's a higher possibility of errors when you're exhausted" (Participant 06).*

Lack of Error Monitoring System

The absence of a continuous error reporting system was identified as a significant factor in the recurrence of errors. Several informants emphasized that clear identification, reporting, and discussion of errors can reduce the likelihood of repeating mistakes. Without such a system, the chance of errors being repeated increases. As one participant mentioned:

> *"I've witnessed and heard about different errors. Some are reported to our supervisors, but most of the time, they remain within our units…There should be a good system for reporting and discussing errors" (Participant 04).*

Additionally, informants reported that the facility lacks peer-review audits of treatment plans. A process where one staff member cross-checks the treatment plans created by another staff member could help detect and correct errors before treatment begins. One respondent noted:

> *"Our treatment approval system isn't effective…Once a staff member completes a plan, another staff member should cross-check the plan, rather than the same person approving it. We used to do this, but I'm not sure why it stopped. It's important to have this process in place" (Participant 06).*

Communication failure

Most participants reported a lack of proper staff-to-staff communication. Some informants narrated that this can compromise the whole process of radiotherapy treatment delivery.

> *"…. lack of proper communication among ourselves is one of the challenges that may affect the whole process of the treatment delivery…" (Participant 02).*

Similarly, failure to provide adequate information to patients leads to a failure of patients to comply with treatment instructions. As a result, patients may not be cooperative during simulation and treatment delivery, which can cause errors.

> *"……how patients are oriented before treatment is a challenge. Information or instructions are not adequately communicated to patients before treatment or before simulation, which also makes patients fail to cooperate...." (Participant 03).*

Discussion

This study explored staff experiences regarding the factors contributing to errors during radiotherapy. Participants reported that the use of outdated and malfunctioning devices during

treatment delivery was a significant factor. Precise patient positioning and the use of immobilization devices are essential for accurate radiotherapy delivery (Asnaashari et al., 2014; Xu et al., 2017; Yan et al., 2013). The use of impaired or old positioning and immobilization devices increases the likelihood of errors (Asnaashari et al., 2014; Goswami et al., 2013).

Additionally, the study found that staff negligence in paying attention to and cross-checking patients' treatment parameters contributed to the occurrence of errors. It is critical for staff to remain attentive and committed to their duties during radiotherapy delivery (Xu et al., 2017; Yang et al., 2014). Maintaining a high level of professionalism is essential to minimize treatment complications.

The study also highlighted the stressful working environment caused by the high patient workload at the facility. A heavy patient load is a common challenge faced by healthcare professionals, particularly in resource-limited settings (Agarwal et al., 2018; Ishiyama et al., 2019). The stress and pressure associated with high patient volumes can impair practitioners' cognitive abilities and decision-making, increasing the likelihood of errors (Asnaashari et al., 2014).

Furthermore, the lack of an error-monitoring system was identified as a factor contributing to the persistent occurrence of errors in radiotherapy. Effective error reporting and feedback mechanisms are crucial in preventing errors from recurring (Kalet et al., n.d.; Macklis et al., 2014; Yang et al., 2014). The study also supports the recommendation for cross-checking treatment plans by different practitioners, which is consistent with research emphasizing the importance of double-checking and verifying treatment plans to minimize errors in radiotherapy (Yang et al., 2014).

Finally, the study highlighted the negative impact of poor communication on various aspects of the treatment process, including patient information accuracy and treatment adherence. Previous research underscores that poor communication can lead to incorrect patient identification, wrong diagnoses, and errors in documentation (Ishiyama et al., 2019). This study's emphasis on inter-professional communication aligns with existing research that stresses the importance of collaborative teamwork and clear communication to prevent errors in radiotherapy treatment (Malicki et al., 2018; Shafiq et al., 2009).

Conclusion

The findings of this study highlight several factors that contribute to errors during radiotherapy planning and delivery. The study emphasizes the need for precise and reliable equipment to ensure accurate treatment. Additionally, staff must adhere to standard operating procedures, paying close attention to patient details and cross-checking patient parameters before delivering treatment.

Improved inter-professional communication is also crucial, along with ensuring that proper information is communicated to patients. Furthermore, the working environment should be enhanced by expanding radiotherapy facilities to accommodate the growing patient population. Finally, the development of a robust error-monitoring system is necessary to improve patient safety and the overall quality of radiotherapy services.

Trustworthiness

The trustworthiness of the study was assessed by ensuring credibility, dependability, conformability and transferability (Graneheim & Lundman, 2004). Credibility was ensured through the inclusion of different professionals working in a radiotherapy department with different experiences. To ensure confirmability, authors derived categories based on the participants' experiences and not their interpretation. The presentation of categories in this study was supported by codes and succinct quotes. Transferability was attained by providing a detailed methodological description so that the findings could be applied to other settings with the same context. Good documentation of the research process was done to enhance dependability.

Acknowledgement
The authors would like to thank and acknowledge the willing participation of the staff at Ocean Road Cancer Institute. We are also grateful to the Muhimbili University of Health and Allied Sciences and Ocean Road Cancer Institute for providing permission to conduct this study.

References

Agarwal, J. P., Krishnatry, R., Panda, G., Pathak, R., Vartak, C., & Kinhikar, R. A. (2018). An Audit for Radiotherapy Planning and Treatment Errors From a Low e Middle-Income Country Centre. *Clinical Oncology*. https://doi.org/10.1016/j.clon.2018.09.008

Asnaashar, K., Gholami, S., & Khosravi, H. R. (2014). Lessons learnt from errors in radiotherapy centers. *Iranian Journal of Radiation Research*, *12*(4), 361–367.

Asnaashari, K., Gholami, S., & Khosravi, H. R. (2014). *Lessons learnt from errors in radiotherapy centers*. *12*(4).

Baskar, R., Lee, K. A., Yeo, R., & Yeoh, K. (2012). Cancer and Radiation Therapy : Current Advances and Future Directions. *International Journal of Medical Sciences*, *9*(3), 193–199. https://doi.org/10.7150/ijms.3635

Burnet, N. G., Thomas, S. J., Burton, K. E., & Jefferies, S. J. (2004). Defining the tumour and target volumes for radiotherapy. *Cancer Imaging*. https://doi.org/10.1102/1470-7330.2004.0054

Chierchini, S., Ingrosso, G., Saldi, S., Stracci, F., & Aristei, C. (2019). Physician and patient barriers to radiotherapy service access: Treatment referral implications. *Cancer Management and Research*, *11*, 8829–8833. https://doi.org/10.2147/CMAR.S168941

Connell, P. P., & Hellman, S. (2009). Advances in radiotherapy and implications for the next century: A historical perspective. In *Cancer Research* (Vol. 69, Issue 2, pp. 383–392). https://doi.org/10.1158/0008-5472.CAN-07-6871

Errifai, R., Chetaine, A., & Bouaouad, S. (2022). *Evaluation of Setup Errors in Radiotherapy with Volumetric Intensity Modulated Arc-Therapy Based On the Cone Beam Computed Tomography for Nasopharyngeal Cancer : Case of the Cheikh Zaid Hospital*. *4*(3), 30–33. https://doi.org/10.35248/2376-0389.22.9.

Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). *What is an adequate sample size? Operationalising data saturation for theory-based interview studies*. Psychology and Health. https://doi.org/10.1080/08870440903194015

Goswami, J., Pal, S., Patra, N., Sarkar, B., & Basu, A. (2013). Dosimetric comparison between conventional and conformal radiotherapy for carcinoma cervix: Are we treating the right volumes? *South Asian Journal of Cancer*, *2*(3), 128. https://doi.org/10.4103/2278-330x.114112

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, *24*(2), 105–112. https://doi.org/10.1016/j.nedt.2003.10.001

Hosseini-Ashrafi, M., & Robinson, N. (n.d.). Treatment errors and near-misses in a radiotherapy department. *International Radiation Protection Association (IRPA)*.

Ishiyama, H., Shuto, N., Terazaki, T., Noda, S., Ishigami, M., Yogo, K., & Hayakawa, K. (2019). Medical Dosimetry Risk factors for radiotherapy incidents : a single institutional experience. *Medical Dosimetry*, *44*(1), 26–29. https://doi.org/10.1016/j.meddos.2017.12.006

Jaffray, D. A., & Gospodarowicz, M. K. (2015). Radiation Therapy for Cancer. *Cancer: Disease Control Priorities*, *3*, 4.

Kalet, A. M., Gennari, J. H., & Ford, E. C. (n.d.). Bayesian network models for error detection in

radiotherapy plans. *Physics in Medicine & Biology*, 2735, 2735. https://doi.org/10.1088/0031-9155/60/7/2735

Macklis, B. R. M., Meier, T., & Weinhous, M. S. (2014). *Error Rates in Clinical Radiotherapy*. *June*. https://doi.org/10.1200/JCO.1998.16.2.551

Malicki, J., Bly, R., Bulot, M., Godet, J., Jahnen, A., Krengli, M., Maingon, P., Prieto, C., Skrobala, A., Valero, M., & Jarvinen, H. (2018). Patient safety in external beam radiotherapy , results of the ACCIRAD project : Recommendations for radiotherapy institutions and national authorities on assessing risks and analysing adverse error-events and near misses. *Radiotherapy and Oncology*. https://doi.org/10.1016/j.radonc.2018.04.006

Portaluri, M., Italo, F., Fucilli, M., Antonio, E., Gianicolo, L., Tramacere, F., Francavilla, M. C., Tommaso, C. De, Castagna, R., & Pili, G. (2010). *Collection and Evaluation of Incidents in a Radiotherapy Department A Reactive Risk Analysis*. *May 2014*. https://doi.org/10.1007/s00066-010-2141-2

Radiation and Nuclear Safety Authority (STUK). (2003). *Quality Assurance in Radiotherapy. STUK Guide ST 2.1/April 2003*. https://www.finlex.fi/data/normit/22197-ST2-1e.pdf.

Shafiq, J., Barton, M., Noble, D., Lemer, C., & Donaldson, L. J. (2009). An international review of patient safety measures in radiotherapy practice. *Radiotherapy and Oncology*, *92*(1), 15–21. https://doi.org/10.1016/j.radonc.2009.03.007

Xu, H., Brown, S., Chetty, I. J., & Wen, N. (2017). A Systematic Analysis of Errors in Target Localization and Treatment Delivery for Stereotactic Radiosurgery Using 2D/3D Image Registration. *Technology in Cancer Research and Treatment*, *16*(3), 321–331. https://doi.org/10.1177/1533034616664425

Yan, G., Mittauer, K., Huang, Y., Lu, B., Liu, C., & Li, J. G. (2013). *Prevention of gross setup errors in radiotherapy with an efficient automatic patient safety system*. *14*(6), 322–337.

Yang, R., Wang, J., Zhang, X., Sun, H., Gao, Y., Liu, L., & Lin, L. (2014). *Implementation of Incident Learning in the Safety and Quality Management of Radiotherapy : The Primary Experience in a New Established Program with Advanced Technology*. *2014*.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.22

Community Perceptions on Mass Drug Treatments for Schistosomiasis and Strategies to Increase Treatment Coverage in Mwanza Region, Tanzania

[1]Ndaro RC*, [2]Kinung'hi SM, [3]Musai A, [3]Kishamawe C, [4]Sambaiga R.

[1]The National Institute for Medical Research, P. O. Box 1462, Mwanza, Tanzania, [2]Department of Parasitic Disease. The National Institute for Medical Research, P. O. Box 1462, Mwanza, Tanzania, [3]Department of Data Management Unity. The National Institute for Medical Research, P. O. Box 1462, Mwanza, Tanzania, [4]Department of sociology and anthropology. University of Dar es Salaam, Mwalimu Julius Nyerere Mlimani Campus P. O Box 35091, Dar es Salaam, Tanzania

Abstract

Background: Schistosomiasis is a significant public health issue in Tanzania, with some areas reporting a prevalence rate as high as 100%. Praziquantel is currently the drug of choice for the preventive treatment of schistosomiasis due to its effectiveness against all Schistosome species. Despite ongoing efforts to combat the disease in villages within the Mwanza region, schistosomiasis remains endemic. However, little is known about the community's perceptions of mass drug treatment and how these perceptions influence treatment coverage and the control of schistosomiasis.

Aim: The study aimed to describe community perceptions of mass drug treatments for schistosomiasis and identify strategies to increase treatment coverage in selected villages.

Methods: A cross-sectional descriptive study using a mixed research approach was conducted in Lutale and Fogofogo villages in the Mwanza region of Tanzania. A total of 387 participants were recruited and consented to provide information through quantitative data collected via a structured questionnaire and qualitative data gathered using a semi-structured interview guide. In the qualitative component, 6 Focus Group Discussions (FGDs) and 12 In-depth Interviews (IDIs) were conducted. Data were analyzed using STATA version 12 for quantitative analysis and manual thematic content analysis for qualitative data.

Results: The study found that community knowledge of schistosomiasis was very low, with only 19.63% (75/382) of participants being aware of the disease. However, a higher percentage, 74.16%, were well-informed about mass drug treatments for schistosomiasis. Traditional medicine accounted for only 4.42% of treatments used for schistosomiasis in the study population. A significant association was found between knowledge of schistosomiasis and drug uptake (P<0.001).

Conclusion: The community in the study area had limited knowledge about schistosomiasis, although most participants viewed mass drug treatment and the approach used as positive. Treatment coverage can be improved by educating the community about the importance of mass treatments and ensuring that the drugs are consistently available. To control and eventually eliminate schistosomiasis in Tanzania, all health stakeholders— including the government, health policy planners, researchers, and healthcare providers— should collaborate to enhance health services for the betterment of public health.

*Corresponding Author: Roza Charles Ndaro; Email: roza.ndaro@yahoo.com/ roza.ndaro@nimr.or.tz

Keywords: Schistosomiasis, Mass drug treatment, Community and Perception

Introduction

Schistosomiasis is still a public health problem affecting about 200 million people worldwide(Dvořák et al., 2009; WHO, 2012) It is caused by several species of a fluke of the genus Schistosoma (McManus et al., 2018). The disease has been endemic in Africa for centuries although commonly found in Asia and South America, especially in areas with water contaminated with freshwater snails which may carry the parasite (Mwaluko et al., 1991; Rugemalila, 1989). Schistosomiasis is endemic throughout Tanzania with varying levels of endemicity. According to Mazigo et al. (Mazigo et al., 2012), there are about 15.4 million people infected with intestinal and urinary schistosomiasis in Tanzania; resulting in lesions of the liver and intestine, chronic growth faltering, death, and anemia (Tuhebwe et al., 2015). The disease has been endemic in Tanzania since the 19th century, and various studies for control, treatment, and intervention have been conducted and reported. Among the popular treatment approaches, the use of mass drug treatments has attracted the attention of many researchers and other stakeholders to understand individuals' perceptions of schistosomiasis.

Mass Drug Administration (MDA) is the administration of drugs to whole populations, to control, prevent, or eliminate the disease, according to the World Health Organization (WHO, 2012; World Health Organization, 2002). Schistosomiasis is one of the seven neglected tropical diseases (NTDs) that can be controlled and treated through targeted MDA. Other diseases include lymphatic filariasis, onchocerciasis, soil-transmitted helminths, and trachoma. (World Health Organization, 2002) suggested chemotherapy of Praziquantel (PZQ) be used for the treatment of schistosomiasis. The mass drug treatment strategy to curb Schistosomiasis has been adopted in many sub-Saharan countries like Tanzania, Uganda, Niger, Burkina Faso, Ghana, and Mali (Muhumuza et al., 2014).

For many years the controls of schistosomiasis often were supported by donor organizations and in separate budgeting but programs were not very successful since there was little support from the government (Bruun et al., 2008). Tanzania and other countries in Africa adopted national control programs for neglected tropical diseases including schistosomiasis; Programs enhanced the availability of drugs for mass drug treatments particularly in school children and other high-risk groups like fishermen, peasants, and communities around water bodies where the prevalence of the disease is very high. Nowadays the government of Tanzania encourages mass drug treatments by advertising in the media that at least once per year every individual should take a single dose for schistosomiasis. This programme is accompanied by distributing praziquantel near communities and targeted places. However, despite these efforts, the prevalence of the disease remains high, especially in areas near water bodies like lakes, swamps, ponds, and rivers (Mazigo et al., 2012).

At its fifth-fourth World Health Assembly, the WHO suggested mass drug treatment chemotherapy with praziquantel as a public health strategy for the treatment and control of schistosomiasis (Webster et al., 2014; World Health Organization, 2002). However, the prevalence of schistosomiasis is still high while the coverage of mass drug treatment and control of schistosomiasis remains very limited (WHO, 2002; World Health Organization, 2012). Yet still, little is known about the community's perceptions of mass drug treatment and how this influences coverage of treatments and control of schistosomiasis. The uptake of a drug is normally compromised by an individual's perception not only the function of its efficacy (World Health Organization, 2012). Against this background, the present study was conducted to describe the social parameters and community perceptions on mass drug treatments for the control of schistosomiasis and treatment-seeking behaviour in Mwanza region.

Material and Methods:

Study Setting and Design

The study used a cross-section descriptive design that aims at establishing general information on the perceptions, knowledge and treatment-seeking behaviour on mass drug treatments for schistosomiasis. Essentially, the design favoured the study to describe the characteristics leading to the prevalence of schistosomiasis in the selected villages, especially those sharing similar risk factors, and adopted a mass drug strategy for the treatment of schistosomiasis.

Study Area

The study was conducted at Lutale village and Fogofogo village, found near Lake Victoria in Magu and Busega districts, respectively, located along the Mwanza -Musoma Road. The major activities in the respective villages are fishing and farming, which lead to direct contact with water, hence the high risk of schistosomiasis. The selected villages were involved in mass drug treatments using praziquantel as a strategy for control of schistosomiasis by the national NTDs control program under the Ministry of Health and Social Welfare and the Schistosomiasis Consortium for Operational Research and Evaluation Project (SCORE) for five years

Participants

The study population was community members (male and female) from the households. Both random sampling and purposive sampling were used to select the participants who were included in the study. Random sampling was used to select 387 community members aged 18 and above, Fogofogo 195 (50.39%) and Lutale 192 (49.61%) for structured questionnaires. Participants for FGDs and IDIs were purposively selected based on age, sex, and those living in a particular village for more than one year. Similarly, key informants for In-depth Interviews have targeted 6 participants in each village, and 3 Focus Group Discussion for each village for community members and other health stakeholders within the particular village; including CHW were 4, SHT was 2, Medical in charge was 2, famous people were 2, and village chairperson was 2 with an equal number for each village.

Data Collection Methods

Survey Questionnaires

Quantitative data were collected through structured questionnaires administered by the researcher. The tool was designed to allow as many community members as possible to provide information on human demographic characteristics, community knowledge, and perception of schistosomiasis, health-seeking behaviour, and drug for treatment.

In-depth Interviews

The method used a semi-structured interview guide to probe for detailed information on participants' enlightenment. A total of 12 key informants, including 4 community health workers, 2 school health teachers,2 medical in-charges, 2 village chairpersons, and 2 well-known people in the selected villages. This group was expected to provide real experience, information, knowledge, and understanding of Mass drug strategies on schistosomiasis and provide recommendations for control of the disease.

Focus Group Discussions

The method was essentially for community members to understand their perceptions and information missing in other data collection tools. The researcher was assisted by one assistant who took notes for later extension. A total of 3 FGDs with 10 people were done in each village; 1 group was only for men aged ≥ 36, the second group was only for women with similar age, and the third FGD had both males and females aged between 18 to 35 years. Before the IDIs and FGDs sessions, respondents were informed that it would take between 13 - 45 minutes and be recorded.

Ethical Considerations

This study was given a permit from the office of the Regional Administrative Secretary (RAS), Mwanza region, and the office of the District Administrative Secretary (DAS) for the Magu and Busega districts. Before data collection, the Ward Executive Officers (WEOs) and Village chairpersons in Lutale and Fogofogo villages were informed of the permits. All participants consented before their participation, and those who accepted were voluntarily recruited into the study. Both written and oral consent were used. The privacy of information remained between the researcher and respondents. Respondents were given codes, and their names were not recorded.

Data Analysis

Quantitative data were collected in the standardized questionnaire in data collection forms and checked for error and completeness. Data were entered into the computer and analysed using STATA version 12 (STATA Corp., Texas, USA). Descriptive statistics, median, and proportional percentages were used in this study and the association between knowledge of schistosomiasis and drug use was performed by cross-tabulation using the Chi-square test. A *P-* P-value < 0.05 was considered to be statistically significant. Qualitative data were collected through a semi-structured interview guide and recorded by audio tape, then transcribed verbatim, translated, and analysed using qualitative thematic analysis,

Results

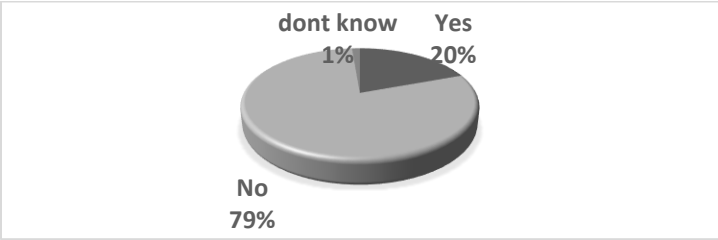
Demographic characteristics of the study population

A total of 387 participants aged 18 years and above were enrolled in the study. In Lutale village, males were 90 out of 196 (45.9%) whereas in Fogofogo village there were 102/196 (53.4%) males. The median age of participants was 23 years the participants, Sukuma ethnic group was dominant in all villages 82.8% (159/387) in Lutale and 70.1% (136/387) in Fogofogo and the majority of participants were having primary education 52.6% (102/194) in Fogofogo, and 64.6% (124/192) in Lutale.

Community Knowledge and Perceptions of Schistosomiasis

Respondents were asked what they understood about schistosomiasis. The majority of respondents 306/387 (79%) don't know schistosomiasis. Only 77/387 (20%) of participants have the concepts of the disease, its causes, symptoms, and side effects on human beings (Figure 1). Many participants in the Focus Group Discussion know schistosomiasis. However, some anonymous responses were observed including one participant from Fogofogo village who assumed that schistosomiasis is inherited.

Pie chart 1: Knowledge of schistosomiasis



Source: Field data, 2016.

> *'Ugonjwa wa kichocho ni wakurisishana kutoka kizazi na kizazi, mtu akipatikana na ugonjwa lazima na watu wengine waje kuugua kwenye familia hiyo"* (*''Schistosomiasis is inherited from one generation to generation, once one in the family found with the disease for sure other people will suffer within the family"* (FGD with male respondent, May 2016, Fogofogo village)

Use of the drugs for schistosomiasis

Respondents were asked if they have used drugs for the treatment of schistosomiasis. The purpose was to understand the coverage of drug usage. We found that a total of 275/387 (71.09%) never used any drug for the treatment of schistosomiasis, and only 111/387 (28.65%) had used drugs for the treatment of schistosomiasis. When asked about the reasons for not using drugs for treating schistosomiasis, especially in the MDA programme, respondents had various responses, including the absence of symptoms that define the disease. For instance, a school teacher from Lutale proclaimed that people ignore using drugs for treating schistosomiasis as they do not experience any symptoms related to the disease as quoted;

''…Watu wanapuuzia kuja kumeza dawa za kichocho kwasababu hawaoni dalili zozote za kuwa mgonjwa''…. (''…….People do not take consideration of going to take drugs for the treatment of schistosomiasis because they don't see any symptoms of being sick''……) (School health teacher in, May 2016 Lutale village).

Statistical Association between Knowledge and Drug Uptake of Respondents

Table 2: Association between knowledge and drug uptake

Knowledge of Schistosomiasis	**Drug uptake**			
Response	**Yes**	**No**	**Don't know**	**Total**
	N (%)	**N (%)**	**N (%)**	**N (%)**
Yes	33 (44.59)	40(54.05)	1(1.35)	74(19.53)

No	75 (24.59)	230(75.41)	0(0.00)	305(80.47)
Total	108 (100)	270 (100)	1 (100)	379 (100)

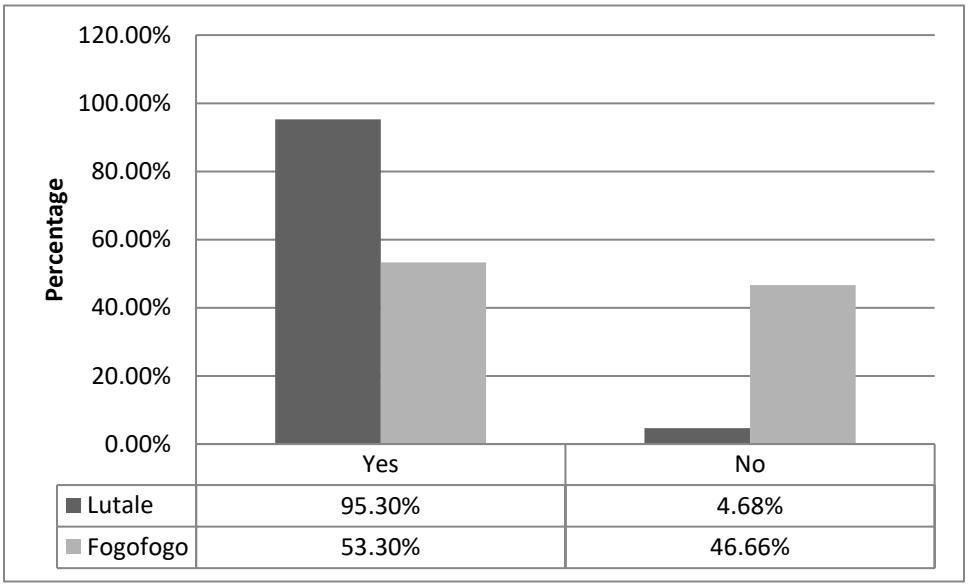
Source: Field data, 2016 Pearson chi² = 16.2970 P = 0.001

Lack of knowledge of schistosomiasis has a higher proportion of respondents than those with appropriate knowledge of schistosomiasis. Those with appropriate knowledge of schistosomiasis 33/108 (44.59%) were likely to take drugs for the treatment of schistosomiasis compared to those who lack knowledge of schistosomiasis 75/108 (24.59%) see Table 2. This means there is a significant association between knowledge of schistosomiasis and drug use (uptake) for treating schistosomiasis. The result shows that there are people who have knowledge but whose drug uptake is 40/270 (54.05%) due to other social-cultural factors that are evidenced in qualitative quotes.

Community perceptions toward mass drug approach for dealing with schistosomiasis

The respondents were asked if the mass drug treatment approach is a good strategy and effectiveness in dealing with schistosomiasis. The majority of respondents 183/192 (95.3%) in Lutale village and 104/195 (53.3%) in Fogofogo village said yes; meaning that people have positive perceptions toward the Mass Drug Administration strategy for treatment and control of schistosomiasis. Only 46.66% (91/195) in Fogofogo and 4.68% (9/192) in Lutale said the approach is not good and provided the reason that their income depends on fishing and farming, the MDA program should reach their remote areas.

Bar chart 1: Perceptions on Mass approach.



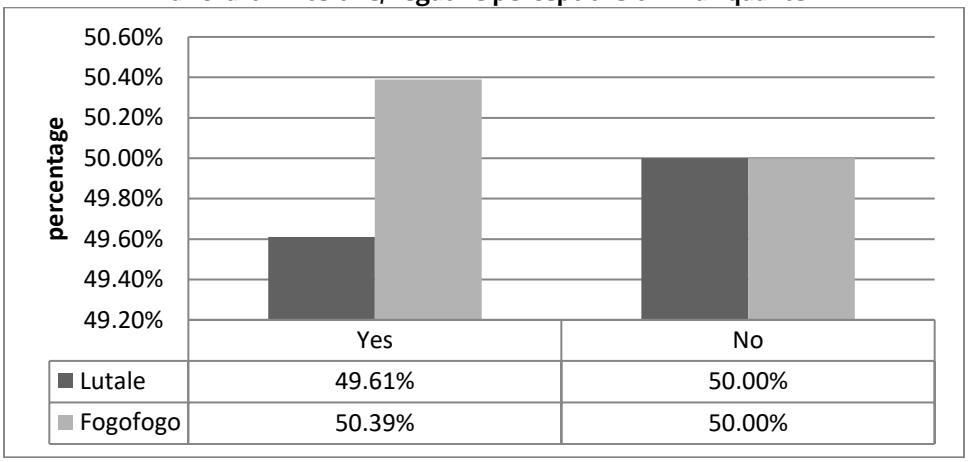
Source: Field data, 2016

Perceptions of drug used in mass treatment

Respondents asked if the drugs used for the treatment of schistosomiasis (praziquantel) are good/effective. About half of the respondents 98/195, (50.3%) in Fogofofgo and 95/192, (49.61%)

in Lutale perceived that the drugs used for the treatment of schistosomiasis are good. Some respondents mentioned the effectiveness of the drug toward the disease, simple to use as a single dose, and that they are provided for free. Those who perceived that the drugs are not good said the praziquantel drug causes erectile dysfunction as their belief; people lose weight and dizziness. (Bar chart 2).

Bar chart 2: Positive/negative perceptions on Praziquantel



Source: Field data, 2016

During the In-depth interview, informants had the following to say:

> ``*……kutokana na hofu zinazotokana na madhara ya vidonge vinavyotolewa wazazi huwazuia Watoto wao kumeza dawa hizo kwakuofia kuwa ni kali*" (``*……due to fears arising from the side effects of tablets provided, parents forbid their children not take drugs as they suspect to be very strong "*) (School health teacher, May 2016, Lutale village).

> Others said``*….Jamii inadai kwamba dawa zinazotolewa zina nguvu nyingi na pia zinapunguza nguvu za kiuume*" (``*The society claims that the drugs given are very powerful and also cause male erectile dysfunction*") (Community Health Worker, May 2016, Lutale village).

Table 4: Sources of drugs for schistosomiasis

	Lutale		**Fogofogo**	
	N (%)	N (%)	N (%)	N (%)
Variable	Yes	No	Yes	No
Drug shop	39(39.80)	6 (23.08)	59 (60.20)	20(76.92)
Health centre	7 (31.82)	34(36.96)	15 (68.18)	58(63.04)

Tradition medicine	1 (20.00)	38(35.19)	4 (80.00)	70(64.81)

Source: Field data, 2016

The findings in Table 4 above show that the majority of respondents prefer to use medicine procured from drug shops: 39.80% (39/98) in Lutale and 60.20% (59/98) in Fogofogo. Only 31.82% in Lutale and 68.18% in Fogofogo search treatment in the health center show that most community members use drugs from drug shops and hospitals compared to respondents who prefer traditional medicines. During the Focus Group Discussions, one had the following to say.

> *'.....mimi hutumia miti shamba ambayo tumekuta wazee wetu wakitumia, miti shamba kama magaka na mninguningu ambayo tunapoona dalili za kichocho kama maumivu ya tumbo na kukojoa damu tunaenda maporini kutafuta.....''*
>
> *(.....I use traditional plants that we have found our elders using, traditional trees such as cactus (magaka) and mninguningu when we see symptoms of schistosomiasis such as stomach pain and urinating blood, we go to the bush to find.....''*) (Female respondent, May 2016, Fogofogo)

Beliefs Associated with the Treatment of Schistosomiasis

Table 5: Beliefs associated with mass drugs

YES	**NO**	
N (%)	N (%)	TOTAL
4 (2.14)	183 (97.86)	187 (100)

Source: Field data, 2016

Table 5 above shows that most respondents 183/187 (97.86%), positively perceived the treatment of schistosomiasis, but very few, 4/187 (2.14%) had negative perceptions about the treatment. They said that the treatment offered for schistosomiasis was causing male erectile dysfunction, dizziness, and loss of energy. Thus, some of the respondents preferred to use traditional medicine instead of biomedical medicine provided by the government or health researchers

Community health-seeking practices for schistosomiasis

On community health-seeking treatment for schistosomiasis, findings show that the majority seek treatments in the hospital, 46.3% in Lutale and 41% in Fogofogo. Others seek treatment in school 34.8% in Lutale and 31.7% in Fogofogo, at home 11.9% in Lutale and 15.3% in Fogofogo, in drug shops and small groups seek treatment in traditional healers 6.7% in Lutale and 11.7% in Fogofogo. The presence of some members seeking treatment at home and in traditional healers shows that there is little knowledge of the importance of using praziquantel drugs for treating schistosomiasis.

Strategies to increase treatment coverage for schistosomiasis

Participants provided their suggestions for future effective control of schistosomiasis through Mass Drug Treatment:

> ``*.....Watafiti na serikali wanapoleta dawa wasilenge Watoto wa shule peke yake pia wawahusishe watu wazima kwasababu wote niwahanga wa ugonjwa huu wa kichocho. Pia mfumo wa maji bomba ufanyike ili kupunguza wakazi kutumia maji moja kwa moja kutoka ziwani.....'' (``.....When the researchers and the government bring medicines, they should not target school children alone, they should also involve adults because they are all victims of this schistosomiasis. Also, a piped water system should be built to reduce residents using water directly from the Lake''*) Male respondent, May 2016, Fogofogo)
>
> ``*Elimu itolewe juu ya umuhimu na namna dawa inavyo fanyakazi ili kuondoa woga uliopo kwa jamii kutokana na madhara yatokanayo na dawa'' (``.....Education should be given on the importance and the way medicine works to remove the fear that exists in the community due to the effects of medicine'')* (Female respondent, May 2016, Lutale).
>
> ``*Dawa ziletwe kwenye hospitali za vijiji ili jamii itumie kila wanapougua nasio kutegemea dawa za msimu'' (``Medicines should be brought to village hospitals so that the community can use them whenever they get sick and not rely on seasonal medicines'')* (Female respondent, May 2016, Fogofogo).

The results show that the majority of respondents suggested the drug should be accessible and laboratory examinations should be conducted before the provision of drugs in their health facilities to reduce the possibility of people taking drugs without the disease.

Discussion

Most studies that attempted to investigate schistosomiasis in Tanzania have particularly stated knowledge, attitude, and practice on schistosomiasis. This study is unique in that it deepens our understanding of community perceptions of mass drug treatment for schistosomiasis and strategies to increase treatment coverage in Mwanza.

The findings of this study show that schistosomiasis is prevalent in Lutale and Fogofogo communities, and mass drug treatments are conducted at least once per year in the area, though community knowledge of schistosomiasis is low. The majority of respondents don't know the symptoms, how the disease is transmitted, as ways to avoid it. Some provide the information that schistosomiasis is caused by drinking unsafe water, similar to other studies (Musuva et al., 2014). This study revealed that most of the communities in Lutale and Fogofogo search for treatment in hospitals, and fewer seek treatment at home.

Knowledge on Schistosomiasis

Previous studies on schistosomiasis show that local people lack knowledge of schistosomiasis 79% only 20% knew schistosomiasis, similar to the current study where the result found that the majority of community members in Lutale and Fogofogo village lack knowledge of schistosomiasis. Those who know about schistosomiasis seek proper treatment compared with those who lack knowledge of schistosomiasis. The finding meant the same with the Health Belief Model that the benefit of taking preventive action and the barrier to take the actions affect the individual action to deal with the disease by not taking part in mass drug treatments (Glanz et al., 2008; Last, 1926; Wingood, 1997).

Community Perceptions on Mass Drug Treatment for Schistosomiasis

The current study revealed that communities of Lutale and Fogofogo had positive perceptions of mass drug treatments for schistosomiasis and provides the reasons for those perceptions that the treatments were carried out in their area and are offered free to all members in the village. There was no barrier community of Lutale ana Fogofogo to being involved in Mass drug treatment as stated in the theory of Health Belief Modal that, personal health-related behavior depends on the barrier of taking action (Glanz et al., 2008; Last, 1926; Wingood, 1997); Nevertheless, negative perceptions were also revealed from the participants, whereby some associated the medicine provided to cause male erectile dysfunction. The study observes that there is no association between community perceptions of mass drugs with drug coverage in current mass drug treatment contrary to the study done in Uganda where the low uptake was challenged by side effects of PZQ. This is consistent with the study done by WHO, the mass drug strategy is a good approach for dealing with schistosomiasis in communities that are at risk(WHO, 2012).

Health Seeking Practice

According to the health belief model, the decision to seek health care is a function of multiple factors such as the severity of the problem, availability of resources, and likelihood of action to the problem with where people prefer the treatment of schistosomiasis. The uptake of a drug depends on how individuals perceive the drug, not only to its efficacy but also the social meaning attached to the drug and the disease (WHO, 2012). The current result revealed that the majority seek treatments for schistosomiasis in hospitals and in school centers where the drug was distributed. Self-medication was preferred among respondents. This involved taking ant schistosomiasis in drug shops, and use of local herbs (``Mninguningu na magaka'') the findings were related to the study done by Mwanga where the study discovered the use of traditional medicine for the treatment of schistosomiasis(Mwanga et al., 2004)

Treatment Coverage and Suggestion for High Coverage

It was recommended by WHO that the coverage must reach 80% in all areas where schistosomiasis was prevalent (World Health Organization, 2012). The findings revealed low treatment coverage in two selected villages (Fogofogo and Lutale) in Mwanza region. This is caused by several factors discovered in this study such as ``the drug is very strong, delay of information about the program in some local members, drug is seasonally offered and other bad perceptions like causes of male erectile dysfunction and dizziness'' The result is equal to another study that shows side effect of the drug lower the uptake (Tuhebwe et al., 2015). This was also associated with the limited knowledge people

have concerning schistosomiasis. Despite this study conducted in 2016, other studies come up with the same findings of low knowledge or misconception of the cause symptoms and treatment of schistosomiasis (Angelo et al., 2019; Mwanga et al., 2020) The findings revealed that the association between drug uptake and knowledge is very strong by testing chi-square the P value was $0.001 < 0.05$ statistical significance.

Strengths and limitations

The major strength of this study is the combined methods using the results of questionnaires and interviews to translate specific situations of the targeted community by the Mass Drug Administration and analyze multiple variables quickly and cheaply.

While the study design has many advantages, this study cannot conclude causality. The study was conducted in a small setting of only two villages. The finding could have been more valuable if it had been conducted in a large setting along Lake Victoria with different cultures, and socio-economic activities.

Conclusion

There were positive perceptions of the community toward mass drug treatment for Schistosomiasis due to the effectiveness of the drug (praziquantel) to treat schistosomiasis, free charges of treatment and diagnosis, and its simple to use as it is a single-dose treatment. The low coverage of mass drug treatment in the studied population can be increased through the provision of more health education and information concerning the causes, transmission, symptoms, and side effects of schistosomiasis drugs. Change of human behavior will help to change schistosomiasis health-seeking practices of community members taking into consideration that schistosomiasis is a public health problem like Malaria among other feared diseases also the increase in the number of people taking part in mass drug treatments, combined efforts by the government, health providers, community and researchers is required to increase treatment coverage and effectively control schistosomiasis. More research is needed to examine why some negative perceptions toward mass drug treatments for schistosomiasis persist in society by involving a large sample of participants for more results, especially research to identify the factor that inhibits mass drug (for example, praziquantel) use.

Acknowledgment

The author would like to thank the willingness of the participants of Lutale and Fogofogo villages to be involved in the study, community health workers, school health teachers, village chairpersons, medical officers in charge, and famous people. Also, the district management of Magu allowed this study to be done in their administrative areas. I express my genuine thanks to my father, Mr. Charles Ndaro, and my mother, Judith Buberwa whose care, love, and partial financial support were significant for the initiation of the study.

References

Angelo, T., Kinung'Hi, S. M., Buza, J., Mwanga, J. R., Kariuki, H. C., & Wilson, S. (2019). Community knowledge, perceptions and water contact practices associated with transmission of urinary

schistosomiasis in an endemic region: A qualitative cross-sectional study. *BMC Public Health*, *19*(1). https://doi.org/10.1186/s12889-019-7041-5

Bruun, B., Aagaard-Hansen, J., & Watts, S. (2008). The social context of schistosomiasis and its control An introduction and annotated bibliography. *Strategies*.

Dvořák, J., Mashiyama, S. T., Sajid, M., Braschi, S., Delcroix, M., Schneider, E. L., McKerrow, W. H., Bahgat, M., Hansell, E., Babbitt, P. C., Craik, C. S., McKerrow, J. H., & Caffrey, C. R. (2009). SmCL3, a gastrodermal cysteine protease of the human blood fluke Schistosoma mansoni. *PLoS Neglected Tropical Diseases*, *3*(6). https://doi.org/10.1371/journal.pntd.0000449

Glanz, K., Rimer K. Barbara, & Viswanath, K. (2008). *HEALTH BEHAVIOR AND HEALTH EDUCATION: Theory, Research and Practice.* (C. T. Orleans, Ed.; 4TH EDITION). Jossey- Bass, A wiley Imprint.

Last, J. M. (1926). *Public Health and Human Ecology* (2 Editon). University of Ottawa.

Mazigo, H. D., Nuwaha, F., Kinung'hi, S. M., Morona, D., de Moira, A. P., Wilson, S., Heukelbach, J., & Dunne, D. W. (2012). Epidemiology and control of human schistosomiasis in Tanzania. *Parasites & Vectors*, *5*(1), 274. https://doi.org/10.1186/1756-3305-5-274

McManus, D. P., Dunne, D. W., Sacko, M., Utzinger, J., Vennervald, B. J., & Zhou, X. N. (2018). Schistosomiasis. *Nature Reviews Disease Primers*, *4*(1). https://doi.org/10.1038/s41572-018-0013-8

Muhumuza, S., Olsen, A., Katahoire, A., Kiragga, A. N., & Nuwaha, F. (2014). Effectiveness of a Pre-treatment Snack on the Uptake of Mass Treatment for Schistosomiasis in Uganda: A Cluster Randomized Trial. *PLoS Medicine*, *11*(5). https://doi.org/10.1371/journal.pmed.1001640

Musuva, R. M., Awiti, A., Omedo, M., Ogutu, M., Secor, W. E., Montgomery, S. P., Alaii, J., & Mwinzi, P. N. M. (2014). Community knowledge, attitudes and practices on Schistosomiasis in Western Kenya-The SCORE Project. *American Journal of Tropical Medicine and Hygiene*, *90*(4). https://doi.org/10.4269/ajtmh.13-0488

Mwaluko, G., Kilama, W., Mandara, M., Murru, M., & Macpherson, C. (1991). *Health and Disease In Tanzania*. Harper Collins Academic.

Mwanga, J. R., Kinung'hi, S. M., Mosha, J., Angelo, T., Maganga, J., & Campbell, C. H. (2020). Village response to mass drug administration for schistosomiasis in mwanza region, Northwestern Tanzania: Are we missing socioeconomic, cultural, and political dimensions? *American Journal of Tropical Medicine and Hygiene*, *103*(5). https://doi.org/10.4269/ajtmh.19-0843

Mwanga, J. R., Magnussen, P., Mugashe, C. L., Gabone, R. M., & Aagaard-Hansen, J. (2004). Schistosomiasis-related perceptions, attitudes and treatment-seeking practices in Magu District, Tanzania: Public health implications. In *Journal of Biosocial Science* (Vol. 36, Issue 1). https://doi.org/10.1017/S0021932003006114

Rugemalila, B. J. (1989). The Prognosis of Schistosomiasis Hematobia Following Community-Based Control Chemotherapy at Misungwi, Tanzania. In *Parasitic Disease* (1st Edition). CRC Press.

Tuhebwe, D., Bagonza, J., Kiracho, E. E., Yeka, A., Elliott, A. M., & Nuwaha, F. (2015). Uptake of mass drug administration programme for schistosomiasis control in Koome Islands, Central Uganda. *PLoS ONE*, *10*(4). https://doi.org/10.1371/journal.pone.0123673

Webster, J. P., Molyneux, D. H., Hotez, P. J., & Fenwick, A. (2014). The contribution of mass drug administration to global health: Past, present and future. In *Philosophical Transactions of the Royal Society B: Biological Sciences* (Vol. 369, Issue 1645). https://doi.org/10.1098/rstb.2013.0434

WHO. (2002). *Prevention and control of schistosomiasis and soil-transmitted helminthiasis: Report of WHO expert committe:192* (p. 63).

WHO. (2012). Integrated preventive chemotherapy for neglected tropical diseases: estimation of the number of interventions required and delivered, 2009-2010. *Relevé Épidémiologique Hebdomadaire / Section d'hygiène Du Secrétariat de La Société Des Nations = Weekly Epidemiological Record / Health Section of the Secretariat of the League of Nations*.

Wingood, G. M. (1997). Health behavior and health education: Theory, research, and practice, 2nd edition: Glanz K, Lewis FM, and Rimer BK (Eds.). Jossey-Bass Inc., San Francisco, CA, 1997. *Annals of Epidemiology*, *7*(6).

World Health Organization. (2002). Prevention and control of schistosomiasis and soil-transmitted helminthiasis: WHO Technical Report Series N° 912. *WHO Library Cataloguing in Publication Data*, *N° 912*.

World Health Organization. (2012). Schistosomiasis: population requiring preventive chemotherapy and number of people treated in 2010. *Relevé Épidémiologique Hebdomadaire / Section d'hygiène Du Secrétariat de La Société Des Nations = Weekly Epidemiological Record / Health Section of the Secretariat of the League of Nations*, *87*(4).

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.23

Oral prosthesis cleaning practice and oral health status of Removable Oral Prosthesis Wearers attended Kilimanjaro Christian Medical Centre, Moshi, Tanzania

Esther Shimba[3, 6], Florida Muro[2, 5], Deogratias Rwakatema[1, 4], Ruchius Philbert[3, 7, *]

[1]Kilimanjaro Christian Medical Center (KCMC), Kilimanjaro, Tanzania, [2]Kilimanjaro Christian Medical University College, Kilimanjaro, Tanzania, [3]Muhimbili National Hospital (MNH), Dar-es-salaam, Tanzania, [4]Dental department, Kilimanjaro Christian Medical Center (KCMC), Kilimanjaro, Tanzania, [5]Department Public Health, Kilimanjaro Christian Medical University College, Kilimanjaro, Tanzania, [6]Clinical Research, Training and Consultancy Unit, Dar es salaam, Tanzania, [7]Department of Paediatrics and Child Health, Dar es salaam, Tanzania

Abstract

Background: Maintaining good oral health and extending the lifespan of prostheses requires effective and regular cleaning practices for both complete and partial removable appliances. Removable oral prostheses should be cleaned daily to remove bacterial plaque and prevent infections such as *Candida albicans* and denture stomatitis. Patients with affected prostheses must continue practicing proper oral hygiene for the rest of their lives. This study aims to assess the oral prosthesis cleaning practices and oral health status of removable oral prosthesis wearers attending Kilimanjaro Christian Medical Centre (KCMC) in Moshi, Tanzania.

Materials and Methods:

The sample size was calculated using the formula for cross-sectional studies developed by Kish and Leslie (1965), and convenience sampling was employed. This hospital-based descriptive cross-sectional study included 200 patients attending the Kilimanjaro Christian Medical Centre dental clinic in Moshi, Tanzania. A closed-ended tool and a self-administered questionnaire were used to assess the oral prosthesis cleaning practices and oral health status of removable oral prosthesis wearers. Descriptive and logistic regression analyses were conducted using STATA software version 15.0. A p-value of less than 5% was considered statistically significant.

Results: The average age of participants was 57 years (SD ± 17.4), with 56% being female. The study revealed that 44% of participants had good denture hygiene. It also found that 49.5% of patients over the age of 60 had poor hygiene habits. Additionally, 64.0% of participants did not remove their dentures at night, and 27.0% cleaned their dentures more than twice a day. Only 9.5% of participants received annual denture examinations, and 25.95% had inflammation on the fit surface of their dentures. Independent predictors of good oral hygiene included age, frequency of denture check-ups, frequency of denture cleaning, and palatal erythema.

Conclusions: The study indicates that hygiene practices for removable dentures were generally inadequate. Most patients slept with their dentures in place, and the preferred cleaning method was using water and toothpaste (a mechanical method). Therefore, dentists should provide clear instructions on proper denture care to prevent oral cavity infections and improve overall oral health.

Keywords: Prosthesis hygiene, denture cleaning frequency, oral mucosa lesion.

* **Corresponding author:** Ruchius Philbert, E-mail: ruchiusphilbert@yahoo.com

Introduction

The use of removable oral prostheses, such as full and partial dentures, is a vital solution for individuals who have lost few or all of their natural teeth. These prostheses help restore essential functions such as mastication, speech, and aesthetics, significantly improving the quality of life for wearers. However, maintaining oral hygiene while using these devices is important, as improper care can lead to various oral health issues, including mucosal infections, plaque accumulation, and even systemic diseases (Coulthwaite & Verran, 2007).

Proper cleaning practices for removable oral prostheses are essential to prevent the growth of harmful microorganisms that can cause conditions like denture stomatitis, halitosis, and periodontal diseases (Szalewski, 2017. The use of appropriate cleaning methods and solutions can help remove food debris, plaque, and stains, thereby reducing the risk of oral infections. Despite the importance of these practices, many wearers of removable oral prostheses often lack sufficient knowledge about proper hygiene techniques, leading to suboptimal oral health outcomes.

In the global context, studies have shown that there is a considerable variation in the oral hygiene practices and health status of removable prosthesis wearers. Factors such as age, socioeconomic status, educational background, and access to dental care play significant roles in influencing these practices (Mushtaq et al., 2019, Shankar et al., 2017). Specifically, in developing countries, limited access to dental healthcare services and education on proper prosthesis care often exacerbate oral health issues among wearers.

In Tanzania, where oral health awareness and access to dental care can be limited, there is a pressing need to understand the current practices and oral health status of individuals wearing removable oral prostheses. Kilimanjaro Christian Medical Centre (KCMC) in Moshi is a healthcare institution that provides dental services to a diverse population. While there is a growing awareness of the importance of oral health, there is still a knowledge gap concerning the specific practices adopted by prosthesis wearers and their impact on oral health. Such as access to dental care and follow-up, limited awareness of appropriate cleaning products, variability in cleaning practices, and inadequate patient education.

This study aims to discover the cleaning practices and oral health status of removable oral prosthesis wearers attending KCMC. By assessing the current practices and identifying any associated oral health issues, this research seeks to contribute valuable insights that could guide patient education and improve oral health outcomes for this population. Understanding these dynamics is crucial for developing targeted interventions and recommendations that can enhance the quality of life for oral prosthesis wearers in the community.

Methodology

This was a hospital-based cross-sectional study involving removable oral prosthesis wearers aged 18 years and above who attended the Dental clinic at KCMC Hospital between periods of February to June 2022 (88 Males and 112 Females). The subject had worn a single or full denture for at least seven days before the commencement of the study. Subjects were examined for oral tissue conditions after completion of a questionnaire.

A minimum of 200 subjects sample size was used by convenient sampling technique and was calculated by using the Kish and Leslie formula to select oral prosthesis wearers attending attended Dental clinic at KCMC Hospital who met inclusion criteria.

A closed-ended tool and a self-administered questionnaire were used to assess the Oral prosthesis cleaning practice and oral health status of Removable Oral Prosthesis Wearers. Where by the questionnaire variables were adopted from different authors (Shankar *et al*., 2017, Auon & Gerges,

2017, Ogunride & Opeodu, 2015, Shigli *et al.*, 2015, Turgut Cancaya *et al.*, 2020 Nair *et al.*, 2016). The questionnaire collected information such as the patient's age, sex, sleeping with the dentures, denture checkups, information on dentist instruction, denture use duration and rinsing a denture after every meal.

The degree of palatal erythema was scored using Budtz-Jorgensen criteria (Budtz-& Bertram, 1970) as it describes the inflammation seen on the palatal mucosa. Palatal erythema was scored using the following clinical index.

0=No inflammation.

1=Inflammation present

Examination of oral prosthesis hygiene was done using the denture cleanliness index (Mylonas et al., 2016). This index grades the severity of denture cleanliness according to the amount of staining on the oral prosthesis fitting surface. A liquid plaque disclosing dye E102 Tartrazine in combination with E 133 Brilliant blue FCF was applied by the dental personnel to the fitting surface of the oral prosthesis to disclose the plaque.

0= Clean denture, no plaque is visibly seen, no staining, no plaque detectable.

1=Denture is visibly clean. Little staining (<25% staining of fit surface).

2= Denture has visible plaque and/or debris. Moderate staining of fit surface (25-50% staining of the fit surface).

3=Denture has visible plaque and/or debris. Severe staining of fit surface (>50% staining of the fit surface).

4=Denture has visible calculus deposit(s) on any surface

However in this study oral prosthesis hygiene level was classified as clean/good denture (0 and 1), Moderate (2) and Poor denture (3 to 4). This was adopted from (Mylonas et al., 2016; Syatirah et al., 2021; Turgut Cankaya Z, 2020).

Furthermore, data were collected, organized, managed, and stored in a computer, secured, backed up, and preserved. Data were checked and cleaned. Variables were labelled and coded for easy interpretation. Categorical variables with levels were identified and coded efficiently as per their levels. In some variables, categorization was based on previous study work in the literature. Quality of data was observed throughout in order not to lose its meaning and have wrong results. Data entry was done using excel.

Descriptive and logistic regression analyses were then conducted using STATA software version 15.0. A p-value <5% was used to determine statistical significance.

Ethical considerations

Ethical approval was obtained from Kilimanjaro Christian Medical University College and permission to conduct a study was obtained from Kilimanjaro Christian Medical Centre (KCMC).

Results

Socio-demographic characteristics of the participants

There were 200 participants, of whom 112 (56%) were women. Among them, 76 participants (38%) had completed their primary education. Additionally, 116 participants (58%) were married or partnered, and 145 participants (72.5%) were self-employed. The average age of the participants was 57 years, with a standard deviation of ±17.4 years. Most participants were aged 60 or older. The socio-demographic characteristics of the participants are summarized in Table 1.

Table 1: Socio-demographic characteristics of the study participants (N=200)

Characteristics	n (%)

 https://dx.doi.org/10.4314/thrb.v26i3.23

Sex	
Male	88(44)
Female	112(56)
Age(years)	
18-40	40(20)
41-60	61(30.5)
60+	99(49.5)
Education level	
Never	8(4)
Primary	76(38)
Secondary	53(26.5)
University	63(31.5)
Employment status	
Employed	44(22)
Self-employment	147(73)
Student	9(4.5)

Figure 1: Hygiene level of the study participants (N=200)

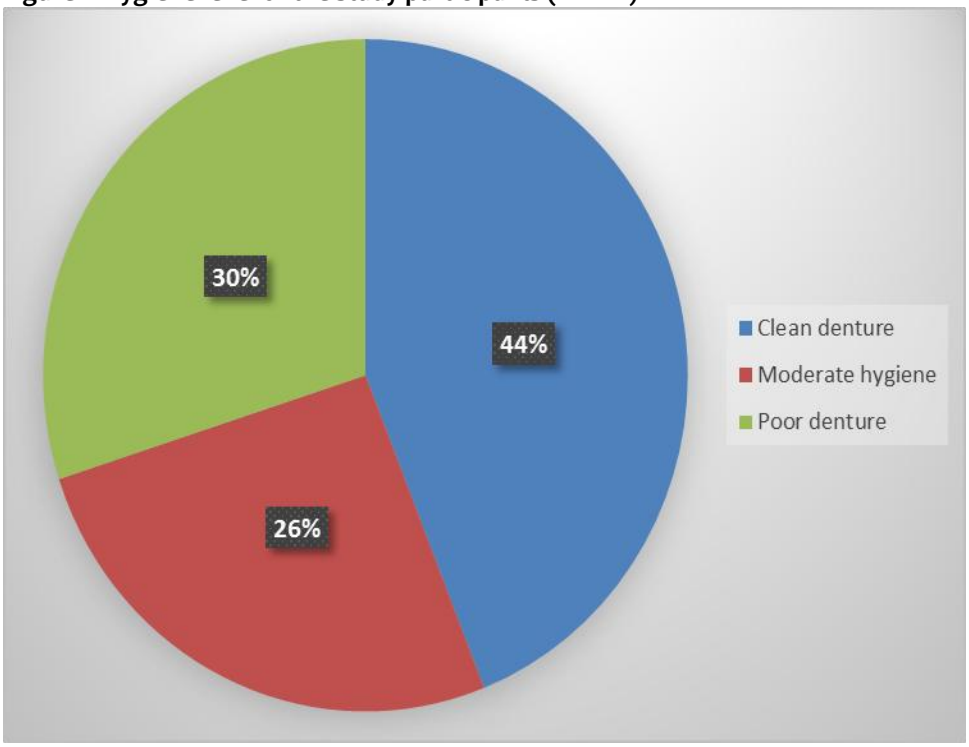


Figure 1: Summarized hygiene levels among study participants at KCMC dental clinic

Cleaning habits and non-cleaning habits of the participants denture (N=200)

Non cleaning habits of the participant's denture

Table 2 displays non-cleaning practices. Of the 200 participants, 81 (40.5%) had new dentures, and 128 (64%) did not sleep with their dentures. After receiving their dentures from a dentist, 143 participants (71.5%) received instructions, and more than half of the participants 118 (59%) had used their dentures for less than a year.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.23

Table 2: Non cleaning habits of the participants denture (N=200)

Characteristics	n (%)
Denture checkups	
Every 3 to 6month	15(7.5)
Once a year	19(9.5)
Not applicable/new	81(40.5)
Never	85(42.5)
Sleep with denture	
No	128(64)
Yes	72(36)
Dentist instruction on how to clean denture	
Yes	143(71.5)
No	57(28.5)
Denture duration	
Less than one year	118(59)
More than one year	82(41)

Cleaning habits of the participant's denture (N=200)

Table 3 displays the cleaning habits of the participant's denture

More than two-thirds of the participants, 148 (74%), soaked their dentures in a solution when they weren't using them. Specifically, 138 participants (69%) soaked their dentures in cold water overnight, and 142 participants (71%) rinsed their dentures after every meal. Additionally, 89 participants (44.5%) reported cleaning their dentures at least twice a day. The majority of participants cleaned their dentures with a toothbrush (193, or 96%), and 146 participants (73%) used toothpaste and water. However, 126 participants (63%) were using dentures for the first time.

Table 3: Cleaning habits of the participants denture (N=200)

Characteristics	**n(%)**
Soak a denture in any substance when not wearing a denture	
Yes	148(74)
No	52(26)
Substance to soak a denture	
Cold water	138(69)
Others specify	62(31)
Rinse a denture every after meal	
Yes	142(71)
No	58(29)
How often to clean denture	

Once a day	57(28.5)
Twice a day More than twice a day	89(44.5) 54(27)
Using denture brush/ tooth brush to clean denture	
Tooth brush	193(96.5)
Others	7(3.5)
What do you use to clean a denture	
Toothpaste and water	146(73)
Others specify	54(27)

Hygiene level by socio-demographic and cleaning habits characteristics

In the adjusted analysis shown in Table 4, older patients aged 60 years and above had three times higher odds of having moderate or poor denture condition compared to those aged 18-40 years, with clean dentures (COR 3.46; 95% CI: 1.17-10.16; P-value = 0.024).

Those who slept with their dentures had three times higher odds of having moderate or poor denture conditions compared to those who did not sleep with their dentures (COR 3.34; 95% CI: 1.32-8.4; P-value = 0.006). Individuals who went for regular denture checkups once a year and those who were new denture wearers had 0.12- and 0.23-times lower odds, respectively, of having moderate or poor denture conditions compared to those who had checkups every 3-6 months (COR 0.12; 95% CI: 0.02-0.82; P-value = 0.031) and (COR 0.23; 95% CI: 0.06-0.90; P-value = 0.042).

In terms of denture hygiene, those who cleaned their dentures more than twice a day had 0.32 times lower odds of having moderate or poor denture conditions compared to those who cleaned their dentures once a day (COR 0.32; 95% CI: 0.11-0.97; P-value = 0.045). Slight inflammation of the palate was associated with twice the odds of having moderate or poor denture conditions compared to a non-inflamed palate (COR 2.43; 95% CI: 1.05-5.9; P-value = 0.038)

Table 4: Adjusted Logistic regression by socio-demographic and cleaning habits characteristics

Characteristics	COR(95%CI)	P-value	AOR(95%CI)	P-value
Sex				
Male	1			
Female	0.871(0.52-1.46)	0.603		
Age				
18-40	1			
41-60	1.583(0.74-3.40)	0.240	1.232(0.39-3.88)	0.721
60+	3.165(1.54-6.49)	0.002	3.457(1.17-10.16)	**0.024**
Sleeping with denture				
No	1			
Yes	5.67(2.87-11.22)	<0.001	3.34(1.32-8.4)	**0.006**
Smoking				
Yes	1			
No	0.858(0.30-2.39)	0.769		
Denture checkup				
Every3-6month	1			
Once a year	1.549(0.43-5.57)	0.502	0.117(0.07-0.82)	**0.031**
New	0.239(0.83-0.69)	0.008	0.232(0.06-0.95)	**0.042**
Never	3.316(1.21-9.08)	0.020	0.859(0.19-3.93)	0.845
Frequency of cleaning denture				

Once a day	1			
Twice a day	0.656(0.35-1.22)	0.180	0.628(0.22-1.83)	0.393
More than twice a day	0.357(1.17-0.73)	0.005	0.323(0.11-0.97)	**0.045**
Palatal erythema				
No inflammation	1			
Inflammation present	2.300(1.16-4.58)	0.018	2.425(1.05-5.9)	**0.038**

Footnote: *COR-Crude odds ratio
* AOR-Adjusted odds ratio
*Bolded p-value indicates statistical significance (P-value<0.05).
*Adjusted for Age, sleep with denture, denture check-up, denture cleaning, denture duration and palatal erythema.

Oral health status information of the study participants

The study's findings reveal that 178 participants (89%) had never noticed an unpleasant odor while wearing their dentures, and 141 participants (70.5%) had never experienced a burning sensation. Additionally, 156 participants (78%) had never observed a reddish lesion when removing their dentures. Among the subjects who used only upper dentures, palatal erythema was clinically evaluated. Of the 117 participants (74.05%) who underwent examinations, none reported irritation. (Shown in table 5).

Table 5: Summarized self-reported and clinical examination of oral health status conditions of the study participants (N=200)

Characteristics	**n (%)**
Bad smell with denture	
Yes	22(11)
No	178(89)
Burning sensation while wearing denture	
Yes	59(29.5)
No	141(70.5)
White or reddish lesion after denture insertion	
Yes	44(22)
No	156(78)
Degree of palatal erythema (maxillary upper denture) (N=158)	
No inflammation	117(74.05)
Inflammation present	41(25.95)

Discussion

The objective of this study was to evaluate oral prosthesis cleaning practices and oral health status among removable oral prosthesis wearers at K.C.M.C. Dental Clinic from February to June 2022. The findings indicated that 44% of participants had clean dentures, 26% had moderate hygiene, and 30% had poor hygiene. These results contrast with a Nigerian study where 78.7% of participants exhibited good denture hygiene, with 15% each having fair and poor hygiene (Ogunride & Opeodu, 2015). Similarly, a Malaysian study reported that 68% of participants had clean dentures, 26% had moderate hygiene, and only 6% had poor hygiene. The discrepancies between these studies and ours may stem from differences in the age groups studied. The Nigerian and Malaysian studies mainly involved middle-aged participants who are more likely to possess the dexterity needed for proper denture cleaning. In

contrast, our study focused on elderly participants who had fewer denture checkups and often wore complete dentures.

Among participants aged over 60 years in our study, 35.5% had clean dentures, 23.2% had moderate hygiene, and 41.4% had poor hygiene. Additionally, 32.32% of participants over 60 cleaned their dentures once a day, compared to 28.2% in an Indian study (Apatrim et al., 2013). Research suggests that more frequent cleaning helps prevent plaque accumulation. For example, Ogunride & Opeodu (2015) and Syatirah et al. (2021) found that cleaning dentures twice a day resulted in oral hygiene levels of 80% and 43%, respectively. The lower rates of adequate denture hygiene among older adults in our study may be attributed to physical limitations or forgetfulness. This highlights the need for dental professionals to provide personalized care plans, support, and reminders for denture cleaning.

The study also found that 36% of participants slept with their dentures in their mouths. This percentage is lower than those reported in Brazil (88%) and Iran (55.1%) (Apratim et al., 2013; Syatirah et al., 2021), but higher than those reported in India (13.2%) (Mushtaq et al., 2019) and Nigeria (20.2%) (Aoun & Gerges, 2017). Possible reasons for this may include the presence of partners, lack of knowledge, or the belief that removing dentures might cause facial muscle shrinkage. However, wearing dentures throughout the day and night can increase the risk of infections and oral health issues like denture stomatitis and gum sores. Ideally, dentures should be removed at night to promote good dental and overall health. Public education on the risks of prolonged denture use and the benefits of nighttime removal is essential for better oral hygiene.

Regarding denture cleaning frequency, 27.5% of participants in our study cleaned their dentures more than twice a day. This is similar to a Lebanese study (26.5%) (Aoun & Gerges, 2017), but much lower than the 73.58% reported in Brazil (Peracin et al., 2010). Certain areas of the denture, such as the intramural labial and buccal sides of the flange, inside surfaces, and spaces between the teeth, may require more frequent cleaning. In our study, participants were motivated to clean their dentures to improve personal hygiene and prevent stains and odors. We recommend cleaning dentures at least once a day, ideally twice a day—once in the morning and once before bed.

The study also found that only 9.5% of participants visited the dentist annually for routine checkups, a percentage similar to the 10.1% reported in Nigeria, where patients typically visit the dentist for treatment or denture adjustments. This figure is higher than the 13% reported in Malaysia (Syatirah et al., 2021). The low frequency of routine dental visits may be explained by the long-term use of dentures and participants' tendency to seek dental care only when experiencing issues like denture breakage or poor fit. Regular dental checkups are crucial for monitoring oral health, adjusting dentures, and detecting potential problems early. Encouraging regular dental visits is essential for maintaining oral health and ensuring timely interventions.

After the clinical examination, 25.95% of participants showed signs of oral mucosal inflammation, such as denture stomatitis. This is lower than the 50% reported in India (Bhat et al., 2003). Possible causes for this include poorly fitting dentures, plaque accumulation, overextended denture flanges, and nocturnal wearing. Dental professionals should prioritize ensuring proper denture fit and providing regular adjustments to enhance comfort and prevent oral trauma, thereby improving the quality of life for denture wearers.

Conclusion

This study sheds light on key aspects of denture hygiene and oral health among removable oral prosthesis wearers at K.C.M.C. Dental Clinic from February to June 2022. The results show that a significant portion of participants had inadequate denture hygiene, with only 44% maintaining clean

dentures. This is notably lower than the hygiene levels reported in studies from Nigeria and Malaysia, possibly due to differences in age demographics and associated dexterity.

The data reveals that elderly participants, particularly those over 60, struggled to maintain proper denture hygiene. The study emphasizes the need for regular denture cleaning, as more frequent cleaning is associated with better oral hygiene. However, challenges such as physical limitations and forgetfulness among older adults highlight the importance of providing personalized care plans and support from dental professionals.

Furthermore, the study observed that many participants slept with their dentures in place, a practice that increases the risk of oral infections and conditions like denture stomatitis. Public education on the benefits of removing dentures at night is essential for reducing these risks.

Additionally, the low rate of annual dental visits among participants underscores the need for routine checkups to monitor and maintain oral health. Regular visits are critical for detecting issues early and ensuring that dentures fit properly, which can prevent oral trauma.

Overall, this study suggests that increased attention to education, personalized care, and regular dental checkups can significantly improve oral health and quality of life for denture wearers. Addressing these factors is vital for promoting better denture hygiene and reducing the occurrence of related oral health problems.

Recommendations

Based on the findings of this study, the following actions are recommended:

- **Oral Health Education Program**: Develop an oral health education program aimed at improving denture hygiene practices among removable denture wearers to reduce the risk of denture-induced oral diseases.
- **Dental Professional Advice**: Dental professionals should advise denture wearers on best practices, including regular denture checkups, rinsing dentures after every meal, and storing dentures in a dry, covered container when not in use.
- **Chemical and Mechanical Cleaning**: To manage dental plaque accumulation effectively, it is essential to combine mechanical cleaning (using a toothbrush and water) with chemical cleaning (such as vinegar, diluted sodium hypochlorite, or chlorhexidine digluconate) to maintain the durability of denture hygiene and promote good oral health.

Ethical consideration

Ethical approval was sought from Kilimanjaro Christian Medical University College (KCMUCo) and the Research Ethics Review Committee with clearance number PG 02/2022. The permission to carry out the study was obtained from the relevant authorities from the KCMC. Confidentiality and anonymity were maintained and observed at every step from data management, analysis and presentation and participants' codes were used instead of names.

Conflict of interest disclosures

The authors declare no conflicts of interest. This article has not been published previously nor is not being considered for publication in other journals.

Author contributions

All authors contributed to the writing of the final report. All authors have approved the final version to be submitted. All of the four authors participated fully in the design of the proposal, study implementation, analysis and manuscript writing. Each has agreed to be included in the list of authors

after it is accepted for publication in the Tanzania Journal of Health Research, and everyone has declared no conflict of interest.

Data sharing statement

We will provide any primary data access to the Tanzania Journal of Health Research anytime when requested during the review process or for editorial decisions.

Disclosures:

The authors declare no conflicts of interest.

Reference

Apratim A, Shah SS, Abubakkar A et al Denture Hygiene Habits among Elderly Patients Wearing Complete Dentures. 2013;14(December):1161–4.

Aoun G, Gerges E. Assessment of Hygiene Habits in Acrylic Denture Wearers : a Cross-sectional Study. 2017;29(August):216–8.

Baba Y, Sato Y, Minakuchi S. et al. Effectiveness of a combination denture-cleaning method versus a mechanical method: comparison of denture cleanliness, patient satisfaction, and oral health-related quality of life. J Prosthodont Res. 2018;62(3):353–8.

Budtz-Jørgensen, E. and Bertram, U. (1970) Denture Stomatitis I. The Etiology in Relation to Trauma and Infection, Acta Odontologica Scandinavica, 28 (1), pp. 71–92. DOI:10.3109/00016357009033133.

Bhat V, Sharma SM, Shenoy SM, et al. Prevalence of Candida Associated Denture Stomatitis (Cads) and Speciation of Candida Among Complete Denture Wearers of South West Coastal Region of Karnataka. J Heal Allied Sci NU. 2013;03(03):059–63.

Coulthwaite L, Verran J. Potential pathogenic aspects of denture plaque. Br J Biomed Sci. 2007;64(4):180–9.

David C Dugdale. Aging changes in teeth and gums: MedlinePlus Medical Encyclopedia. Natl Libr Med [Internet]. 2022; Available from: https://medlineplus.gov/ency/patientinstructions/000951.htm

Hobdell M, Petersen PE, Johnson N. et al Global goals for oral health 2020. Int Dent J. 2003;53 (5):285–8.

Lauritano D, Moreo G, Lucchese A, et al. Oral Health Status and Need for Oral Care in an Aging Population : A Systematic Review. 2019.

McHugh ML. Lessons in biostatistics interrater reliability : the kappa statistic. Biochem Medica [Internet]. 2012; 22(3):276–82. Available from: https://hrcak.srce.hr/89395

Mushtaq MA, Altaf J, Shah AA et al . Assessment of Knowledge and Practices about Denture Hygiene among Complete Denture Wearers in Lahore City. J Pakistan Dent Assoc. 2019;28 (.0):187–91.

Natto ZS, Aladmawy M, Papas A. et al Factors contributing to tooth loss among the elderly : A cross sectional study. Singapore Dent J [Internet]. 2014; 35:17–22. Available from: http://dx.doi.org/10.1016/j.sdj.2014.11.002

Nair VV, Karibasappa GN, Prashanth VK.et al Microbial contamination of removable dental prosthesis at different interval of usage: An in vitro study. J Indian Prosthodont Soc. 2016;16 (4):346–51.

Ogunrinde TJ, Opeodu OI. Denture care practice among patients attending the prosthetic clinic in a Nigerian teaching hospital. 2015; 56(3):199–203.

Peracini A, de Andrade IM, de Souza RF. et al. Behaviors and hygiene habits of complete denture wearers. Braz Dent J. 2010; 21(3):247–52.

Shankar T, Gowd S, Suresan V, et al. Denture hygiene knowledge and practices among complete denture wearers attending a postgraduate dental institute. J Contemp Dent Pract. 2017; 18(8):714–21.

Shigli K, Hebbal M, Agrawal N.et al The knowledge , attitude and practice of edentulous patients attending a dental institute in India regarding care of their dental prostheses. 2015; 294–9.

Syatirah N, Noor M, Husein A. et al The Significance of Knowledge , Instructions , Habits and Denture Hygiene Practice in Relation to the Maintenance of Denture Hygiene at Hospital USM ' s Dental Clinic. 2021;16(1):49–55.

Szalewski L. Oral hygiene in patients using removable dentures. 2017; 127(1):28–31.

Takamiya AS, Monteiro DR, Compagnoni MA, et al. Complete denture hygiene and nocturnal wearing habits among patients attending the Prosthodontic Department in a Dental University in Brazil. 2011; 91–6.

Torabi Parizi et al. Evaluation of denture hygiene among removable denture wearers referred to clinics of Kerman, Iran. JOHOE/ Winter & Spring. 2013;2 (1):44–8.

Turgut Cankaya Z, Yurdakos A, Gokalp Kalabay P. The association between denture care and oral hygiene habits, oral hygiene knowledge and periodontal status of geriatric patients wearing removable partial dentures. Eur Oral Res. 2020;54(1):9–15

World Health Organization. The World Oral Health Report 2003. Community Dent Oral Epidemiol. 2003;31 Suppl 1:3–2

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.24

Availability and quality of vaccine cold chain equipment at healthcare facilities in Mtwara region, Tanzania: evidence from routine assessment of vaccine cold chain equipment

Serveus Ruyobya Kamala[1] Hamad Nyembea[2], Florence Salvatory Kalabamu[3], Amos Justinian Ngonzi[4], Fatuma Manzi[4], Bonaventura Nestory[5], Florian Tinuga[5]*

[1]Health, Social Welfare, and Nutrition Services Section, Mtwara Regional Secretariat, Tanzania, [2] Curative Health Services Section, Ministry of Health, Tanzania, [3] Department of Pediatrics and Child Health, Kairuki University, Tanzania, [4] Department of Health Systems, Policy, and Impact Evaluation – Ifakara Health Institute, [5] Immunization and Vaccine Development Program, Ministry of Health, Tanzania

Abstract

Background: The quality of vaccines is heavily dependent on maintaining proper cold chain equipment (CCE) throughout the supply chain. However, Tanzania faces significant challenges in this area. According to the Effective Vaccine Management Assessment (EVMA) of 2021, the country score was 73%, falling short of the 80% benchmark. The ongoing measles outbreak in several districts may be linked to the delivery of low-quality vaccines due to inadequate storage conditions. This study aimed to assess the availability and quality of CCE at healthcare facilities in the Mtwara region and identify areas for improvement.

Methods: A descriptive cross-sectional study was conducted, utilizing an updated vaccine CCE inventory from 263 healthcare facilities (HFs) across nine councils in the Mtwara region. The updated inventory was compiled into a single Microsoft Excel dataset, which was then analyzed to determine the frequency and functionality of CCE. The findings were presented in tables for comparative analysis.

Results: Routine immunization services were available at 263 out of 301 healthcare facilities (87.4%), with 234 (89%) of these being public facilities. Among them, 218 (82.9%) were dispensaries, and 209 (79.5%) were in rural areas. A total of 252 (95.8%) healthcare facilities had functional refrigerators, 115 (43.7%) of which were RCW 50EG models. Although all refrigerators met the World Health Organization's pre-qualification standards, 192 (76%) exhibited functional deficiencies. Additionally, 115 (43.7%) had been in use for over ten years, and 48 (19%) lacked temperature monitoring devices. While vaccine carriers were available, they showed deficiencies that made them unsuitable for effective vaccine storage.

Conclusion: Most cold chain equipment (CCE) in the Mtwara region was in sub-optimal condition, potentially compromising vaccine quality and hindering immunization services. This could result in canceling immunization sessions, leading to low vaccination coverage and a failure to protect recipients. Urgent action is needed to repair or replace non-functional, outdated, and inefficient CCE. In addition, regular refresher training for healthcare providers on assessing and maintaining vaccine CCE is recommended, as well as the procurement of refrigerator models that are suitable for local conditions in alignment with manufacturer guidelines.

Keywords: routine immunization, healthcare facility, cold chain equipment, vaccine refrigerator, vaccine quality, equipment inventory

[*]***Corresponding author*** Email: sekakamala@gmail.com (SK)

Introduction

Since the establishment of the Expanded Programs on Immunization (EPI) in 1974 (K Keja , C Chan, G Hayden, 1988), vaccination has always been one of the most cost-effective public health interventions for controlling vaccine-preventable diseases (VPDs). Vaccination contributed to the global eradication of smallpox and the elimination of wild poliovirus and Haemophilus influenza type B (Hib) in many countries (Rémy et al., 2015). Consequently, childhood vaccination reduced infant and childhood mortality (Bhandari et al., 2007; Bobo et al., 2022; Ndirangu et al., 2009; Shukla & Shah, 2018) and is currently estimated to avert about 2 to 3 million under-five deaths globally each year (Paul A, 2020; UNICEF, 2023). Vaccination remains a key channel for attaining the Sustainable Development Goal (SDG 3.2) (WHO, 2021). Moreover, vaccination contributes directly or indirectly to the achievement of the other 13 SDGs, such as ending poverty (SDG 1) by reducing out-of- pocket expenditure on treatment, reducing hunger (SDG 2) by preventing diseases that reduce nutrient absorption, and reducing inequalities (SDG 10) by avoiding inequity caused by epidemics (Decouttere et al., 2021).

Despite the lifesaving impact of vaccines, vaccine-preventable diseases (VPDs) are still prevalent, causing about 3 million deaths globally every year (Albright et al., 2005). In 2018, VPDs caused nearly 700,000 under-five mortalities worldwide, 99% of which occurred in low and middle-income countries (Nair et al., 2011). In recent years (2022–2023), both wild poliovirus and circulating vaccine-derived poliovirus type 2 (cVDPV2) outbreaks have recurred in some African countries, including Malawi (WHO Africa, 2022), Mozambique (GPEI, 2022; WHO, 2022b), Tanzania (WHO, 2023), the Democratic Republic of the Congo, and Burundi (GPEI, 2023). This situation has emerged behind the polio-free certification awarded to the World Health Organization (WHO) African Region on August 25, 2020 (WHO, 2023). Such outbreaks pose a public health threat and undermine the achievement of the global polio eradication initiative (GPEI 2022–2026) (GPEI, 2021) and immunization agenda (IA 2030) goals.

Several reports have attempted to identify probable reasons for these outbreaks. Among the identified reasons is the disruption of immunization services by the COVID-19 pandemic (Maltezou et al., 2020; Muhoza et al., 2021). The World Health Organization declared COVID-19 disease a global pandemic on March 11, 2020, with an immediate endorsement of control interventions such as physical distancing and transportation reductions (WHO, 2020). Adherence to these interventions reduced access to routine immunization, resulting in a drop in vaccination coverage rates and the accumulation of zero-vaccine doses and under-vaccinated children in many communities (Maltezou et al., 2020; Muhoza et al., 2021; WHO, 2022a). It is no wonder that the drop in vaccination coverage below the threshold for herd immunity increases the chance of the occurrence of VPD outbreaks. Amongst others, failure to adhere strictly to recommended specifications for vaccine storage and handling can render vaccines unable to prevent targeted diseases (Dairo & Osizimete, 2016; Paunio et al., 1998; Yeung et al., 2005). Suboptimal vaccine handling practices, CCE failure, and weak temperature monitoring and control systems have previously been reported in several studies (Dairo & Osizimete, 2016; Nestory et al., 2022; Sinnei et al., 2023; Yauba et al., 2019).

In Tanzania, for instance, EVMA-2021 reported a suboptimal country-wide score of 73% below the 80% benchmark on vaccine storage and transportation equipment (UNICEF, 2021). Therefore, the ongoing measles outbreaks in several councils of Tanzania (The Citizen, 2022) could be linked to the provision of low-quality vaccines to children due to sub-optimal storage conditions along the supply chain. In 2022, Tanzania attained 110% and 97% of MR1 and MR2 administrative coverage, respectively. These coverages exceeded the minimum target endorsed by the WHO in the Immunization Agenda 2030 (IA 2030) (WHO, 2021) and the 2012 Global Vaccine Action Plan (Zewdie et al., 2016). Therefore,

this suggests that measles outbreaks could not be due to low coverage but likely due to vaccine quality issues related to cold chain management. Unless there were reporting or target issues with the administrative data.

Therefore, this study aimed to evaluate the availability and quality of vaccine CCE at the HF level in Mtwara region following routine CCE commissioning and decommissioning. Outcomes are intended to inform policy on CCE gaps and guide future repair, maintenance, replacement, and/or re-distribution plans.

Materials and Methods

Study Setting

This study was conducted in Mtwara, one of the coastal regions located in the southern part of Tanzania. The region shares borders with Mozambique, a country where the WHO reported several cases of both wild poliovirus and cVDPV-2 (GPEI, 2022). According to the 2022 national census, the region has approximately 1.6 million people living in nine councils, 76.3% of whom reside in rural areas where access to immunization services is challenging (Vasudevan et al., 2020). The region has a total of 301 HFs, out of which 17 (5.6%) are faith-based (FBO), 39 (13%) are private for-profit, and 245 (81.4%) are public HFs. The increment in the number of health facilities providing routine immunization services from 243 in 2022 to 263 in 2023, the occurrence of Measles Rubella outbreak in several councils in Mtwara, as well as the recommendations from the EVMA 2021, prompted the need to assess the quality of CCE currently used to store vaccines at the HFs in Mtwara.

Study design

A descriptive cross-sectional study was conducted using a periodically updated vaccine CCE inventory to ascertain the availability and quality of vaccine storage equipment at healthcare facilities across nine districts in Mtwara region. A detailed vaccine CCE inventory used in this study was obtained from District Health Management Teams (DHMTs) upon completion of the fourth-quarter inventory updates for the 2022/2023 fiscal year. From this inventory, this study assessed the common vaccine storage equipment used at 263HFs that are providing routine immunization services. This equipment included vaccine refrigerators, vaccine carriers, cool water packs, foam pads, a 30-day temperature recorder (30-DTR), i.e., fridge-tag devices (FT2), and remote temperature monitoring devices (RTMDs). In this context, availability meant the presence of vaccine storage equipment by the established standards, while parameters of quality checked out on each piece of equipment included physical condition (outer body, accessories, and fittings); the length of time a device has been used, and functional deficiencies as reported by users.

Data management and analysis

Upon receipt of updated vaccine CCE inventories from all districts, the Regional Health Management Team (RHMT) compiled individual vaccine CCE inventories to form a single Microsoft Excel dataset. The dataset was then analyzed in Microsoft Excel for frequencies and percentages representing the quantity and functionality of CCE. Then, the results were presented in tables for comparison. The primary outcome of the analysis was the availability and quality of CCE found in HFs providing immunization services.

Ethical approval

This study did not involve human subjects; we only assessed the availability, functionality, and quality of CCE; therefore, formal consent was not required. Furthermore, data were collected as part of routine monitoring and evaluation of government initiatives to improve quality health services as

guided by the Ministry of Health. However, the permission for program data use and publication of the results was obtained from the Mtwara Regional Secretariat.

Results

Demographic characteristics of health facilities providing routine immunization services

Routine immunization services were available in 263/301 (87.4%) of THE HFs found in Mtwara region. The government owned the majority of these facilities 234 or 89%). The analysis further indicated that routine immunization services were mostly provided in dispensaries 218 (82.9%). Nearly eighty percent 209 (79.5%) of vaccinating HFs were located in rural areas (
Table 1)

Table 1: Demographic characteristics of HFs providing RI services

Variables	Quantities	Percent (%)
Ownership		
FBO	17	6.5%
Private for Profit	12	4.6%
Public	234	89.0%
Facility location		
Rural	209	79.5%
Semi-Urban	20	7.6%
Urban	34	12.9%
Facility type		
Dispensary	218	82.9%
Health Center	36	13.7%
Hospital	9	3.4%

Condition of vaccine cold chain equipment

The study findings revealed that 252 (95.8%) HFs had functional refrigerators, 115 (43.7%) of these refrigerators being the RCW 50EG model, followed by 98 (37.3%) SunDanzer (BFRV 55) and 36 (13.7%) Haier HTC-110 model. Although all HFs were equipped with WHO-qualified refrigerators, over three quarters 192 (76%) of these refrigerators had functional deficiencies, including moisture formation 84 (33.3%); defective ignition coil 57 (22.6%); ruptured gasket rubber 21 (12.3%); defective cooling unit 10 (4.0%); defective unit control panel 9 (3.6%); and defective door lock 1 (0.4%). It was also found that the main sources of power for these refrigerators were solar 137 (52.1%), liquefied petroleum gas 85 (32.3%), and grid electricity 41 (15.6%).

The study further established that 43 (16.3%) of HFs had no power backup for continued cold chain management during power outages. Over half, 137 (52.1%) of HFs had solar direct drive (SDD) refrigerators that needed no external backup other than an internal battery. Of all electric refrigerators running on grid electricity, only 10 (24.4%) had a voltage stabilizer to safeguard the refrigerator from fluctuating power. The assessment also pointed out that the length of time a refrigerator has been in use was over ten years among 115 (43.7%) refrigerators, 0 to 4 years among 108 (41.1%) refrigerators, 5 to 10 years among 4 (1.5%) refrigerators, and less than 1 year among 36 (13.7%) refrigerators (Table 2).

 https://dx.doi.org/10.4314/thrb.v26i3.24

Table 2: CCE models, functionality, alternative and main sources, installation dates, voltage stabilizer, and functional defects.

Variable	Quantity	Percent (%)
Refrigerator models		
TCW 3000 AC	1	0.4
MK 404 AC	1	0.4
VLS 054 DC	2	0.8
Vest frost VLS 200 AC	10	3.8
Haier HTC 110 DC	36	13.7
SunDanzer (BFRV 55) DC	98	37.3
RCW 50EG AC/Gas	115	43.7
Is a refrigerator functional?		
No	11	4.2
Yes	252	95.8
Refrigerator source of power		
Grid Electricity	41	15.6
Liquefied Petroleum Gas	85	32.3
Solar power	137	52.1
Type of power backup		
Solar inverter	1	0.4
Generator	4	1.5
LP Gas	36	13.7
Electricity	42	16.0
No power backup	43	16.3
In-built refrigerator battery	137	52.1
Availability of voltage stabilizers on electrical		
No	31	75.6
Yes	10	24.4
Vaccine refrigerators defects		
Defective door lock/hinge	1	0.4
Defective unit control panel	9	3.6
Defective cooling unit for RCW 50EG	10	4.0
Ruptured gasket rubber	31	12.3
Defective ignition coil for RCW 50 EG	57	22.6
A refrigerator forms a moisture	84	33.3
Length of time refrigerators have been used		
Over 10 Years	115	43.7
5-10 years	4	1.5
0-4 years	108	41.1
Less than a year	36	13.7

Almost all HFs, 99.6% (262/263),had a vaccine carrier, and over eighty percent,225 (85.6%) of these facilities had at least two vaccine carriers. Despite their adequate availability, some vaccine carriers had deficiencies, including the absence of a foam pad at 185 (70.3%) HFs; a short supply of cool water packs at 31 (11.8%) HFs; breaking belts at 27 (10.3%) HFs; cracks on the hard lids at 67 (25.5%) HFs; and cracks on the outer body at 63 (24%) HFs. None of the HFs had a cold box (Table 3).

Table 3: Availability and physical condition of insulated containers at the HF

Variable	Quantity	Percent (%)
Is a vaccine carrier available?		
Yes	262	99.6
No	1	0.4
HF has ≥ 2 vaccine carriers		
Yes	225	85.6
No	38	14.4
Does a vaccine carrier have 4 cool water packs?		
Yes	232	88.2
No	31	11.8
A vaccine carrier has a foam pad		
Yes	78	29.7
No	185	70.3
A vaccine carrier has a belt		
Yes	236	89.7
No	27	10.3
A vaccine carrier has cracks on a hard lid		
Yes	67	25.5
No	196	74.5
A vaccine carrier has cracks on the outer body		
Yes	63	24.0
No	200	76.0
The health facility has a cold box		
Yes	0	0.0
No	263	100.0

The assessment of temperature monitoring devices highlighted that 52 (19.8) of all functional refrigerators had no temperature monitoring devices. A refrigerator was equipped with both 30 DTRs and RTMDs at 131 (49.8%) HFs. Although RTMDs were installed at the HFs in 165 (62.7%) refrigerators, the majority of 108 (65.5%) were not transmitting data to the https://tz.coldtrace.org data server (
Table 4).

Table 4: Temperature Monitoring Devices and Temperature Distribution in Vaccine Refrigerators

Variable	Quantity	Percent (%)
Is a functional 30-DTR available and inserted in the refrigerator?		
Yes	178	67.7
No	85	32.3
Is a remote temperature monitoring device (RTMD) installed?		
Yes	165	62.7
No	98	37.3
RTMD Data Transmission		
Vaccine refrigerators maintaining a temperature range of	39	23.6
RTMDs recorded the hot temperature from the vaccine	9	5.5
RTMDs recorded cold temperatures (below +2) in a	9	5.5
RTMDs transmitted no data	108	65.5
Are both functional 30-DTR and RTMDs available?		
Yes	131	49.8
No	34	12.9
A refrigerator has no temperature monitoring devices		

Yes	52	19.8
No	211	80.2

Discussion

Findings from this study pointed out that routine immunization services were unavailable in 38/301 (12.6%) of functional HFs, 71% of which were owned by private sectors. Although we did not explore factors limiting the introduction of routine immunization programs into these facilities, we advocate for strengthening public-private partnerships (PPP) to create a better environment for engaging the private sector in the provision of routine immunization (RI) services. Available evidence shows that providing RI services through the private sector contributes significantly to raising immunization coverage and the adoption of new vaccines (Levin & Kaddar, 2011). A health facility is a key place for storing vaccines and implementing RI programs (Pinaka et al., 2021; Sanghavi, 2007). The ongoing construction and/or renovation of HFs to expand the concept of primary health coverage (Kapologwe et al., 2020; MoH, 2021; Mtema, 2022; Mwenda, 2019) provides room for expansion of immunization services upon inclusion of reproductive and child health (RCH) units in the building plans. This will contribute to reducing barriers to immunization access caused by distance from HFs (Blas E, Sivasankara Kurup A, 2010) and/or poor geographical access (Marti et al., 2017; Vasudevan et al., 2020). In favor of 80.6% of vaccinating HFs located in rural areas where electricity is always a challenge (Moner-Girona et al., 2021), solar direct-drive vaccine refrigerators should be prioritized during the replacement and expansion of cold chain infrastructure.

The availability of adequate and well-functioning CCE at the HF ensures proper vaccine storage at all times and every stage until the moment they are given to children, adolescent girls, pregnant women, and adults coming for COVID-19 vaccines. On the contrary, it was observed in this study that 4.2% of HFs registered in VIMS for delivery of routine immunization services in Mtwara had either no vaccine refrigerator at all or were equipped with non-functional vaccine refrigerators. The absence of refrigerators or the presence of a non-functional vaccine refrigerator at the service delivery points interrupts immunization services and is therefore likely to cause missed opportunities for immunization (MOV) and distress to healthcare providers, similar to what was observed by Kimmel *et al* (Kimmel et al., 2003). To ensure the availability of functional refrigerators at the HF, there should be adherence to routine planned preventive maintenance (PPM), which was reported to be considerably low in Morogoro, Tanzania (Nestory et al., 2022), and Ethiopia (Feyisa, 2021). However, this will require understanding and solving available barriers such as low funding, the non-inclusion of PPM in the health facility's annual plans and budgets, and a shortage of biomedical technicians and refrigerator spare parts, as reported earlier (Sinnei et al., 2023; World Health Organization (WHO), 2013). As such, training healthcare workers on the basics of handling CCEs, recruiting and training local refrigerator technicians on refrigerator maintenance, and equipping HFs with sufficient CCE spare parts for easy access are paramount.

The presence of refrigerators with functional deficiencies in 76% of vaccinating HFs is a major turn-off to vaccine quality. It increases the likelihood that vaccines are exposed to damaging temperatures and the risk that vaccine recipients will not be protected against VPDs, as earlier reported (Dairo & Osizimete, 2016). The presence of broken refrigerators at HFs is not an uncommon challenge along the supply chain and was found to be higher in Mtwara than in Cameroon (Yauba et al., 2019). However, this difference might be due to differences in the parameters of the refrigerators assessed. Vaccine refrigerators with deficiencies were also reported to cause unusual vaccine wastages by Dairo *et al*. (Dairo & Osizimete, 2016). As such, there should be urgent efforts to rehabilitate or replace the broken and old refrigerators, preferably with solar direct-drive

refrigerators. The WHO and UNICEF have both published guidelines stating that solar refrigerator technologies should be prioritized over absorption devices (World Health Organization (WHO), 2013). However, the environmental suitability and drawbacks of certain solar refrigerator technologies should be considered during all these processes.

The current study indicated that a voltage stabilizer was connected to only 24.4% of needy vaccine refrigerators in Mtwara. The absence of voltage stabilizers, also known as automatic voltage regulators, exposes equipment to power disturbances, which can cripple the equipment, place vaccines at risk, and cause tension among healthcare workers. Although the availability of voltage stabilizers at the HFs was low in Mtwara, the situation was more unpromising in Surat City, Western India, as reported by Naik *et al.* (Naik et al., 2013). Several other studies also reported a shortage of voltage stabilizers in (Bachani & Bansal, 1990; Mallik et al., 2011). This calls for the inclusion of voltage stabilizer procurement and maintenance in the health facility's annual work plans and budgets.
Refrigerator power backup during power outage emergencies among needy refrigerators was also a challenge in Mtwara, similar to what was reported in Morogoro, Tanzania, by (Nestory et al., 2022). However, initiatives taken by the Ministry of Health (MoH) to roll out SDD refrigerators in 52.1% of HFs have reduced this requirement. Unless there is still a need, consideration for the procurement of generators and solar inverters remains vital. The recommendations provided in the EVMA 2021 report should be amplified among decision-makers and controllers of health facility resources. This will ensure the inclusion of an effective vaccine management agenda in the health facility's daily operations. The absence of an alternative power source at the health facility is responsible for vaccine wastage, increased facility operational costs due to storage of vaccines at neighboring health facilities, and interruption of immunization services (Nestory et al., 2022).

The absence of an adequate number (at least two) of vaccine carriers in 14.4% hinders the delivery of simultaneously fixed immunization and outreach sessions and is likely the reason for the cancellation of outreach sessions in Mtwara region, as displayed on the Vaccine Information Management System (VIMS) dashboard at www.vims.moh.go.tz. Vaccine carriers are designed to keep vaccines and diluents cold during transportation from the collection store at the HF, on journeys to outreach sites, or for temporary storage during health post-immunization sessions. Therefore, deficiencies observed in some of the vaccine carriers in Mtwara render them unfit for effective vaccine storage and distribution at the health facility. Inadequacy and deficiencies in vaccine carriers were also reported in Kenya (Sinnei et al., 2023). Moreover, the shortage of both vaccine carriers and cold boxes is distressing to healthcare workers due to the lack of temporary storage of vaccines when a refrigerator is out of order or being manually defrosted. All these gaps in insulated containers are likely to impair vaccine potency and negatively impact vaccination services. Therefore, decision-makers need to take necessary actions, including procuring and distributing new vaccine carriers to the HFs. Further, healthcare workers should be trained on how to improvise foam pads from mattresses to extend storage time and prevent exposure of vaccine vials to damaging temperatures and/or light during sessions.

In addition, 19.8% of HFs in Mtwara region lacked any kind of temperature monitoring device (TMD) in vaccine refrigerators. The absence of a continuous temperature monitoring and control system has previously been reported in several studies (Nestory et al., 2022; WHO, 2022a; Yeung et al., 2005). This is detrimental regarding vaccine wastage and patient safety due to the failure to identify and correct possible temperature excursions as recommended in the Centers for Disease Control and Prevention Vaccine Storage & Handling Toolkit (CDC, 2023). Temperature excursions have been identified as a potential cause of vaccine wastage in several settings (Mukherjee et al., 2004; Setia et al., 2002). Investing in a reliable device is less expensive than replacing vaccines

wasted due to the loss of potency that comes from storage at out-of-range temperatures. Therefore, this calls for the provision of functional TMDs for continuous monitoring of vaccine storage at HFs, as proposed by Falcon *et al.* (Falcón et al., 2020).

Gains observed in installing RTMDs in 165 (62.7%) HFs should be sustained and scaled up to all other vaccinating HFs in the region. The RTMDs' potential lies in their integration into VIMS, where they can easily monitor the performance of the CCEs and trigger alerts for any equipment failure. However, the RTMD reports in VIMS need to be enhanced to improve the reporting and utilization of the reported data, as suggested in the EVMA report 2021 (UNICEF, 2021).

Study limitations

This study had two limitations. One, researchers could not easily access refrigerator initial installation dates to assess the length of time a refrigerator has been in use. This is because refrigerators are being rotated within and between councils in the region during cold chain improvement struggles among HFs. Available installation details for certain models were extrapolated to all other similar models whose information was not easily accessible. Therefore, the active use of electronic cold chain inventory integrated into VIMS should be encouraged to ease future assessments. Second, this study only assessed the availability and status of vaccine cold chain equipment but did not assess the quality of vaccines being stored in the available CCE at the healthcare facility level. Therefore, findings from this study cannot be used to conclude its linkage with the occurrence of the ongoing VPD outbreaks in Mtwara. We recommend another study to assess the quality of vaccines during storage within the same HFs.

Conclusion and Recommendations

The findings from this study have revealed that most vaccine storage equipment were performing sub-optimally, which may impair the quality and potency of the vaccine and have a subsequent negative impact on the vaccination services, including cancellation of immunization sessions and vaccine failure to confer protection to the recipients. Therefore, efforts are needed to improve the availability and quality of vaccine storage equipment by rehabilitating or replacing the non-functioning and old equipment. Furthermore, we recommend frequent refresher training for healthcare providers in assessing and maintaining vaccine refrigerators and RTMDs, as well as procuring and using refrigerator models that are suitable for the local environment according to the manufacturer's guides.

Supporting information

Data requests may be made to Serveus Ruyobya Kamala (corresponding author), Health, Social Welfare, and Nutrition Services Section, Mtwara Regional Secretariat, P.O. Box 544, Mtwara, Tanzania, email: sekakamala@gmail.com, Tel: + 255718041765.

Acknowledgments

We sincerely thank everyone who contributed to editing this work, particularly Dr. Jasmine Chilembu from the Tanzania Southern Zone Referral Hospital. We are also thankful to the staff of the respective local government authorities in Mtwara, who updated the CCE inventory and to the Government of Tanzania for granting permission to publish this work.

References

Albright, A., Kremer, M., Levine, R., & Center for Global Development. (2005). *Making markets for vaccines : ideas to action : report of the Center for Global Development working group*.

Bachani, D., & Bansal, R. D. (1990). Logistics management in Universal Immunisation Programme.

Indian Journal of Public Health, *34*(4), 179–184.

Bhandari, P., Shrestha, S. S., & Ghimire, D. J. (2007). Sociocultural and geographical disparities in child immunization in Nepal. *Asia-Pacific Population Journal*, *22*(1), 43–64. https://doi.org/10.18356/1e441780-en

Blas E, Sivasankara Kurup A, W. (Eds). (2010). *Immunizatio Agenda 2030 (IA 2030): Coverage and Equity*. 1–16. https://www.immunizationagenda2030.org/images/documents/BLS20116_IA_Global_strategy_document_SP_3_001.pdf

Bobo, F. T., Asante, A., Woldie, M., Dawson, A., & Hayen, A. (2022). Child vaccination in sub-Saharan Africa: Increasing coverage addresses inequalities. *Vaccine*, *40*(1), 141–150. https://doi.org/10.1016/j.vaccine.2021.11.005

CDC. (2023). *Vaccine Storage and Handling Toolkit: Updated with COVID-19 and Mpox Vaccines Storage and Handling Information Addendum added January, 2023*. *January*.

Dairo, D. M., & Osizimete, O. E. (2016). Factors affecting vaccine handling and storage practices among immunization service providers in Ibadan, Oyo State, Nigeria. *African Health*, *16*(2). https://www.ajol.info/index.php/ahs/article/view/138627

Decouttere, C., De Boeck, K., & Vandaele, N. (2021). Advancing sustainable development goals through immunization: a literature review. In *Globalization and Health* (Vol. 17, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s12992-021-00745-w

Falcón, V. C., Porras, Y. V. V., Altamirano, C. M. G., & Kartoglu, U. (2020). A vaccine cold chain temperature monitoring study in the United Mexican States. *Vaccine*, *38*(33), 5202–5211. https://doi.org/10.1016/j.vaccine.2020.06.014

Feyisa, D. (2021). Cold Chain Maintenance and Vaccine Stock Management Practices at Public Health Centers Providing Child Immunization Services in Jimma Zone, Oromia Regional State, Ethiopia: Multi-Centered, Mixed Method Approach. *Pediatric Health, Medicine and Therapeutics*, *12*, 359–372. https://doi.org/10.2147/PHMT.S312039

GPEI. (2021). *Polio Eradication Strategy 2022–2026: Delivering on a promise*. https://polioeradication.org/wp-content/uploads/2022/06/Polio-Eradication-Strategy-2022-2026-Delivering-on-a-Promise.pdf

GPEI. (2022). *Wild poliovirus type 1 (WPV1) and circulating vaccine- derived poliovirus type 2 (cVDPV2) Co-infection in Mozambique*. *1*(May). https://polioeradication.org/where-we-work/mozambique/

GPEI. (2023). *GPEI Statement on cVDPV2 detections in Burundi and Democratic Republic of the Congo*. *March*. https://polioeradication.org/news-post/gpei-statement-on-cvdpv2-detections-in-burundi-and-democratic-republic-of-the-congo/

K Keja , C Chan, G Hayden, R. H. H. (1988). Expanded programme on immunization. *National Library of Medicine*, 1–2. https://pubmed.ncbi.nlm.nih.gov/3176515/

Kapologwe, N. A., Meara, J. G., Kengia, J. T., Sonda, Y., Gwajima, D., Alidina, S., & Kalolo, A. (2020). Development and upgrading of public primary healthcare facilities with essential surgical services infrastructure: A strategy towards achieving universal health coverage in Tanzania. *BMC Health Services Research*, *20*(1), 1–14. https://doi.org/10.1186/s12913-020-5057-2

Kimmel, S. R., Burns, I. T., & Zimmerman, R. K. (2003). Addressing immunization barriers, benefits, and risks. *The Journal of Family Practice*, *52*(1 Suppl), S47-55.

Levin, A., & Kaddar, M. (2011). *Role of the private sector in the provision of immunization services in low- and middle-income countries y*. 4–12. https://doi.org/10.1093/heapol/czr037

Mallik, S., Mandal, P. K., Chatterjee, C., Ghosh, P., Manna, N., Chakrabarty, D., Bagchi, S. N., &

Dasgupta, S. (2011). Assessing cold chain status in a metro city of India: an intervention study. *African Health Sciences*, *11*(1), 128–133.

Maltezou, H. C., Medic, S., Cassimos, D. C., & Effraimidou, E. (2020). *Decreasing routine vaccination rates in children in the COVID-19 era*. *January*, 2020–2023.

Marti, M., De Cola, M., MacDonald, N. E., Dumolard, L., & Duclos, P. (2017). Assessments of global drivers of vaccine hesitancy in 2014 - Looking beyond safety concerns. *PLoS ONE*, *12*(3), 1–12. https://doi.org/10.1371/journal.pone.0172310

MoH. (2021). *Health Sector Strategic Plan V (HSSP V): July 2021- June 2026*. *2026*(July).

Moner-Girona, M., Kakoulaki, G., Falchetta, G., Weiss, D. J., & Taylor, N. (2021). Achieving universal electrification of rural healthcare facilities in sub-Saharan Africa with decentralized renewable energy technologies. *Joule*, *5*(10), 2687–2714. https://doi.org/10.1016/j.joule.2021.09.010

Mtema, B. L. and N. (2022). *Tanzania : 207 Health Centres Set for Construction: Daily News Dar es Salaam*. *February*, 2022. https://allafrica.com/stories/202202090482.html

Muhoza, P., Danovaro-holliday, M. C., Diallo, M. S., Murphy, P., & Sodha, S. V. (2021). *Routine Vaccination Coverage — Worldwide , 2020*. *70*(43).

Mukherjee, A., Ahluwalia, T. P., Gaur, L. N., Mittal, R., Kambo, I., Saxena, N. C., & Singh, P. (2004). Assessment of vaccine wastage during a pulse polio immunization programme in India. *Journal of Health, Population, and Nutrition*, *22*(1), 13–18.

Mwenda, K. (2019). *Tanzania to commence construction 67 new health facilities*. *March 29*. https://constructionreviewonline.com/news/tanzania/tanzania-to-commence-construction-67-new-health-facilities/

Naik, A. K., Rupani, M. P., & Bansal, R. K. (2013). Evaluation of vaccine cold chain in urban health centers of municipal corporation of surat city, Western India. *International Journal of Preventive Medicine*, *4*(12), 1395–1401.

Nair, H., Brooks, W. A., Katz, M., Roca, A., Berkley, J. A., Madhi, S. A., Simmerman, J. M., Gordon, A., Sato, M., Howie, S., Krishnan, A., Ope, M., Lindblade, K. A., Carosone-Link, P., Lucero, M., Ochieng, W., Kamimoto, L., Dueger, E., Bhat, N., … Campbell, H. (2011). Global burden of respiratory infections due to seasonal influenza in young children: A systematic review and meta-analysis. *The Lancet*, *378*(9807), 1917–1930. https://doi.org/10.1016/S0140-6736(11)61051-9

Ndirangu, J., Bärnighausen, T., Tanser, F., Tint, K., & Newell, M. L. (2009). Levels of childhood vaccination coverage and the impact of maternal HIV status on child vaccination status in rural KwaZulu-Natal, South Africa. *Tropical Medicine and International Health*, *14*(11), 1383–1393. https://doi.org/10.1111/j.1365-3156.2009.02382.x

Nestory, B., Anasel, M., Nyandwi, J. B., & Asingizwe, D. (2022). Vaccine management practices among healthcare workers in Morogoro, Tanzania: a cross-sectional study. *Journal of Pharmaceutical Policy and Practice*, *15*(1), 1–10. https://doi.org/10.1186/s40545-022-00496-y

Paul A, O. (2020). *Global Immunization:Worldwide Disease Incidence*. https://www.chop.edu/centers-programs/vaccine-education-center/global-immunization/diseases-and-vaccines-world-view

Paunio, M., Peltola, H., Valle, M., Davidkin, I., Virtanen, M., & Heinonen, O. P. (1998). Explosive school-based measles outbreak: intense exposure may have resulted in high risk, even among revaccinees. *American Journal of Epidemiology*, *148*(11), 1103–1110. https://doi.org/10.1093/oxfordjournals.aje.a009588

Pinaka, O., Spanou, I., Papadouli, V., & Papanikolaou, E. (2021). Public Health in Practice The role of local primary healthcare units in increasing immunization uptake among children in

vulnerable social groups through vaccination campaigns. *Public Health in Practice*, *2*(August), 100185. https://doi.org/10.1016/j.puhip.2021.100185

Rémy, V., Zöllner, Y., & Heckmann, U. (2015). *Vaccination: the cornerstone of an efficient healthcare system*. *6689*. https://doi.org/10.3402/jmahp.v3.27041

Sanghavi, M. M. (2007). Assessment of Routine Immunization Program at Primary Health Centre Level in Jamnagar. *NATIONAL JOURNAL OF MEDICAL RESEARCH*, *Oct-Dec 2013*, 323.

Setia, S., Mainzer, H., Washington, M. L., Coil, G., Snyder, R., & Weniger, B. G. (2002). Frequency and causes of vaccine wastage. *Vaccine*, *20*(7), 1148–1156. https://doi.org/https://doi.org/10.1016/S0264-410X(01)00433-9

Shukla, V. V., & Shah, R. C. (2018). Vaccinations in Primary Care. *Indian Journal of Pediatrics*, *85*(12), 1118–1127. https://doi.org/10.1007/s12098-017-2555-2

Sinnei, D. K., Karimi, P. N., Maru, S. M., Karengera, S., & Bizimana, T. (2023). Evaluation of vaccine storage and distribution practices in rural healthcare facilities in Kenya. *Journal of Pharmaceutical Policy and Practice*, *16*(1), 1–7. https://doi.org/10.1186/s40545-023-00535-2

The Citizen. (2022, September). *Tanzania declares measles outbreak*. https://www.thecitizen.co.tz/tanzania/news/national/tanzania-declares-measles-outbreak-3950072

UNICEF. (2021). *Effective Vaccine Management Assessment (EVM) and cIP Report in Tanzania , 2021.*

UNICEF. (2023). *Vaccines are the world's safest method to protect children from life-threatening diseases*. https://www.unicef.org/immunization

Vasudevan, L., Baumgartner, J. N., Moses, S., Ngadaya, E., Mfinanga, S. G., & Ostermann, J. (2020). Parental concerns and uptake of childhood vaccines in rural Tanzania – a mixed methods study. *BMC Public Health*, *20*(1), 1–11. https://doi.org/10.1186/s12889-020-09598-1

WHO. (2020). *The World Health Organization (WHO) Director-General 's opening remarks at the media briefing on COVID-19 pandemic. 11 March*. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

WHO. (2021). *Immunization agenda (IA 2030): A global strategy to leave no one behind*. 1–24. https://www.who.int/immunization/ia2030_Draft_One_English.pdf?ua=1

WHO. (2022a). Global Immunization coverage in 2021. *Fact Sheet*, *14 July*. https://www.who.int/news-room/fact-sheets/detail/immunization-coverage

WHO. (2022b). *Wild poliovirus type 1 (WPV1) - Mozambique*. *1*(8.5.2017), 2003–2005. https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON395

WHO. (2023). *Circulating vaccine- derived poliovirus type 2 in the United Republic of Tanzania*. *2*(July), 2–5. https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON480

WHO Africa. (2022). *Malawi declares polio outbreak*. https://www.afro.who.int/news/malawi-declares-polio-outbreak

World Health Organization (WHO). (2013). *Optimize Immunization systems and technologies for tomorrow: Direct-drive solar vaccine refrigerators — a new choice for vaccine storage*.

Yauba, S., Harmelle, E. E., Marius, V. Z., Jude, N., Delphine, K., Christain, B., Leonard, E., Alain, B., Marianne, M., Robinson, M., & Divine, N. (2019). *Availability and Status of Vaccine Cold Chain Equipment in Cameroon Journal of Vaccines & Vaccination*. *10*(400), 1–7.

Yeung, L. F., Lurie, P., Dayan, G., Eduardo, E., Britz, P. H., Redd, S. B., Papania, M. J., & Seward, J. F. (2005). A limited measles outbreak in a highly vaccinated US boarding school. *Pediatrics*, *116*(6), 1287–1291. https://doi.org/10.1542/peds.2004-2718

Zewdie, A., Letebo, M., & Mekonnen, T. (2016). Reasons for defaulting from childhood immunization

program : a qualitative study from Hadiya zone , Southern Ethiopia. *BMC Public Health*, 1–9. https://doi.org/10.1186/s12889-016-3904-1

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025 https://dx.doi.org/10.4314/thrb.v26i3.25

Voluntary Choice of Lifestyle Modification in Secondary Prevention of NCDs

Soumik Gangopadhyay[1*], *Soma Sur*[2], *Saugat Ghosh*[3], *Somnath Chatterjee*[4]

[1]IEM-Kolkata, India, [2]St. Xavier's University, Kolkata, India, [3]St. Xavier's University, Kolkata, India and [4]Aliah University, Kolkata, India

Abstract:
Background: A cheap and simple intervention strategy that is effective in the fight against non-communicable illnesses is lifestyle change. Furthermore, if the victims are interested in it, it is considerably more effective as primary, secondary, and tertiary prevention than it is as primordial prevention.
Objective: The main goal was to learn how NCD patients and/ attendants seek information about lifestyle modifications, health and healthcare.
Method: This is an opinion-based study where opinions were collected from 500 NCD patients and their attendants or relatives who visited the OPD at 10 specialty tertiary care hospitals in Kolkata, India.
Results: The study showed that specific lifestyle modification-related advice from hospitals is needed to prevent NCDs.
Conclusion: In conclusion, private hospitals are changing their focus from product promotion to health promotion. Both the formation of strategic policy and the generation of commercial value may benefit from this study. This can support the use of health promotion as a hospital's strategic communication tool.
Keywords: NCDs, Lifestyle modification, Information, Secondary prevention, Health seeking behaviour

Introduction

The epidemic of non-communicable or in other words, lifestyle diseases (NCDs), poses a threat to human health and existence in both industrialised and developing nations. The WHO estimates that this public health burden kills over 36 million men and women each year, including close to nine million individuals under the age of 60. Middle- and low-income countries account for 90% of these early fatalities. According to the World Health Organisation (WHO), unhealthy lifestyles have led to a disproportionate increase in the rate of cardiovascular disease, and also in case of diseases like chronic respiratory diseases, diabetes, and cancer, across different age groups and also in areas of middle- and low-income countries. 53 percent of all NCD-related deaths in India occurred prior to COVID-19. In West Bengal, infectious diseases outnumber them due to lifestyle-related illnesses (CBHI, 2019).

The typical characteristics of NCD attacks are silence, lately diagnosed, demands long-term care, and offer zero guarantee treatment outcomes. Furthermore, a skilled workforce must be assembled as part of a comprehensive health system response to the chronic care of many NCDs (Ramli et al., 2022). Hospital-centred tertiary care is currently the main focus of healthcare for these diseases in many low- and middle-income countries that leads to penury (Johansson et al., 2010).

* **Corresponding Author:** Email: soumik.gangopadhyay@iem.edu.in

Finally, the commercial value of the Indian healthcare sector is being fuelled by these disorders, which is driving the inorganic growth of private corporate hospitals. Strong evidence from West Bengal, India links non-communicable diseases and their risk factors to poverty, illiteracy, and other social injustices (Chatterjee & Laha, 2019; Mondal et al., 2014). Additionally, a lack of access to fundamental primary healthcare causes undiagnosed subjective status, which exacerbates difficulties. Only the use of effective intervention strategies can stop the spread of NCDs in low- and middle-income nations. A healthy lifestyle can be adopted with individual responsibility for their health through the process of modification of existing ways of living, which is the best prevention measure for managing NCDs (Budreviciute et al., 2020). Therefore, health care service paradigms should change from providing urgent, acute care to providing ongoing, chronic care.

Survey of Literature

Mitigation of NCDs

The prevalence of NCDs is skyrocketing as a result of recent social and economic changes (Ramaraj& Alpert, 2008). The urban population's accelerated trend of rising mortality and falling morbidity from diseases linked to a sedentary lifestyle has created commercial potential in the health sector (Bhattacharya, 2011). However, treating NCDs is expensive (Bertram et al., 2018). Through population-wide and individualised health-care measures, the worldwide non-communicable disease epidemic can be halted. For the Indian health administration, implementing population-wide surveillance of the main risk factors and tracking disease-specific morbidity and mortality status for NCDs is a massive endeavour. In the end, inadequate political commitment, unsuitable non-health sector involvement, low resource access, vested interests of important constituencies, and limited participation of key stakeholders are the main causes of ineffective interventions (Baron-Epel et al., 2003).

According to the WHO's Global Status Report on NCDs, some resolution-based actions have been recommended, such as "best buys" and "good buys" (Baba et al., 2009), which include limiting access to retail alcohol, enforcing bans on alcohol advertising, lowering the salt and sugar content of packaged foods and beverages (Robertson & Baker, 2017), and swapping trans-fats for unsaturated fat in processed foods (Strychar et al., 2009). Additionally, proactive preventative culture is a more advantageous choice than reactive treatment in the context of managing NCDs to reduce subjective health costs (Miller et al., 2013) and enhance the quality of life for NCD sufferers by maximising QALYs (AbalKahi et al., 2007).

Role of Lifestyle modification

The risk of lifestyle diseases has enhanced by the overuse of alcohol and tobacco products, improper eating habits, obesity and hypercholesterolemia linked to sedentary lifestyles. With a comprehensive and integrated participation programme, such as educational interventions aimed at changing eating habits and lifestyle factors, lifestyle-related risk concerns can be avoided (Haque, 2021). From the public health perspective, there is a growing need to create NCD prevention programmes complying with the distinct dietary habits and cultural practices among Indian population (Sinha et al., 2003). The basic Lifestyle Modification Programme (LMP) has been found to be effective for secondary prevention by reducing the risk of NCDs and trying to minimise risk factors. This action also primarily aids in restructuring healthy habits, such as an emphasis on physical exercise, wholesome nutrition, smoking cessation of smoking, and stress management techniques. LMP are currently mandated in every worldwide protocol for the management of NCDs because they have the potential to prevent more than 70% of cardio-metabolic diseases and approximately half of the cancer-related deaths (Lucini et al., 2020).

Further, the severity of NCDs can be minimised by raising awareness of health issues and diseases through creative educational strategies (Sriratanaviriyakul et al., 2010). The willingness to adopt a healthy lifestyle may be influenced by factors such as credibility among the urban

population, ease of diffusion (Starfield et al., 2005), and successful implementation examples (Kilkkinen et al., 2007). Promoting a few LMPs, such as cognitive behavioural strategies, patient-tailored dietary recommendations and home-based exercise under the supervision of a clinician, can help people to achieve sustainable health (Lucini et al., 2020). People are unaware of the important role that nutritious food and its nutritional content play in ensuring human survival (Krishnaswamy, 2001). In order to lower the risk factors associated with NCDs, people should be made aware of the benefits of physical activity and nutritional adjustment (Naghii et al., 2011; Winter et al., 2011). According to research findings, these strategies are effective at intervening to avoid lifestyle diseases, but the reports of minimal success even with constant application imply their low likelihood of success (Calderon et al., 2011; Glasgow et al., 2003). Moreover, the key to secondary prevention is to encourage lifestyle alteration through subjective behaviour interventions (Piepoli & Villani, 2017). Therefore, to stop the progression of these diseases, people must be educated about healthy lifestyles that prevent NCDs and their risk factors (Abdalla et al., 2022).

Attitude towards Lifestyle modification

The discrepancy in awareness is a factor in the prevalence of NCDs. However, the consciously assessed perceived value of a healthy lifestyle is also a major factor in the subjective acceptance of a healthy lifestyle (Mote, 2016). According to Marques et al. (2020), this rate is higher among those with lower levels of education. In addition, research has shown that lower income groups respond to health promotion programmes less favourably than higher income groups do, and their dropout rates are considerably higher (Dahlgren et al., 2007). Additionally, both subjective and objective biasness results in unequal information on the methods of lifestyle adjustment to avoid NCDs (Gangopadhyay & Chakraborty, 2021).

Health education and information have a strong potential to improve health outcomes and are especially helpful for healthcare services that lack the resources for human resources (Ebina et al., 2010). Additionally, encouraging people to adopt a healthy lifestyle through the use of board games is a beneficial method (Nakao, 2019). However, comprehensive health policy is increasingly stifling efforts to promote healthy lifestyle adoption through health education (Nutbeam, 2019). Lack of time, shady mentality, and perceived workload priorities of clinicians' & health professionals' limit the extent of health promotion (Nolan et al., 2012; Ribera et al., 2005). Additionally, urban residents are thought to be relatively unresponsive to educational information transmission for boosting health or associated issues (Robertson et al., 2007). The most efficient way to raise knowledge of a healthy lifestyle and lower risk factors for NCDs is through social media marketing, individual counselling, workshops, educational materials, etc. (Crouch et al., 2011). But getting every Indian to live a healthy lifestyle will be a huge challenge. Moreover, as opportunity costs cannot be estimated, raising awareness to avoid NCDs (primary, secondary, and tertiary prevention) and to encourage people to adopt healthy lifestyles is merely a social imperative (Bertram et al., 2018).

The most effective methods for influencing people towards a healthy lifestyle are group work, videos, telephonic communication, counselling, workshops, educational materials, etc. (Crouch et al., 2011). It's interesting that patients are willing to follow instructions for knowledge they don't have from a reliable source (Rollnick et al., 1993). Additionally, patient counselling has demonstrated a beneficial effect on reducing the severity of disorders (Atreya et al., 2010). Only positive attitudes towards lifestyle treatments can result from thorough understanding (Kardakis et al., 2013). However, the success of a health care service critically depends on a certain combination of human potential and/or organisational efficiency. The typical barriers to health promotion include a lack of time, knowledge gaps, perceived priorities, and scepticism about the efficacy of lifestyle interventions among clinical and nonclinical populations (Ampt et al., 2009; Calderon et al., 2011; Johansson et al., 2010; Nolan et al., 2012).

Seeking health information

Prevent care is shifting from reactive to proactive care (Clarke, 2010). Modern patients would like to be more engaged with 'value-based health care delivery' support their personalized preventive health need (Vilhelmsson, 2017). Seeking information for being healthy is desirable (Lambert and Loiselle, 2007). Health information-seeking behaviour is multidimensional (Choi and Jeong, 2021). It is perceptual and supported by level of literacy, knowledge and access to information (Ezeh et al., 2017). It serves the purpose of cognitive outcomes, such as increase knowledge, behavioral outcomes, including discussing information obtained with health care professional(Andreassen et al., 2005), physical outcomes, such as increase physical quality of life (Ransom et al., 2005); and/or affective outcomes, including decrease anxiety, fear, distress and empowerment (Gray et al., 2005).In order to find information about illnesses and health, patients are increasingly turning to the internet (Rahmqvist & Bara, 2010). They do depend on physician (Pilarska, 2022). In particular, they are looking for information about clinical facilities, procedures, treatments, staff care, doctors, and disease progression during urgent medical situations (Gangopadhyay & Ghosh, 2011; Bamfo et al., 2017).

Indian patients require information about NCDs to help them fight lifestyle-related disorders (Gangopadhyay & Ukil, 2017). It is a monumental effort to promote healthy lifestyle adoption in a country with a high population density like India. Additionally, choosing to live a healthy lifestyle is a personal choice. As decisions about healthy consumption are a function of information obtained from clinical establishments like hospitals in addition to or supplemented by their own preferences, the decision to value health is a summative outcome of normative and felt needs. Tertiary care hospitals manage increasing disorders related to lifestyle (Hooda, 2017).

If victims are interested and/or it satisfies the goal of the clinical establishment's commercial value development, hospitals that provide tertiary care for NCDs must play their full part in raising awareness. The patient's willingness or unwillingness to accept the information relating to lifestyle change will also play a role in the success of lifestyle intervention through awareness generation, and this will be the deciding factor in selecting the theme of "lifestyle modification awareness generation" as a strategic marketing technique of a private major speciality hospital.

Objective of the Study

The broader objectives of the study were to find the perceived type of information seeking for NCD prevention from hospitals, to retrieve the patient's voluntary choice of lifestyle modification-related information to prevent or mitigate NCDs and to identify the scope of providing lifestyle modification-related information by tertiary care hospitals from the perspective of marketing strategy.

Hypothesis:

H_{01}: Life-style related disease awareness generation by the hospitals may act as a tool to influences the perception of NCDs irrespective of people's affordability.

H_{02}: Lifestyle modification related Information is more preferred than health information, diseases information, and facility related information by the hospital patients and/ their relatives.

The Theoretical Construct

The present research aims to unravel the hidden intention of the respondents about gathering information about NCDs. With the support of the existing research works, the research proposes that the decision to receive information regarding NCDs depend upon Perceptions of NCDs,

Significance of lifestyle changes in preventing NCDs and Perceived role of Hospital in providing information about health and healthcare. Thus, from the theoretical construct, the following hypothetical model has been developed:

$$Infrm = f(w, x, y)$$

Where Infrm = decision to receive information regarding NCDs, W = Perceptions of NCDs, X = Significance of lifestyle changes in preventing NCDs and Y = Perceived role of Hospital in providing information about health and healthcare.

Research Methodology

Framing Questionnaire:

The first stage of the study involved creating the multi-item assessment scales and evaluating their validity and reliability. It is necessary to establish and quantify the relationship between several constructs about the preference for information about changing one's lifestyle. These constructs, which include respondents' perceptions of NCDs (w), the significance of lifestyle changes in preventing NCDs (x), and the hospital's perceived role in providing information about lifestyle changes (y), must all be measured before the relationship between them can be established. Several scales have been designed to quantify these constructs. Five constructs have been identified from the literature to measure the significance of lifestyle changes in preventing NCDs (x) while perceived role of hospitals in providing information about health and healthcare (y) is measured by four constructs. Perceptions of NCDs (w) were measured by five constructs, which are also collected from the existing research works. The list of the constructs and their sources are as follows:

Table1: List of Scale Items

Construct	Scale Items	Theoretical Framework
Perceptions of NCDs (w)	NCD creates critical health consequences (Criticl)	Health Belief Model (Dennison et al., 2019; Jaspers et al., 2015; George et al., 2011; Rai et al., 2020)
	NCD create life threatening situations (Mortlty)	
	NCD is a stigma (Stgm)	
	NCD leads to penury (Pnry)	
	NCD arrives silently (Var e)	
Significance of lifestyle changes in preventing NCDs (x)	Lifestyle modification helps to avoid onset of NCD (Onset)	Social cognitive theory & Theory of planned behaviour(Budreviciute et al., 2020; Nordgren et al., 2022)
	Lifestyle modification helps to avoid progress of NCD (Prgrss)	
	Lifestyle modification helps to avoid intensity of NCD (Intsty)	
	Lifestyle modification is the only option to avoid intensity of NCD (Optn)	
	Lifestyle modification helps to mitigate NCD (Mtgt)	
Perceived role of Hospital in providing information	Hospital is a repository of Lifestyle modification related information (LMI)	Timmers et al., 2010; Paige et al., 2021

about health and healthcare (y)	As a traditional practice modern Hospital should provide care and facility-related information (FRI)	
	Hospital must promote their service by list of availability doctors (DRI)	
	Providing health-related information to prevent NCDs is the responsibility of a hospital (HRI)	

The above-mentioned sources have been used to frame the questionnaire. Keeping the research objectives in mind, each question has been developed aiming to capture the insight of the respondent's perception about the NCD prevention and life-style modification. Questions were framed in a clear and concise manner avoiding the technical jargons for the ease of understanding of the respondents. The reliability and validity of the questionnaire were evaluated for the purpose of testing the scale.

Except for the demographics and illnesses or clinical reactions, all the questions on the multi-item scales to determine w, x, and y were rated on a five-point scale where 1 = "strongly disagree" and 5 = "strongly agree." The respondents were invited to express their opinions on the decision to receive information regarding NCDs using "yes" or "no" options, which were regarded as dependent variables (Infrm). Several measures have also been employed to limit the response bias. To prevent the order-effect, the questions were randomized.

Besides that, neutral options for every question were given for each question to receive an honest and unbiased response. The survey was administered anonymously to reduce the fear of judgement among the respondents and receive more candid response.

Sampling Scheme

Selection of samples is very crucial for this particular study as the data are required to be collected from the respondents who have faced or have knowledge about the research topics. Thus, non-probability purposive sampling was used for this research. Initially a pilot survey was planned to be conducted on 50 respondents to test the internal consistency of the scale items.

Respondents for the pilot survey were planned to be selected from the same hospitals in Kolkata where the final survey was planned to be conducted. In the final phase, data was planned to be collected from 500 respondents of ten tertiary care hospitals in Kolkata who are undergoing treatment for major NCD cases. Since the ratio of "total number of outpatients with NCDs per month in a particular hospital/total number of outpatients per month in the respective hospital" was multiplied by 500, the rationality of a proportionate sample size from each hospital (due to disparity in inpatient footfall among hospitals) is justified. Geographically, the entire study is conducted in Kolkata, India, which is one of the limitations of this study.

Analysis Technique:

Several statistical tools were employed in the study to derive a meaningful insight from which a valid conclusion could be attained. The measurement of the internal consistency of the scale items was done on the basis of the values of Cronbach's alpha. Once the scale items were found to have significant values for their reliability, the next stage of the survey proceeded. The key characteristics of the samples were tested through descriptive statistics.

Identification of the scale items under the respective domains were also required to be tested. A Principal Component Analysis was administered with a Varimax orthogonal rotation, to

identify the presence of the scale items under their respective factors. The values of KMO and Bartlett's test of sphericity was checked to confirm the sample adequacy and the legitimacy of running the PCA. The 'Total Variance Explained' table was checked for identification of the amount of variance explained and the 'Rotated Component Matrix' table was checked to identify the items under the components.

Inferential statistical tools like ANOVA and Logistic Regression were administered to explore the interrelationship among variables and also for testing the research hypothesis. ANOVA was used to test the influence of affordability on the perception of respondents about the awareness on NCD communicated by the tertiary care hospitals.

The impact of the independent variables, such as lifestyle awareness and modification-related information, hospital facility-related information, doctor-related information, and health-related information to prevent NCDs were tested on the dependent variable, which is related to the decision of the respondents to receive information about life-style modification. Logistic regression was administered as a statistical tool for this purpose. The findings of the regression analysis were used to test the validity of the proposed theoretical construct.

Findings and Interpretation:

Demographic description of the respondents

As discussed earlier, data were collected from 500 respondents of ten tertiary care hospitals in Kolkata treating major NCD cases. Patients who have at least five years history of suffering from non-communicable disease (Cardio vascular diseases, diabetes, hypertension, chronic obstructive pulmonary diseases, orthopaedic) have been considered as respondents. Geriatric males were found to have more hypertensive, diabetic and orthopaedic problems. On the other, females were observed to be suffering from chronic obstructive pulmonary diseases. The demographic profiles of the respondents are as follows:

Table 2: Demographic description of variables

Gender (%)	Age (Yrs) %	Income per month (INR) %	Education %	Profession %
Male (78%)	<20 (3%)	5000-10000 (2%)	High School (12th -Standard) (1%)	Business (8%)
Female (22%)	21-30 (12%)	10001-20000 (18%)	Graduate (75%)	Student (4%)
	31-40 (19%)	20001-30000 (22%)	Post Graduate (24%)	Service (78%)
	41-50 (26%)	30001-40000 (23%)		
	51-60 (35%)	40000+ (35%)		Retired (10%)
	60+ (5%)			

Findings related to the internal consistency of the scale items:

As discussed earlier, the internal consistency of the scale items was analysed with the help of the values of the Chronbach's alpha. The alpha values of w, x and y are respectively 0.7195, 0.802, and 0.701. As all the values of Chronbach's alpha are higher than 0.70, the internal consistency of the scale items could be confirmed.

Findings of PCA

As discussed earlier, the identification of the scale items under their designated factors is an important aspect of the research and PCA with Varimax rotation was administered for this purpose. The findings show that the value of the KMO test is 0.59, which is higher than 0.5. This indicates that the analysis does not have the problem of sample adequacy. The p-value of Bartlett's Test of Sphericity is 0.000 < 0.05, which indicates that the correlation matrix is not an identity matrix, and the null hypothesis of the test is rejected. The findings of the 'Total Variance Explained Table' show that three items have eigenvalues > 1, which indicates that there are three factors. These three factors cumulatively explain 63.928% of the total variance. The 'Rotated Component Matrix' table shows the factor loadings of different variables under the designated factors. The findings are as follows:

Table 3: Rotated Component Matrix Table

Scale Items	Factor Loading		
	Factor 1	**Factor 2**	**Factor 3**
NCD creates critical health consequences (CriticI)	0.631		
NCD create life threatening situations (MortIty)	0.682		
NCD is a stigma (Stgm)	0.749		
NCD leads to penury (Pnry)	0.646		
NCD arrives silently (Var e)	0.704		
Lifestyle modification helps to avoid onset of NCD (Onset)		0.712	
Lifestyle modification helps to avoid progress of NCD (Prgrss)		0.658	
Lifestyle modification helps to avoid intensity of NCD (Intsty)		0.691	
Lifestyle modification is the only option to avoid intensity of NCD (Optn)		0.724	
Lifestyle modification helps to mitigate NCD (Mtgt)		0.645	
Hospital is a repository of Lifestyle modification related information (LMI)			0.702
As a traditional practice modern Hospital should provide care and facility related information (FRI)			0.664
Hospital must promote their service by list of availability doctors (DRI)			0.613
Providing health-related information to prevent NCDs is the responsibility of a hospital (HRI)			0.628

The findings of the 'Rotated Component Matrix' show that all the factor loadings are > 0.5 and thus, they are significant under the estimated factor. As discussed earlier, the aim of administering the PCA was to find out the legitimacy of the scale items under their specific domain. The findings of the 'Rotated Component Matrix' table confirms that the choses scale items represent the identified domains.

Findings the interrelationship between different Income Group and Desire for Information about Lifestyle Change

One of the hypothesis the research work aimed to test was whether life-style related disease awareness generation by the hospitals can act as a tool to influences the perception of NCDs irrespective of people's affordability, and to test this hypothesis, ANOVA was administered. The findings of the test are as follows:

Table 4: ANOVA table

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	8.642	4	2.160	2.981	.019
Within Groups	358.750	495	.725		
Total	367.392	499			

The findings show that the gap between the mean preferences expressed by one income level and the other income levels is not that different. The results show no evidence of a favourable difference in preferences for information linked to lifestyle awareness among the various economic categories. The ANOVA's significance value of 0.019 shows that, regardless of people's ability to pay, the hospitals' efforts to raise awareness of lifestyle-related diseases have an impact on how people perceive NCDs. In reality, respondents have expressed a strong desire to learn diverse information from hospitals irrespective of their income. They have overwhelmingly demonstrated the want and desire for information on lifestyle change, together with information on healthcare, facilities, treatments, etc. 34% respondents were found to be suffering from more than one NCD out of which at least one among this is either hypertension or diabetes.

The majority of respondents expressed curiosity about this material, indicating that they felt threatened by the potential outcomes of NCDs. People with the lowest and highest levels of income were both found to be equally interested in information related to lifestyle change. Thus, it could be inferred that H_1, which claimed that income has no impact on the desire to acquire information about the information related to lifestyle change to prevent NCD, has been substantiated through the findings of ANOVA.

Findings related to the interrelationship between

To reveal the preferred type of information requirement, the direct connection between "Infrm" and other independent variables, such as LMI (lifestyle awareness and modification-related information), FRI (hospital facility-related information), DRI (doctor-related information), and HRI (health-related information to prevent NCDs), the logit approach was used as a tool to estimate the model. As the dependent variable is categorical and binary, logistic regression was administered. FRI has been eliminated after applying multi-collinearity among the independent variables. The rationale is that patients have separated the need for facility-related information from the need for other types of information because they view this as an emergency demand.

Table 5: Logistic Regression

Infm	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
NCDI	1.48310	.2578319	5.75	0.000	.9777657	1.988448
HRI	1.96293	.2314233	8.48	0.000	1.509349	2.416512
DRI	1.18990	.1836307	6.48	0.000	.8299929	1.549812
LMI	3.03989	.3567858	8.52	0.000	2.340605	3.73918
_cons	-26.3562	2.610728	-10.10	0.000	-31.47316	-21.2393

The pseudo-R-squared for the logit analysis is 0.6385, which indicates that 63.85% of the respondents endorse the finding, demonstrating its applicability and rationale. The p-value is less than 0.05 for all of the components, including NCDI, HRI, DRI, FRI, and LMI (95% degree of confidence, chi2 = 417.92), indicating that all of the independent variables are statistically significant in explaining the dependent variable, i.e., "Infrm." The resulting models are,

Infrm = - 26.35 + 3.03 *LMI + 1.48 *NCDI + 1.96 *HRI + 1.18 *DRI

The results show that, in the respondents' opinions, information from the hospital relating to lifestyle change is the most preferred type of information. Additionally, knowledge about a healthy lifestyle is being considered as a method of reducing non-communicable diseases. The outcome

also shows that NCDI, HRI, and DRI are the second, third, and fourth orders of preference anticipated from the hospital through the respective values of the coefficients of the dependent variables. For the prevention of lifestyle-related diseases, patients prefer information about lifestyle adjustment over information about disorders.

Conclusion

The people under study were not seen to be either recalcitrant or complacent but rather compelled to look for the needed knowledge. The victims of NCDs in West Bengal have an intense desire to stop the progression and severity of lifestyle-related diseases. Because NCDs might have fatal consequences, the patient under study believes that awareness of them is necessary. When there is an emergency, information about facilities or doctors takes precedence, whereas information about lifestyle changes is crucial for avoiding and controlling NCDs. As a result, they prefer to prevent NCDs rather than treat them. Therefore, it supports the acceptability of lifestyle modification for NCD secondary prevention. Therefore, a private hospital can incorporate information about lifestyle changes or the effects of an untreated NCD as part of its communication strategy.

This study showed that the focus of a private super-specialty hospital's marketing promotions is changing from being on healthcare to being on health promotion. Therefore, hospitals can offer information on lifestyle changes that can help prevent and/or alleviate NCDs. The higher rate of positive chance of escaping the damaging effects of NCDs by adopting lifestyle modification should be highlighted in the hospital's promotional materials. However, the effectiveness of any promotional plan depends on the message's personalised design, which also takes the target segment's demographics and behavioural factors into account. This method can also help a super-specialty hospital achieve its social and commercial goals.

Validation of Policy Recommendations:

While the present study provides valuable insights into the potential effectiveness of lifestyle modification interventions for NCD prevention, the importance of validating policy recommendations is also acknowledged, and the same is planned to be executed through consultation with healthcare professionals and stakeholders. It has also been planned to engage in discussions with doctors, hospital administrators, and public health experts to solicit their feedback on our study findings and policy recommendations.

This collaborative approach will help ensure the practicality, feasibility, and effectiveness of proposed interventions in real-world healthcare settings. Furthermore, there has been a need for ongoing dialogue and partnership between researchers and healthcare practitioners to address any implementation challenges to optimize the impact of policy interventions on population health outcomes. By actively involving stakeholders in the validation process, the relevance and applicability of this research findings could be enhanced, and it will help to contribute to evidence-based policymaking in the field of NCD prevention and management.

Reference

AbalKahi, B.A., Tawfik, M., Hussain, G., and Albar, M.S. (2007). Cardiovascular Disease health risk appraisal, *Annuals of Internal Medcine*, 29(2), 5.

Abdalla, M.S., Mohamed, Y.E, Elsabagh, M.H. (2022). Stroke perception and risk factors knowledge within Saudi population, *Ethics, Medicine and Public Health*, 20, 100736.

Ampt, A.J., Amoroso, C., Harris, M.F. (2009). 'Attitudes, norms and controls influencing lifestyle risk factor management in general practice, *BMC FamPract*, 10, 59.

Andreassen, S., Randers, I., Naslund, E., Stockeld, D., &Mattiasson,A.-C. (2005). Family members' experiences, information needsand information seeking in relations to living with a patient withoesophageal cancer. European Journal of Cancer Care, 14(5),426-434.

Atreya, A., Kamath, A., Varma, M., Nair, S. (2010). Behavioural risk factors and health promotional activities in adults at risk of cardiovascular disease in a south Indian tertiary care hospital, *International Journal of Collaborative Research on Internal Medicine & Public Health,* 2(8), 280-290.

Baba, S., Ozawa, H., Sakai, Y., Terao, A., Konishi, M., Tatara, K. (2009). Heart disease deaths in a Japanese urban area evaluated by clinical and police records. *Journal of Association of Physicians India*, 57, 568-573.

Bamfo, B.A. and Dogbe, C.S.K. (2017). Factors influencing the choice of private and public hospitals: empirical evidence from Ghana", *International Journal of Pharmaceutical and Healthcare Marketing*, 11(1), 80-96.

Baron-Epel, O., Drach-Zahavy, A., Peleg, H. (2003). Health promotion partnerships in Israel: motives, enhancing and inhibiting factors, and modes of structure.*Health Promotion International*, 18(1), 15–23.

Bertram, Y.M., Sweeny, K., Lauer, A.J., Chisholm, D., Sheehan, P., Rasmussen, B., Upreti, R.S., Dixit, P.L., George, K., Deane, S. (2018). Investing in non-communicable diseases: an estimation of the return on investment for prevention and treatment services. *The Lancet Taskforce on NCDs and economics*, 5, 8.

Bhattacharya, S. (2011). Major Risk of Morbidity in Indian Urban Women: Causes, Prevention and Protection. *The IUP Journal of Risk and Insurance*, VIII(4), 75-79.

Budreviciute, A., Damiati, S., Sabir, D.K., Onder, K., Goetzburg, P.S., Plakys, G., Katileviciute, A., Khoja, S., Kodzius, R. (2020). Management and Prevention Strategies for Non-communicable Diseases (NCDs) and Their Risk Factors, *Front Public Health*; 8:574111.

Calderon, C., Balague, L., Cortada, J.M., Sanchez, A. (2011). Health promotion in primary care: how should we intervene? A qualitative study involving both physicians and patients, *BMC Health Service Research*, 11, 62-70.

CBHI (2019), ''National Health Profile 2019'', No. 16. http://www.cbhidghs.nic.in/showfile.php?lid=1147.

Chatterjee, S., Laha, A. (2019). Decision on Institutional Choice in the Healthcare Sector: Micro-empirical Evidences from West Bengal (India), *Journal of Health Management*, 21(1), 177-191.

Choi H, Jeong G. (2021). Characteristics of the Measurement Tools for Assessing Health Information–Seeking Behaviors in Nationally Representative Surveys: Systematic Review J Med Internet Res, 23(7), e27539.

Clarke L.J. (2010). Preventive Medicine: A Ready Solution for a Health Care System in Crisis. Population Health Management. 13(Oct), S-3-S-11. http://doi.org/10.1089/pop.2010.1382

Coulston, A.M. (2008). Cardiovascular disease risk in women with diabetes needs attention, *American Journal of Lifestyle medicine*, 2(3), 191- 213.

Crouch, R., Wilson, A., Newbury, J. (2011). A systematic review of the effectiveness of primary health education or intervention programs in improving rural women's knowledge of heart disease risk factors and changing lifestyle behaviours. *International Journal of Evidence Based Healthcare*, 9(3), 236-45.

Dahlgren, G. and Whitehead, M. (2007). European strategies for tackling social inequities in health: levelling up part 2.Copenhagen, WHO Regional Office for Europe, http://www.euro.who.int/__data/assets/pdf_file/0018/103824/E89384.pdf.

Ebina, R., Kawasaki, F., Taniguchi, I., Togari, T., Yamazaki, Y., Sparks, M. (2010). The effectiveness of health communication strategies in health education in Kushima, Japan. *Global Health Promotion*. 17(1), 05-15. doi:10.1177/1757975909356628.

Ezeh, C. and Ezeh, O. (2017) Perception and Information Seeking Behaviour of Rural Households towards Health Promoting Practices in Maigana District of Kaduna State, Nigeria. Open Journal of Medical Psychology, 6, 233-242. doi: 10.4236/ojmp.2017.64019.

Gangopadhyay, S., Ghosh, B. (2011). Factors Effecting Patient Satisfaction In Private Sector Hospitals: A Case Study Of West Bengal, *Indian Journal of Commerce and Management Studies*, 2(6), 102-106.

Gangopadhyay, S., Chakraborty, S. (2021). A Model of Strategic Communication for Clinical Premises Based on Perceived Risk of NCDs: A Study of Kolkata, India, *International Journal of Business Innovation and Research*, 25(3), 353-364.

Gangopadhyay, S. and Ukil, A. (2017). *Sustainable Health Development Model Based on Patient's Perception: A Study of Kolkata*, in Contemporary Economic Issues in India. edited by P.K. Chaubey K. P., Beg A.M. 48-52.

Glasgow, R.E., Lichtenstein, E., Marcus, A.C. (2003). Why don't we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. *American Journal of Public Health*,93, 1261–1267.

George Alleyne, Basu S, David Stuckler. Who's Afraid of Noncommunicable Diseases? Raising Awareness of the Effects of Noncommunicable Diseases on Global Health.*Journal of Health Communication*.2011;16(sup 2):82-93.

Gray, N. J., Klein, J. D., Noyce, P. R., Sesselberg, T. S., &Cantrill, J. A. (2005). Health information-seeking behaviour in adolescence: The place of the Internet. Social Sciences &Medicine, 60, 1467-1478.

Gupta, I., Kandemuthan, S., Devmani. (2006). Economic Impact of Cardiovascular Disease in India, *Upadhgaya Institute of Economic growth*, 63-66.

Haque, M. (2021). Lifestyle Changes in the Management of Non-Communicable Diseases in Low and Middleincome Countries, *International Journal of Human and Health Sciences*; 05(01), 04-06.

Hooda, K.S. (2017). Out-of-pocket Payments for Healthcare in India: Who Have Affected the Most and Why ?, *Journal of Health Management*. 19(1), 1-15.

Jaspers L, Colpani V, Chaker L. et al. (2015). The global impact of non-communicable diseases on households and impoverishment: a systematic review. Eur J Epidemiol,30: 163–188.

Johansson, H., Stenlund, H., Lundstro¨m, L., Weinehall, L. (2010). Reorientation to more health promotion in health services—a study of barriers and possibilities from the perspective of health professionals, *Journal of Multidisciplinary Healthcare*, 3(0), 213–24.

Kardakis, T., Weinehall, L., Jerden, L., Nystrom, E.M., Johansson, H. (2013). Lifestyle interventions in primary health care: professional and organizational challenges, *The European Journal of Public Health*, 23(4), 1-6.

Kilkkinen, A., Heistaro, S., Laatikainen, T. (2007). Prevention of type 2 diabetes in a primary health care setting: interim results from the Greater Green Triangle (GGT) Diabetes Prevention Project, *Diabetes Research Clinical Practice*, 76, 460–462.

Krishnaswamy, K. (2001). Perspectives on nutrition needs for the new millennium for South Asian regions, *Biomedical Environmental Science*, 14(1-2), 66-74.

Lambert, S. D.; Loiselle, C. G. (2007). Health Information Seeking Behavior. Qualitative Health Research, 17(8), 1006–1019. doi:10.1177/1049732307305199.

Lucini, D., Malacarne, M., Gatzemeier, W., Pagani, M. (2020). A Simple Home-Based Lifestyle Intervention Program to Improve Cardiac Autonomic Regulation in Patients. *Sustainabilit*, 12, 7671.

Marques, A., Bordado, J., Tesler, R., Demetriou, Y., Sturm, D.J., & de Matos, M. G. (2020). A composite measure of healthy lifestyle: A study from 38 countries and regions from Europe and North America, from the Health Behavior in School Aged Children survey. *American Journal of Human Biology*, 32(6), e23419.

Miller, G., Daly, M., Roehrig, C. (2013). Tradeoffs in Cardiovascular disease prevention, treatment and research, *Healthcare Management Science*, 16(2), 87-100.

Mondal, S., Lucas, H., Peters, D., Kanjilal, B. (2014). Catastrophic out-of-pocket payment for healthcare and implications for household coping strategies: evidence from West Bengal, India, *Economics Bulletin*, Access Econ, 34(2), 1303-1316.

Mote, B. N. (2016). A regional epidemiology of India's "NCD's risk factors" focusing particularly on Maharashtra: A call for "Health promotion" once again, *Int J Med Public Health*, 6(1), 26-30.

Naghii, M.R., Almadadi, M., Zarchi, A.A. (2011). Regular physical activity as a basic component of lifestyle modification reduces major cardiovascular risk factors among male armored force personnel of Shabestar army installation in Iran, *Work*, 40(2), 217-227.

Nakao, M. (2019). Special series on "effects of board games on health education and promotion" board games as a promising tool for health promotion: a review of recent literature. *BioPsychoSocial Medicine*, 13(1).
https://link.gale.com/apps/doc/A581368614/AONE?u=anon~cf0237e8&sid=googleScholar&xid=7d914c2c.

Nolan, C., Deehan, A., Wylie, A. and Jones, R. (2012). Practice nurses and obesity: professional and practice-based factors affecting role adequacy and role legitimacy. *Primary Health Care Research and Development*, 13(4), 353–363.

Neutel, C.I., Camphel, N.R.C. (2008). Changes in lifestyle after hypertension diagnosis in China, *Canadian Journal of cardiology*, 24(3), 199-204.

Nolan, C., Deehan, A., Wylie, A., Jones, R. (2012). Practice nurses and obesity: professional and practice-based factors affecting role adequacy and role legitimacy. *Prim Health Care Res Dev*. 13, 353–63.

Nutbeam, D. (2019). Health education and health promotion revisited. *Health Education Journal*, 78(6), 705–709.

Paige R.S., Flood-Grady E., Krieger L.J., Stellefson M., Miller D. (2021). Measuring health information seeking challenges in chronicdisease: A psychometric analysis of a brief scale, Chronic Illn. 17(2), 151–156. doi:10.1177/1742395319836476.

Piepoli, M.F., Villani, G. Q. (2017). Lifestyle modification in secondary prevention. *European Journal of Preventive Cardiology*.24, 101-107.

Pilarska A., Zimmermann A., Ryzewska Z.A. (2022). Access to Health Information in the Polish Healthcare System-Survey Research, Int. J. Environ. Res. Public Health, 19(12), 7320.

Rahmqvist, M., & Bara, A.C. (2007). Patients retrieving additional information via the Internet: a trend analysis in a Swedish population, 2000–05. *Scand Journal of Public Health*, 35, 533–539.

Rahmqvist, M., Bara, C. A. (2010). Patient characteristics and quality dimensions related to patient satisfaction. *International Journal for Quality in Health Care*, 22(2). 86–92.

Rai SS, Syurina EV, Peters RMH, Putri AI, Zweekhorst MBM. (2020). Non-Communicable Diseases-Related Stigma: A Mixed-Methods Systematic Review. International Journal of Environmental Research and Public Health. 17(18), 6657. https://doi.org/10.3390/ijerph17186657.

Ramaraj, R., Alpert, J.S. (2008). Indian poverty and cardiovascular disease. *American Journal of Cardiology*, 102(1), 102-106.

Ramli, Nik, N.N., Malik, Abdul, A.M., Fazly, A.A.S, Arasu, R., Rusli, A.N. (2022), Preventing the first stroke attack via mobile application technology, *Ethics, Medicine and Public Health*, 23, 100780.

Ransom, S., Jacobsen, P.B., Schmidt, J. E., &Andrykowski, M. A. (2005). Relationship of problem-focused coping strategies tochanges in quality of life following treatment for early stagebreast cancer. Journal of Pain and Symptom Management,30(3), 243-253.

Ribera, A.P., McKenna, J., Riddoch, C. (2005). Attitudes and practices of physicians and nurses regarding physical activity promotion in the Catalan primary health-care system. *European Journal of Public Health*, 15, 569–75.

Robertson, S. and Baker, P. (2017). Men and health promotion in the United Kingdom: 20 years further forward? Health Education Journal, 76(1), 102-113.

Rollnick, S., Kinnersely P., Stott, N. (1993). Methods of helping patients with behavior change." *BMJ*, 307, 188-90.

Saved off, W. D. (2007). What should a country spent on health care? *Health Affairs*, 26(4), 962–970.

Schroder, H., Masabeu, A., Martin, J., Cols, M. (2008). Myocardial infarction and alcohol consumption : a population based control study, *Nutrition Abstracts and Reviews*, 77(12), 34-38.

Sinha, R., Anderson, D.E., McDonald, S.S., Greenwald, P. (2003). Cancer risk and diet in India, *Journal of Postgraduate Medicine*, 49(3), 222-228.

Sriratanaviriyakul, N., Kangkagate, C., Krittayaphong, R. (2010). Prevalence and association of ECG findings and cardiovascular risk factor in Shinawatra employees, *Journal of Medical Association of Thailand*, 89(1), 109-115.

Starfield, B., Shi, L., Macinko, J. (2005). Contribution of primary care to health systems and health, *Milbank Q,* 83, 457–502.

Strychar, I., Cohn, J.S., Reniner, G., Rivard, M., Aris-Jilwan, N., Beauregard, H., Meltzer, S., Belanger, A., Dumas, R., Ishac, A., Radwan, F. and Yale, J.F. (2009). Effects of a diet higher in carbohydrate / lower in fat versus lower in carbohydrate /higher in monounsaturated fat on triglyceride concentrations and other cardiovascular risk factors in type I diabetes, *The American Diabetes Association Research Center*, 1597-1599.

Timmers, Caroline F.; Glas, Cees A.W. (2010). Developing scales for information-seeking behaviour. Journal of Documentation, 66(1), 46–69.

Vilhelmsson A. (2017). Value-Based Health Care Delivery, Preventive Medicine and the Medicalization of Public Health. Cureus 9(3), e1063.

Winter, A.C., Hoffmann, W., Meisinger, C., Evers, S., Vennemann, M., Pfaffenrath, V., Fendrich, K., Baumeister, S.E., Kurth, T., Berger, K. (2011). Association between lifestyle factors and headache, *Journal of Headache Pain*, 12(2), 147-155.

WHO (2021). *Noncommunicable diseases*.
https://www.who.int/news-room/factsheets/detail/noncommunicable-diseases.

Prevention and control of noncommunicable diseases. *Report of secretary general, UN general assembly 66th Session.* (A/66/83) 19th May, 2011.

Annual report of health to people of India 2011. https://www.gov.uk/government/uploads/.../23735_HC-66-DoH.pdf.

Tanzania Journal of Health Research
Volume 25: Issue 3, April 2025
https://dx.doi.org/10.4314/thrb.v26i3.26

Knowledge, Attitudes, Perceptions and Health-Seeking Practices Towards Rabies and Dog-Bite Injuries among Residents in Ibadan, South-Western Nigeria

[1]*Blessing Seun, Agbajelola (B. Ed, MPH)*, [2]*Victor Ibukun, Agbajelola (DVM, MVSc.)*[*], [3]*Mojisola Morenike, Oluwasanu (B.Sc., MPH, M.Sc., PhD)*

[1]Department of Health Promotion and Education, Faculty of Public Health, College of Medicine, University of Ibadan, Nigeria. [2]Department of Veterinary Parasitology, Faculty of Veterinary Medicine, University of Ibadan, Nigeria. [3]Department of Health Promotion and Education, Faculty of Public Health, College of Medicine, University of Ibadan, Nigeria.

Abstract

Background: Rabies is a fatal viral infection causing encephalomyelitis in carnivores and other vertebrates, including humans, primarily transmitted through bites or scratches from infected animals. Understanding knowledge and health-seeking behaviors related to rabies is critical for designing effective public health interventions. This study evaluated knowledge, attitudes, perceptions, and health-seeking practices regarding dog-bite injuries and rabies infection.

Methods: A community-based, cross-sectional study was conducted among 418 adults, selected using a multi-stage sampling technique. Data were collected via a pre-tested, interviewer-administered questionnaire and analyzed with descriptive and inferential statistics at a 5% significance level.

Results: The mean age of respondents was 35.6±12.7 years, with 35.4% aged 21–30 years. Nearly half of the respondents (45.2%) demonstrated poor knowledge of rabies and dog-bite injuries, while 60% showed a positive attitude toward prevention and management. A moderate negative correlation was found between knowledge and perceived susceptibility ($r = -0.314$, $p < 0.001$) and perceived severity ($r = -0.638$, $p < 0.001$).

Conclusion: The study identified low perceived susceptibility and severity of rabies, highlighting the need for One Health interventions and targeted advocacy campaigns to improve awareness and preventive practices.

Keywords: rabies, dog bites, knowledge, attitudes, perceptions, health-seeking behavior.

Introduction

Rabies, a viral infection caused by the Lyssavirus genus of the family *Rhabdoviridae*, is an acute disease affecting the central nervous system (CNS) of carnivores and other mammals, including humans, often leading to fatal encephalomyelitis if untreated (Singhai *et al.,* 2022; Thombare & Malviya, 2022). Globally recognized as a Neglected Tropical Disease (NTD), rabies remains endemic in many regions, transmitted predominantly through the saliva of infected animals via bites or scratches (Kapoor *et al.,* 2019; Thombare & Malviya, 2022). The disease imposes a significant economic and public health burden worldwide, yet effective prevention through post-exposure prophylaxis (PEP) is widely underutilized in low-resource settings, where awareness and access to treatment are limited (WHO, 2023; Meslin & Briggs, 2013).

[*] **Corresponding Author:** Email address: agbajelolavictor@gmail.com

Rabies is a leading cause of mortality, with Africa and Asia accounting for over 95% of global rabies deaths, many of which occur in rural or underserved areas where health services are scarce (Adesina *et al.,* 2020; WHO, 2023). In Nigeria, rabies was first recorded in 1912, with subsequent studies revealing the disease's endemic nature and its persistent transmission to humans, primarily through bites from rabid dogs (Al-Mustapha *et al.,* 2021, 2022; Mshelbwala *et al.,* 2021; Adedeji *et al.,* 2020; Onyemocho *et al.,* 2020; Audu *et al.,* 2019). Despite the known routes of transmission and available PEP measures, knowledge gaps, and cultural beliefs surrounding rabies in Nigeria continue to hinder effective prevention and control efforts.

Previous studies in Nigeria and other developing countries have highlighted widespread misunderstandings about rabies transmission, treatment, and prevention. For instance, Charulatha *et al.* (2021) and Mshelbwala *et al.* (2021) have identified low rabies awareness levels in rural communities, which significantly impact morbidity and mortality. Similarly, Jakeman *et al.* (2020) and Kisaka *et al.* (2020) described how cultural myths and traditional healing practices often undermine scientific approaches to dog bite management in both Asia and Africa. This trend underscores the challenge of rabies control in regions where medical resources are limited, and reliance on traditional beliefs remains strong.

Dog bites are common in many developing communities, often involving unvaccinated or stray dogs, contributing to the high rabies exposure risk (WHO, 2023). Compliance with vaccination protocols for dogs remains limited, and the unregulated presence of stray dogs in urban and peri-urban areas exacerbates the problem (Mshelbwala *et al.,* 2021). Studies from other regions, including Southeast Asia, have reported that poor health-seeking behavior following dog bites is linked to a lack of awareness of rabies risk and reluctance to access healthcare due to costs or logistical barriers (Kapoor *et al.,* 2019; Ahmad *et al.,* 2018; Jakeman *et al.,* 2020; Kisaka *et al.,* 2020).
This is consistent with findings in Nigeria, where limited knowledge and cultural misconceptions about rabies contribute to delays in seeking medical intervention and increase the mortality burden associated with the disease.

Examining health-seeking behaviors and safety practices following dog bites or potential rabies exposure is essential to improve prevention strategies and reduce the rabies burden. Our study aims to fill gaps in the literature by assessing the current knowledge, attitudes, perceptions, and health-seeking behaviors regarding rabies and dog-bite injuries among residents in Ibadan, a southwestern city in Oyo State, Nigeria. Through a detailed comparison with studies in similar settings, this study highlights regional challenges and identifies critical areas for intervention in rabies awareness and prevention efforts.

Methods

Study design and sampling method.

This study employed a cross-sectional design and collected data through a semi-structured questionnaire administered to residents of Lagelu, a Local Government Area (LGA) in Ibadan, located in southwestern Nigeria. To ensure representativeness and minimize bias, individuals below 18 years and above 65 years, as well as those who had been residing in Lagelu LGA for less than two years at the time of data collection, were excluded from the study. To ensure a focused assessment of the adult population's knowledge, attitudes, perceptions, and health-seeking behaviors, we excluded individuals under 18 and over 65 years. Individuals younger than 18 were excluded because they may lack autonomy in health decision-making, and responses may not accurately reflect household-level knowledge or practices regarding rabies. Those over 65 were excluded due to potential recall bias or

differing health-seeking behavior patterns, which could complicate comparisons with the broader adult population.

Participants were selected using a multi-stage sampling technique. In the first stage, a simple random sampling method was applied to select four wards from the fourteen wards within Lagelu LGA. This ensured that each ward had an equal chance of being selected, reducing the likelihood of selection bias. In the second stage, one community was randomly chosen from each of the four selected wards. Households within each community were then systematically selected by choosing every nth household, depending on the total number of households and the required sample size from each community. Finally, within each chosen household, one respondent who met the inclusion criteria was randomly selected to participate in the study. This multi-stage approach helped ensure a diverse and representative sample of the population, allowing for a more accurate assessment of knowledge, attitudes, perceptions, and health-seeking behaviors regarding rabies and dog-bite injuries in the study area.

Questionnaire design and data collection

This study employed a quantitative approach, using a semi-structured questionnaire to collect data. The questionnaire was developed based on existing research on knowledge, attitudes, perceptions, and health-seeking behaviors related to rabies. It was divided into five sections to systematically gather relevant information viz: Section A - socio-demographic characteristics of respondents. Section B - knowledge of rabies, history of dog-bite injuries, and safety practices, section C - perceptions of rabies susceptibility, severity, and barriers, along with vaccination practices and service utilization following dog bites, section D - attitudes toward dog-bite injuries and rabies, and section E - Health-seeking behaviors in response to dog-bite injuries and rabies.

The questionnaire items were adapted from validated tools used in similar studies, notably those by Ba *et al.* (2021) and Tiwari *et al*. (2018), with modifications tailored to the objectives and population specifics of the current study. The socio-demographic section covered variables like age, gender, occupation, education level, and religion. Knowledge of rabies was measured using items assessing understanding of rabies causation, transmission, and prevention practices, scored on a 20-point scale, categorized into "poor" (≤10) and "good" (≥20) knowledge. Health-seeking behaviors were assessed on an 8-point scale, with scores of ≤4 categorized as poor and ≥8 as good. Perceptions of rabies risk were based on three constructs from the Health Belief Model, measured on a 13-point scale (Barley & Lawson, 2016).

Instrument validation

To ensure content and face validity, the questionnaire was developed through an extensive review of relevant literature. Construct validity was addressed by aligning items with the study objectives and theoretical framework, ensuring an accurate representation of key variables. The instrument was further reviewed by subject matter experts for quality assurance and refinement. To assess reliability, the draft questionnaire was pre-tested with a sample comprising 10% of the target population in Egbeda Local Government Area, Ibadan. This LGA was chosen for its similarities to Lagelu LGA in demographics and settings. Responses from the pilot were analyzed using Cronbach's alpha in SPSS, yielding a reliability coefficient of 0.949, indicating strong reliability (above the 0.7 threshold). Revisions were made to address ambiguities identified during the pre-test, ensuring clarity and accuracy.

Data was collected via interviewer-administered questionnaires, sequentially numbered for tracking. The authors, along with five trained research assistants, administered the questionnaire in selected households. Research assistants underwent two days of training with a structured manual

to standardize procedures and enhance data quality. Consent was obtained from participants, and completed questionnaires were reviewed on-site by the researcher to verify completeness and accuracy before concluding each field visit.

Statistical analysis

Data analysis was conducted using the Statistical Package for Social Science (SPSS®) for Windows Version 20.0 (Chicago, IL, USA). Sociodemographic characteristics were summarized as frequencies and percentages. To evaluate associations between variables, chi-square or Fisher's exact tests were used based on data distribution and sample size, enabling us to assess the relationships between knowledge, attitudes, safety practices, and health-seeking behaviors concerning rabies and dog-bite injuries at a 5% significance level. Additionally, Spearman's rank correlation was applied to explore potential relationships between knowledge levels and perceptions (e.g., susceptibility, severity), providing insight into the influence of knowledge on behavioral and attitudinal outcomes.

Ethical Considerations

This study received ethical approval from the Ethical Review Committee of the Oyo State Ministry of Health, Nigeria (AD13479/282) before data collection. Ethical standards were rigorously upheld throughout the research process to protect participants' rights, privacy, and well-being. Written informed consent was obtained from all participants before administering the questionnaire. Participants were provided with a detailed explanation of the study's purpose, procedures, and their rights, including the voluntary nature of participation and the option to decline or withdraw from the study at any time without any consequences. Consent forms outlined the purpose of the research, expected contributions, and assurances of data confidentiality. To ensure participants' privacy, no personally identifying information, such as names or home addresses, was collected. Data confidentiality was strictly maintained, with all information used solely for research purposes. Participants were informed that their responses would remain anonymous, and no data would be presented in a manner that could reveal individual identities.

The study's potential benefits were explained to participants, emphasizing that the data collected would contribute to the body of scientific knowledge on rabies, aid in assessing public knowledge and attitudes toward rabies and dog-bite injuries, and provide insights into strengthening safety measures. Participants understood that the findings could inform policy decisions to enhance rabies control, increase dog vaccination rates, and ultimately improve community health. Participation was entirely voluntary. Participants were made aware of their right to withdraw from the study at any point without any loss of benefits or repercussions, reinforcing their autonomy throughout the research. This approach ensured that all ethical principles, including autonomy, confidentiality, beneficence, and voluntary participation, were adhered to, safeguarding the rights and well-being of all participants.

Results

Respondents' Socio-Demographic Characteristics

A total of 418 respondents participated in this study, with a mean age of 35.6 years ±12.7. The majority (35.4%) were aged 21–30 years, while 61.2% were male, and 56.2% were married. In terms of education, 57.4% had tertiary education, and 60.5% identified as Christians. Most respondents (77.5%) were residents of the community, with 72.5% being tenants. Among occupations, 27.8% were artisans, and 37.1% lived with at least one dog.

Knowledge of Rabies and History of Dog-Bite Injuries

https://dx.doi.org/10.4314/thrb.v26i3.26

Rabies knowledge and dog bite history were assessed on a 20-point scale, with an average score of 11.7 ± 4.4. Overall, 54.8% of respondents demonstrated good knowledge, while 45.2% scored in the lower range, indicating poor knowledge of rabies. 62.0% of respondents recognized that rabies is viral in origin, and 72.5% were aware that rabies can be transmitted from dogs to humans. Among the respondents, 55.5% noted that paralysis is one of the symptoms of rabies, while 56.5%, 64.4%, 54.8%, and 36.1% identified excessive salivation, aggressive behavior, identified difficulty breathing, and hydrophobia respectively. Furthermore, approximately 45% of respondents were aware of the need for annual dog vaccinations, but 62.0% disagreed with the misconception that being bitten by a rabid dog causes the person to "bark." Most participants (75.8%) believed that suspected rabid dogs should be euthanized and buried, while 79.7% affirmed the effectiveness of post-exposure vaccination for individuals bitten or scratched by rabid dogs. Interestingly, 33.7% held a misconception that chaining dog-bite victims could prevent them from transmitting rabies (Table 1).

Table 1: Knowledge, and safety practices regarding dog bite and rabies infection among Respondents

Variable	Frequency (**n**)	Percentage (%)
Knowledge of rabies and its prevention among respondents		
Know about rabies		
Yes	312	74.6
No	99	23.7
Don't Know	7	1.7
The virus can infect humans through dogs		
Yes	303	72.5
No	50	12.0
Don't know	65	15.6
Rabies is preventable in both humans and animals by vaccination		
Yes	314	75.1
No	47	11.2
Don't Know	57	13.6
One of the first aid to dog bite injuries is to apply pressure at the site of injection?		
Yes	269	64.4
No	75	17.9
Don't Know	74	17.7
Knowledge of safety practices towards dog bite and rabies infection		
People who are in contact with dogs should receive anti-rabies vaccinations to prevent them from rabies		
Yes	347	82.8
No	72	17.2
Dog bite injuries should be reported and presented only at healthcare centers		
Yes	347	83.0
No	71	17.0

 https://dx.doi.org/10.4314/thrb.v26i3.26

Stray and roaming dogs with unknown vaccination history should be eliminated from the community		
Yes	305	73.0
No	113	27.0
Only registered and licensed health practitioners should handle cases of dog bite injuries		
Yes	343	82.1
No	75	17.9

Perceptions and Attitudes Toward Rabies and Dog-Bite Injuries

Among respondents, 44.3% perceived themselves as at risk of being bitten by their dogs. Nearly half (46.4%) reported previous incidents where their dogs had scratched them, which they believed could heighten their risk of infection. The mean score for attitudes towards dog-bite injuries and rabies was 11.8±4.4, with 60.3% of respondents demonstrating a positive attitude towards prevention and safety practices (Table 2). These findings suggest a majority recognize the importance of preventive actions, yet a substantial portion remains either uncertain or holds beliefs that could undermine proactive measures.

Table 2: Respondents' perception and attitudes to rabies and dog bite injuries

Variable	Agree (%)	Disagree (%)	Undecided (%)
Perceived Susceptibility and Severity of dog bites among Respondents			
Do you consider yourself to be at risk of being bitten by your dog?	44.3	44.0	11.7
My dog has scratched my body before and that may increase my risk of infection	40.0	46.4	13.6
I don't have contact with dogs so I cannot have dog injuries or rabies	53.1	34.9	12.0
Rabies can lead to paralysis	60.0	18.2	21.8
Rabies can lead to death in infected persons	63.9	14.8	21.3
Rabies can lead to madness in infected humans	55.5	23.0	21.3
Perceived barriers to vaccination of dogs and utilization of services when bitten by dogs.			
Uninfected dogs can become infected during mass dog vaccination campaign venues because of fights among themselves	68.7	17.5	13.9
There is little awareness about dog vaccination campaigns in my community.	58.4	27.3	14.4
The quality of vaccines and veterinary services is not sufficient to prevent rabies infection in dogs	33.0	48.8	18.2
Most health workers are not familiar with the effective management and treatment of victims of dog bite	33.3	53.6	13.2

 https://dx.doi.org/10.4314/thrb.v26i3.26

Pre-exposure prophylaxis (PrEP) is not readily available to victims of dog bites in most health centers.	33.7	50.5	15.8
Victims of dog bites are often denied admission into health centers because of a lack of experience with healthcare workers.	26.6	58.9	14.6
Attitude to dog bite injuries and rabies infection among respondents			
Most dogs that bite their owners are demonic dogs	22.0	69.1	8.9
Victims of bites from rabid dogs should be taken for deliverance sessions at religious centers for spiritual healing	17.5	73.0	9.6
Injuries resulting from dog bites should be presented to healthcare facilities	74.6	18.7	6.7
Trained dogs, even when infected with rabies infection do not bite people	45.0	40.9	14.1
Those who allow their dogs to lick their faces are at higher risk of getting infected with rabies	68.4	20.8	10.8
Injuries resulting from dog bites can never be treated or cured even in the hospital	26.6	62.0	11.5
There is no need to seek medical care for rabies infection because the victim can never survive the infection	18.7	70.8	10.5
Local herbs and traditional medicine are the best approach for managing rabies infection	19.6	67.0	13.4
Rabies virus is a public health risk in my environment/area	62.0	19.1	18.9

Health-Seeking Behaviors for Dog-Bite Injuries and Rabies

Health-seeking behaviors for dog-bite injuries and rabies were assessed on a 9-point scale, yielding a mean score of 4.2± 1.8. Over half of the respondents (56.9%) demonstrated good health-seeking practices, including actions such as seeking medical care after a dog bite and awareness of post-exposure prophylaxis options. These findings are detailed in Table 3, providing insight into community readiness to manage potential rabies exposure effectively.

Table 3: Health-seeking behaviors to dog bite injuries and rabies among respondents

Variable	Yes (%)	No (%)	Don't Know (%)
I can take antibiotics and apply anti-tetanus injections if bitten by a rabid dog.	59.1	25.1	15.8
One of the first aid for dog bite injuries is to apply pressure at the site of the bite	62.7	21.3	16.0
Anti-toxins can be self-administered to treat bite wounds	28.0	55.3	16.7
I can treat dog bite injuries traditionally by applying chili pepper	17.9	62.4	19.6

Dog infected with rabies can be treated with antibiotics	59.6	23.4	17.0
To treat rabies infection, once bitten, the victim should slaughter the dog and eat the meat	20.1	64.4	15.6
When bitten by a dog, the site of the bite should be washed with detergents, and the victim taken to the hospital	27.3	56.9	15.8
Victims of dog bites can be chained with iron and fetters to prevent them from biting humans and transmitting the infection	16.5	67.9	15.6
Once bitten by a rabid dog, the toxins should be pressed or sucked out using the hand or mouth	21.3	63.2	15.6

Association between socio-demography, knowledge, and safety practices among respondents.

Chi-square analysis identified significant associations between socio-demographic characteristics and respondents' knowledge of rabies, as well as their safety practices. Specifically, age ($p = 0.001$), educational level ($p < 0.001$), religion ($p = 0.026$), duration of residence in the community ($p = 0.001$), and whether respondents owned or lived with a dog ($p = 0.0012$) were all significantly associated with rabies knowledge and adherence to safety practices (Table 4). These findings indicate that higher education and longer community residence, for instance, may positively influence rabies awareness and responsible behaviors toward dog bites.

Table 4: Association between socio-demographic factors and knowledge of rabies and safety practices among respondents

Variables	Knowledge		χ^2	p-value
	Poor n (%)	Good n (%)		
Age (years)				
Up to 20years	79.3	20.7		
21-30years	49.0	51.0	19.660	0.001**
31-40years	36.3	63.7		
41-50years	37.5	62.5		
51 and above	44.4	55.6		
Educational status				
Primary	75.9	24.1		
Secondary	68.5	31.5	75.339	<0.001**
Tertiary	27.1	72.9		
Religion				
Christianity	41.1	58.9		
Islam	50.0	50.0	9.261	0.026**
Traditional	100.0	0.0		
Others	50.0	50.0		
Community Duration				
Up to 5years	41.5	58.5		

 https://dx.doi.org/10.4314/thrb.v26i3.26

6-10years	29.3	70.7	25.398	<0.001**
11-15years	65.5	34.5		
Above 15 years	50.0	50.0		
Own or lived with a dog				
Yes	38.1	61.9		
No	48.4	51.6	8.908	0.012*
I don't know	85.7	14.3		

** p < 0.05

Association between knowledge of rabies and safety practices and health-seeking behaviors to dog-bite injuries and rabies among the respondents

The analysis revealed a statistically significant association between respondents' knowledge of rabies and their safety practices and health-seeking behaviors related to dog-bite injuries and rabies ($p < 0.001$; Table 5), suggesting that higher knowledge levels about rabies are linked to more effective safety practices and proactive health-seeking behaviors following dog bites.

Table 5: Knowledge and safety practices and health-seeking behaviors to dog-bite injuries and rabies among the respondents

Variables		Health seeking behaviour		X2	p-value
		Poor n (%)	Good n (%)		
Knowledge	Poor	65.1	34.9	68.207	<0.001**
	Good	24.9	75.1		

** p < 0.05

Correlation Between Knowledge of Rabies and Perception Variables

Spearman's rank-order correlation analysis indicated a mild, negative correlation between respondents' knowledge of rabies and their perceived susceptibility to the disease ($r = -0.314$, $p < 0.001$), suggesting that higher knowledge levels may slightly decrease individuals' perception of their susceptibility. A stronger negative correlation was observed between knowledge of rabies and perceived severity ($r = -0.638$, $p < 0.001$), indicating that as knowledge of rabies increases, perceived severity tends to decrease notably. Additionally, there was a weak negative correlation between knowledge and perceived barriers ($r = -0.179$, $p < 0.001$), implying that increased knowledge may marginally reduce the perceived obstacles to taking preventive measures.

Discussion

This study assessed knowledge, attitudes, perceptions, and health-seeking behaviors related to dog-bite injuries and rabies infection. Results showed that over half of the respondents had a satisfactory level of knowledge about rabies, which is lower than the levels reported in similar studies, such as Edukugho *et al.* (2018) in the Federal Capital Territory (FCT), Abuja. The discrepancy in knowledge may reflect differences in socio-economic factors and public health awareness initiatives across regions, with FCT residents likely benefiting from more robust health campaigns compared to Lagelu, Ibadan.

Such disparities highlight the need for targeted education in lower-resourced areas to raise awareness about rabies.

Notably, all respondents recognized dogs as the main host for rabies and understood the preventive role of vaccination, which aligns with findings by Kabeta *et al.* (2015) in Ethiopia. This awareness suggests an effective transmission of core rabies knowledge across various African contexts, perhaps driven by recent awareness campaigns. However, the Health Belief Model (HBM) could further elucidate this finding by examining perceived susceptibility and perceived severity—key constructs that appear to diverge in our study. Although respondents were knowledgeable about rabies, over half did not perceive themselves as susceptible to dog-bite injuries. This risky perception, particularly among male dog owners, may stem from a sense of control over their dogs or cultural attitudes toward dog ownership. Addressing this through targeted behavioral interventions could improve safety practices among dog owners, emphasizing that even familiar dogs can pose risks.
Interestingly, knowledge of rabies did not correlate with the perception of its severity, a pattern also seen in studies like Tiwari *et al.* (2018) among healthcare staff in India. This gap may indicate a knowledge-behavior disconnect, where information about rabies does not translate into an accurate risk assessment. Future interventions should focus not only on knowledge dissemination but also on enhancing understanding of the severe consequences of rabies, especially fatal outcomes if left untreated. Such awareness could motivate preventive actions, including vaccination compliance and proper health-seeking behavior after dog bites.

The perception of barriers to accessing healthcare for dog-bite injuries was another critical finding, as some respondents reported denial of access at health centers. This barrier could stem from cultural or logistical issues, as noted in Abubakar & Bakari (2012) and Ogundare *et al.* (2015). Regional discrepancies in healthcare access for bite injuries could be addressed by policy interventions that ensure consistent medical support for rabies prevention across different Nigerian states. Strengthening partnerships with local health providers and incorporating traditional leaders into awareness campaigns could mitigate cultural resistance to seeking medical care.

The positive attitude of respondents toward proper management of dog-bite injuries, contrasting with findings from Uganda (Monje *et al.,* 2020), Kenya (Omemo *et al.,* 2012), and Senegal (Ba *et al.,* 2021), is encouraging. This may reflect higher educational levels and exposure to information among those sampled in the current study, particularly among married individuals and those with tertiary education. The Health Belief Model could be used here to interpret attitudes as a product of perceived benefits and cues to action, where educational attainment and familiarity with the disease might have strengthened the respondents' commitment to appropriate management practices. Encouraging a similar approach in regions with lower educational levels may promote positive health-seeking behaviors for rabies.

Respondents generally exhibited good health-seeking behavior, a factor possibly linked to educational background and awareness of rabies. However, expanding the study to include more remote areas in the region might yield different results, highlighting potential gaps in rabies awareness and healthcare access in underserved regions. Further research across diverse Nigerian communities could provide insights into regional health-seeking behaviors and inform targeted strategies to improve healthcare access and rabies education. Finally, respondents' awareness of first-aid measures for dog bites signifies a notable step toward the operationalization of the One Health approach (Ba *et al.,* 2021; Thys *et al.,* 2021). Continued reinforcement of this integrative model, through community-based education and cross-sector collaboration, could help sustain and expand rabies control efforts.
In summary, this study reveals critical areas where public health interventions could enhance rabies prevention, including addressing knowledge-perception gaps, reducing healthcare access barriers,

and promoting the One Health approach. By leveraging the Health Belief Model to understand these behavioral factors, public health practitioners can design more effective, context-sensitive campaigns to reduce rabies incidence and improve safety practices among dog owners and community members.

Implications for Health Promotion

This study underscores the need for tailored, evidence-based health promotion interventions to address gaps in perceptions of susceptibility and severity of rabies and dog-bite injuries within the community. The mixed views on personal risk and the gravity of rabies observed among respondents suggest that targeted education campaigns could be crucial in motivating preventive actions and timely healthcare-seeking behavior. These campaigns should emphasize the real risks and severe consequences associated with rabies, thereby encouraging individuals to adopt safety practices, vaccinate their pets, and seek prompt medical attention after dog bites.

The findings also reveal significant barriers to dog vaccination and healthcare utilization following dog bites, including concerns about the risk of infection during mass vaccination campaigns, doubts regarding the quality of vaccines, and a lack of trust in healthcare providers. To address these barriers, a coordinated approach is necessary, involving veterinarians to enhance vaccine quality and accessibility, particularly in rural areas. This partnership can ensure reliable vaccination campaigns while simultaneously building community confidence in the services provided.

Government health agencies and healthcare providers should collaborate to enhance the knowledge and skills of healthcare workers in managing dog-bite injuries and administering rabies post-exposure prophylaxis. Community-based awareness programs, including workshops and outreach initiatives, should focus on dispelling misconceptions, highlighting the importance of rabies prevention, and fostering trust in local healthcare and veterinary facilities. Engaging the community through schools, religious institutions, and media platforms can further extend outreach, help dispel myths and promote awareness regarding the symptoms and prevention of rabies, as well as the critical importance of seeking prompt medical care for dog bite injuries.

In conclusion, sustained efforts in public health education and collaboration across the One Health spectrum are essential for effectively preventing and controlling rabies. Continued partnerships among public health practitioners, veterinarians, and local stakeholders will strengthen rabies prevention and health-seeking behaviors throughout Nigeria. By building on the positive knowledge, attitudes, and practices observed in this study, public health programs should expand the One Health approach nationwide, ensuring that rabies prevention strategies are accessible, culturally relevant, and responsive to community needs. Implementing these recommendations will be pivotal in advancing Nigeria toward a safer, rabies-free future.

References

Abubakar, S. A., & Bakari, A.G. (2012). Incidence of dog bite injuries and clinical rabies in a tertiary health care institution: a 10-year retrospective study. *Annal of African Medicine*, 11(2):108-111 doi.org.10.4103/1596-3519.93534

Adedeji, A. O., Okonko, I. O., Eyarefe, O. D., Adedeji, O. B., Babalola, E. T., Ojezele, M. O., Nwanze, J. C., & Amusan, T. A. (2010). An overview of rabies - History, epidemiology, control, and possible elimination. *African Journal of Microbiology Research*, 4(22):2327-2338. http://www.academicjournals.org/ajmr

Adesina, M. A., Olufadewa, I. I., OgaH, Y. I., & Nwachukwu, N. (2020). Incidence and mortality from a neglected tropical disease (rabies) in 28 African countries. *Folia Veterinaria*, 64(2), 46-51. doi.org/10.2478/fv-2020-0016

Ahmad, I., Kudi, C. A., Abbas, M., Yakubu, Y., Muhammad, U., & Salisu, M. D. (2018). Human death from a suspected rabid dog bite in Zamfara State, Nigeria. *Sokoto Journal of Veterinary Sciences*, 16(4): 92-95 doi.org/10.4314/sokjvs.v16i4.13

Ahmed, H., Chafe, U. M., Magaji, A.A., & Abdul-Qadir, A. (2000). Rabies and dog bites in children: a decade of experience in Sokoto. *Sokoto Journal of Veterinary Sciences*, 1:2-10 http://www.sokvetjournal.net/images/PDF/Vol_2_1/1.%20Ahmed%20et%20al.%202000.pdf

Alabi, O., Nguku, P., Chukwukere, S., Gaddo, A., Nsubuga, P., & Umoh, J. (2014). Profile of dog bite victims in Jos Plateau State, Nigeria: a review of dog bite records (2006-2008) *Pan African Medical Journal*. 18(Supp 1),12 doi.org.10.11694/pamj.supp.2014.18.1.4341

Al-Mustapha, A. I., Bamidele, F. O., Abubakar, A. T., Ibrahim, A., Oyewo, M., Abdulrahim, I., … Bolajoko, M. B. (2022). Perception of canine rabies among pupils under 15 years in Kwara State, North Central Nigeria. *PLOS Neglected Tropical Diseases*, 16(8):16 e0010614. doi.org.10.1371/journal.pntd.0010614

Al-Mustapha, A. I., Tijani, A. A., Bamidele, F. O., Muftau, O., Ibrahim, A., Abdulrahim, I., … Endie, W. N (2021). Awareness and knowledge of canine rabies: A state-wide cross-sectional study in Nigeria. *PLoS One*, 16(3), e0247523. doi.org.10.1371/journal.pone.0247523

Audu, S. W., Mshelbwala, P. P., Jahun, B. M., Bouaddi, K., & Weese, J. S. (2019). Two fatal cases of rabies in humans who did not receive rabies postexposure prophylaxis in Nigeria. *Clinical Case Reports*, 7(4), 749-752. doi.org.10.1002/ccr3.1972

Ba, M. F., Kane, N. M., Diallo, M. K., Bassoum, O., Boh, O. K., Mboup, F. Z., … Faye, A (2021). Knowledge, attitudes, and practices on rabies among human and animal health professionals in Senegal. *Pathogens*. 10(10):1282. doi.org.10.3390/pathogens10101282

Barley, E., & Lawson V. (2016). Using health psychology to help patients: theories of behaviour change. Br J Nurs.25(16):924-7. doi.org.10.12968/bjon.2016.25.16.924

CDC., (2014). Rabies Postexposure Prophylaxis (PEP). Center for Disease Control and Prevention. Available from: https://www.cdc.gov/rabies/medical_care/index.html#:~:text=Postexposure%20prophylaxis%20(PEP)%20consists%20of,3%2C%207%2C%20and%2014

Charulatha, R. J., Umadevi, R., & Ananthaeashwar, V. M. (2021). Pattern of Injuries among Dog Bite Victims in an Urban Area of Kancheepuram District, Tamilnadu. *National Journal of Community Medicine*.12(08), 236-240. Available from: https://njcmindia.com/index.php/file/article/view/341

Edukugho, A. A., Umoh, J. U., Diem, M., Ajani, O., Uba, B., Okeke, L., … Nguku, P. (2018). Knowledge, attitudes, and practices towards rabies prevention among residents of Abuja municipal area council, Federal Capital Territory, Nigeria. *Pan African Medical Journal*. 31(1):21 doi.org.10.11604/pamj.2018.31.21.15120

Jakeman, M., Oxley, J. A., Owczarczak-Garstecka, S. C, & Westgarth, C. (2020). Pet dog bites in children: management and prevention. *BMJ pediatrics Open*. 4(1), e000726. doi.org/10.1136/bmjpo-2020-000726

Kabeta, T., Deresa, B., Tigre, W., Ward, M. P., & Mor, S. M. (2015). Knowledge, attitudes, and practices of animal bite victims attending an Anti-rabies Health Center in Jimma Town, Ethiopia. *PLoS Neglected Tropical Diseases*.2015; 9(6): e0003867. doi.org/10.1371/journal.pntd.0003867

Kapoor, P., Baig, V. N., Kacker, S., Sharma, M., & Sharma, M. (2019). A cross-sectional study of knowledge regarding rabies among attendees of an anti-rabies clinic of a teaching hospital, Jaipur. *Journal of Family Medicine and Primary Care*, 8(1), 194-198. doi.org/10.4103/jfmpc.jfmpc_205_18

Kisaka, S., Makumbi, F. E., Majalija, S., Bangirana, A., & Thumbi, S. M. (2020). Epidemiology, and preclinical management of dog bites among humans in Wakiso and Kampala districts, Uganda: Implications for prevention of dog bites and rabies. *Plos One*. 15(9): e0239090. doi.org/10.1101/2020.02.16.20023556

Meslin, F. X., & Briggs, D. J. (2013). Eliminating canine rabies, the principal source of human infection: what will it take? *Antiviral Res*, 98(2), 291-6. doi.org/10.1016/j.antiviral.2013.03.011

Monje, F., Erume, J., Mwiine, F. N., Kazoora, H., & Okech, S. G. (2020). Knowledge, attitude, and practices about rabies management among human and animal health professionals in Mbale District, Uganda. *One Health Outlook*. 2,1-11. doi.org/10.1186/s42522-020-00031-6

Mshelbwala, P. P., Weese, J. S., Sanni-Adeniyi, O. A., Chakma, S., Okeme, S. S., Mamun, A. A., … Soares Magalhaes, R. J. (2021). Rabies epidemiology, prevention, and control in Nigeria: Scoping progress towards elimination. *PLOS Neglected Tropical Diseases*. 15(8), e0009617. doi.org/10.1371/journal.pntd.0009617

Ogundare, E. O., Olatunya, O. S., Oluwayemi, I. O., Inubile, A. J., Taiwo, A. B., Agaja, O. T., … Fabunmi, A. (2017). Pattern and outcome of dog bite injuries among children in Ado-Ekiti, Southwest *Nigeria Pan African Medical Journal*. 27:81. doi.org/10.11604/pamj.2017.27.81.7360

Omemo, P., Ogola, E., Omondi, G., Wasonga, J., & Knobel D. (2012). Knowledge, attitude, and practice towards zoonoses among public health workers in Nyanza province, Kenya. *Journal of Public Health in Africa.* 3(2), e22. doi.org/10.4081/jphia. 2012.e22

Onyemocho, A., Moses, A., Kisani, A., Victoria, O. N., & Joseph A. (2020). Assessment of knowledge and practice of vaccination of dogs against rabies by dog owners in Makurdi, Benue State, Nigeria. *Annals of Medical Research and Practice*, 1(1), 1-5. doi.org/10.25259/ANMRP_1_2020

Singhai, M., Sood, V., Yadav, P., Kumar, K.K., Jaiswal, R., Madabhushi, S., … Tiwari, S. (2022). Diagnosis of Rabies in Patients with Acute Encephalitis: A Study of Two Cases. *Infectious Disease Reports*, 14(6), 967-970. doi.org/10.3390/idr14060095

Thombare, M.G., & Malviya S. (2022). Characterization, quantification, and establishment of coefficient extinction of rabies antigen samples using different analytical methods. *Journal of Pharmaceutical Negative Results*, 13(10), 690-700. doi.org/10.47750/pnr.2022.13.S10.073

Thys, S., Knobel, D. L., Simpson, G., Rooyen, J. V., Marcotty, T., Gabriël, S., … Boelaert, M. (2021). Perceptions and practices of dog ownership and rabies control at a human-wildlife domestic animal interface in South Africa. *Anthrozoös*. 34(2):281-302 doi.org/10.1080/08927936.2021.1885146

Tiwari, H. K., Vanak, A. T., O'Dea, M., & Robertson, I. D. (2018). Knowledge, attitudes, and practices towards dog-bite related rabies in para-medical staff at rural primary health centers in Baramati, western India. *PLoS One.* 13(11): e0207025. doi.org/10.1371/journal.pone.0207025

WHO. (2023) Rabies https://www.who.int/news-room/fact-sheets/detail/rabies

NATIONAL INSTITUTE FOR MEDICAL RESEARCH
3 Barack Obama Drive
P.O. Box 9653, 11101 Dar-es-Salaam
Tel: +255-22-2121400
Fax: +255-22-2121360
hq@nimr.or.tz | info@nimr.or.tz
www.nimr.or.tz