



Patterns of fruits and vegetable consumption among adults aged 18 to 69 years in Tanzania: Results from the 2023 National STEPS survey

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Abstract

Background: Chronic under-consumption of fruits and vegetables contributes to micronutrient deficiencies and significantly drives the global burden of preventable non-communicable diseases. Evidence indicates that average intake remains below the World Health Organization recommended minimum of 400 grams per person per day. However, local and national evidence on the patterns, magnitude and determinants of inadequate fruit and vegetable consumption remains limited.

Objective: To assess the patterns, prevalence and socio-demographic determinants of consuming zero or fewer than five servings of fruits and vegetables per day among individuals aged 18–69 years.

Methods: A national population-based household survey employed a three-stage cluster sampling design based on the 2022 Tanzania Population and Housing Census, with 4,320 participants, conducted from September 2022 to September 2023. Data on major Non-Communicable Diseases (risk factors) were collected using WHO STEPS methodology. Fruit and vegetable intake was assessed using WHO standards based on reported frequency and daily servings. Chi-square tests and modified Poisson regression were used to examine factors associated with inadequate fruit and vegetable consumption.

Results: Overall, 92.4% (n=3262) consumed zero or fewer than five servings per day/ inadequate intake (zero or <5 servings/day). Rural residence was associated with significant increase in the likelihood of inadequate consumption (aPR=1.04, 95% CI: 1.01–1.06). All geographical zones exhibiting higher prevalence ratios compared to the Lake zone, ranging from aPR=1.14 in the Central zone to aPR= 1.28 in the Southwest Highlands. Participants who reported no engagement in leisure-time physical activity had a higher probability of inadequate dietary intake (aPR=1.04, 95% CI: 1.02–1.07).

Conclusion: Inadequate fruit and vegetable intake is highly prevalent among Tanzanian adults, with significant disparities by residence, region and physical activity status. These findings underscore the need for targeted, context-specific interventions to improve dietary behaviours and reduce nutrition-related non-communicable disease risk across populations.

Keywords: Patterns, Fruits and Vegetable Consumption, adults aged 18 to 69 years

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Background

Dietary-related risks are acknowledged as the leading cause of preventable non-communicable diseases (NCDs) worldwide, including in sub-Saharan Africa. One of the major nutritional deficiencies resulting from the chronic under-consumption of fruits and vegetables, which is responsible for the increased incidence of cardiovascular diseases, various forms of cancers, and deaths from all causes as well, is not adequately supplied in diets (Amunga et al., 2024; Msambichaka et al., 2018). In Tanzania and the rest of East Africa, many nutritional profiles show that the average intake of fruits and vegetables is far below the World Health Organization's minimum recommendation of 400 grams per person per day (Amunga et al., 2024). These patterns reflect a regional dietary transition marked by an increased dependency on refined staples and ultra-processed foods that reduce dietary variety and worsens the already existing micronutrient deficiencies (Amunga et al., 2024).

Recent analyses of food availability and intake patterns reveal that adult Tanzanians eat considerably less fruit and vegetables (F&V) than what the guidelines advise. Nationally, the estimation of daily consumption varies between 100 and 280 grams, approximately, depending on the method of measurement, which supports the existence of a huge gap if compared to international norms (Borazon et al., 2025; Mwombeki et al., 2024). National planning offices' reports also point out that only a very small fraction of the population reaches the "five servings per day" target, and the level of consumption remains consistently quite low in both rural and urban areas (Mwombeki et al., 2024). Besides that, seasonal variations, inability to afford, as well as rural/urban differences, lead to the creation of big inequalities in food habits across the country (Msambichaka et al., 2018; Mwombeki et al., 2024).

The reasons for these consumption shortfalls lie in several systemic and structural aspects. A significant majority of Tanzania's horticultural production comes from smallholder farmers, whose work capacity is continually undermined by climate change and the unavailability of basic infrastructural elements such as irrigation and cold-chain store facilities (El-Beltagi et al., 2023; Makule et al., 2024). The fresh produce distribution channels are very dependent on informal markets, which in turn are usually affected by transport problems and unstable pricing (Bisheko & G, 2024; Makule et al., 2024). Such issues mitigate the availability and affordability of these items throughout the year for economically disadvantaged households. Furthermore, unawareness of nutritional values and the quick spread of urban life have caused consumers to change their tastes to more energy-rich, low-nutrient convenience food (Amunga et al., 2024; Johnson et al., 2018).

Implications for public health due to these trends are serious (2019). In Tanzania, a diet low in fruits and vegetables is one of the main factors that contribute to increasing the burden of diet-related non-communicable diseases such as hypertension, type 2 diabetes, and cardiovascular diseases (Kagaruki et al., 2022; Msambichaka et al., 2018). In Tanzania, at ban centers, the discovery shows that the increasing rate of overweight and obesity goes together with not consuming fiber-rich plant foods, which speed up metabolic risk factors (Amunga et al., 2024). Besides dietary risks, there is still child undernutrition, thus creating the "double burden" of malnutrition, which puts a great strain on the national health system and slows down the achievement of developmental goals (Amunga et al., 2024).

To increase the consumption of F&V, integrated, multisectoral interventions are needed. Agricultural interventions concentrating on diversified production, value chains, and post-harvest loss reduction, which is a major constraint to supply, are the key elements of market stabilization (Bisheko & G, 2024; Rutta, 2024). On the demand side, behavior-change communication that is targeted, nutrition programs in schools, and workplace-based interventions will be able to increase the consumption of households (Koyratty et al., 2025). Making foods safer in informal markets and encouraging women to be horticultural value chains are ways of bringing the reproduce to a larger number of people at a lower price (Amunga et al., 2024).



The situation of dietary surveillance also needs extensive improvement. In Tanzania, national datasets are based on diverse methodologies, such as household expenditure surveys or limited dietary recalls. Moreover, the consequent dietary estimates are inconsistent and comparing them across years becomes a challenge (Amunga et al., 2024). National progress cannot be effectively tracked without regular, standardized assessments of intake patterns (measured in grams per day) and dietary diversity, broken down by sociodemographic characteristics (Mwombeki et al., 2024). Besides, this data is extremely useful in targeted interventions and making policy changes that rely on actual consumption trends (Amunga et al., 2024).

In the end, taking a national view of diet-related risks is a prerequisite for stemming the tide of Tanzania's NCDs epidemic. Even while the health guidelines are explicit, the data show that F&V consumption continues to be alarmingly low due to socio-economic and geographic issues (Msambichaka et al., 2018; Mwombeki et al., 2024). Besides amassing updated, representative analyses of these consumption patterns, it is necessary to develop them so that, through such evidence, multisectoral planning will become most effective. Indeed, such evidence will be an important part of agricultural investments, health system re-prioritization, as well as national food environment reforms, which in turn will have a positive impact on the dietary quality and resilience of the food system in Tanzania and East Africa (Mwombeki et al., 2024).

Methodology

Study Design

This is the analysis of Tanzania STEPS survey conducted between September 2023 to November 2023 (Kagaruki et al., 2025; Ministry of Health Tanzania Mainland and Zanzibar, 2023). The Tanzania STEPS survey aimed to evaluate the national prevalence of risk factors for Non-Communicable Diseases (NCDs) among adults aged 18–69 years in Tanzania. Utilizing a quantitative, cross-sectional, household-based design, the survey incorporated structured interviews, physical measurements, and biochemical sample collection to assess NCD risk factors.

Study Setting

The survey was conducted in all 26 regions of mainland Tanzania and all 5 regions of Zanzibar. The United Republic of Tanzania, located in Eastern Africa, is a lower-middle income economy, with a population of 62 million. Nearly two-thirds of the population resides in rural areas, and the overall life expectancy is 68 years (Ministry of Finance and Planning, 2022).

Study population

The survey included individuals aged 18–69 years residing in mainland Tanzania and the Zanzibar archipelago. Eligibility criteria excluded individuals residing in the selected household for less than 6 months, household members absent from the home for more than 2 months, and those with mental incapacitation or severe illness preventing participation.

Sample size and Sampling

The survey utilized a three-stage stratified sampling design based on the sampling frame constructed for the 2022 Tanzania Population and Housing Census (Ministry of Finance and Planning, 2022). The sampling frame comprised a complete listing of Enumeration Areas (EAs). In rural settings, an EA corresponds to a natural village, a segment of a large village, or a cluster of small villages, whereas in urban settings it corresponds to a street or city block. The overall sample size was determined to yield nationally representative estimates of the prevalence of non-communicable disease (NCD) risk factors among individuals aged 18–69 years, with a targeted relative standard error of $\leq 5\%$ at the national level. Within each EA, 15 households were selected,



resulting in a sample of 4320 individual adults aged 18-69 years (one eligible adult male or female per household) drawn from 288 EAs. Research assistants interviewed only the pre-selected households, and no substitutions were permitted for non-respondents. To minimize non-response, at least three to four follow-up visits were conducted. Further details on the STEPS sample size determination and sampling procedures are available elsewhere (Kagaruki et al., 2025).

Data collection tools and methods

The STEPS Tanzania questionnaires was based on the standard WHO STEPS questionnaires (World Health Organisation, 2008), adapted to the Tanzania situation and needs. demographic details; behavioural measures on tobacco use, alcohol consumption, and the intake of fruits and vegetables; and an assessment of physical activity.

Consuming 0 or <5 fruits and or vegetables of servings per day

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. Consumption of fruits and vegetables below the standards were considered if the frequency is 0 or <5 servings per day. More, details can be accessed elsewhere (Kagaruki et al., 2025).

Variables

The prevalence of consuming 0 or <5 fruits and or vegetables of servings per day was the outcome of interest for this paper. Explanatory variables were grouped into three domains: demographic, socio-economic, and health-related factors. Demographic factors included sex (male, female), age group (18–30, 31–45, 46–69 years), location (rural, urban), and geographical zone (Western, Northern, Central, Southern Highlands, Southern, Southwest Highlands, Lake, Eastern, Unguja, Pemba), with marital status categorized as never married, married/cohabiting, or separated/divorced/widowed. Socio-economic factors comprised education level (no formal, primary, secondary, college) and occupation (employed, self-employed, other). Health-related factors encompassed body mass index (BMI; not obese/overweight, obese/overweight), depression status (not depressed, depressed), overall physical activity (insufficient, sufficient, high), and leisure-time physical activity (no, yes).

Personnel and training

Fifteen data collection teams, each comprising one supervisor and four interviewers, were deployed. Before fieldwork, a six-day training program was conducted for field staff, covering the questionnaire's content, completion procedures, and interviewing techniques. A pretest was performed to provide survey organizers with insights into questionnaire design, training effectiveness, and fieldwork logistics, enhancing the overall survey implementation process.

Data management and analysis

Data were collected electronically using tablet-based devices and monitored daily by the quality assurance team. All records were automatically uploaded to the central server of the eSTEPS platform, with backup copies maintained on the servers of the National Institute for Medical Research (NIMR). Centralized data cleaning and verification were conducted by a designated technical working group. Data weighting was applied using three complementary methods to enhance the accuracy, reliability, credibility, representativeness, and overall validity of the survey findings. The weighting process accounted for variations in selection probability, non-response adjustments, and post-stratification to align the sample distribution with national population estimates. Further details regarding data analysis and weighting procedures can be accessed

elsewhere (Kagaruki et al., 2025). Cleaned data were exported to Stata version 17 (StataCorp LLC, College Station, TX, USA) for further processing and statistical analysis. Outliers and inconsistencies were identified and excluded prior to analysis. Descriptive statistics are presented as proportions and mean. Bivariate analyses were conducted to examine differences in mean fruit and vegetable consumption and related rates among Tanzanians aged 40–69 years. For continuous outcomes such as daily servings of fruits and vegetables, independent samples t-tests, one-way analysis of variance (ANOVA), and simple linear regression were applied. For binary outcomes, including the proportion of participants consuming below the recommended daily servings, the chi-square test was used. Finally, Modified Poisson logistic regression modelling was employed to identify independent risk factors associated with prevalence of consuming 0 or <5 fruits and or vegetables of servings per day among Tanzanians aged 18-69 years. The modified Poisson regression model with robust variance estimation was used because the proportion of participants consuming below the recommended daily servings exceeded 10% (Lee et al., 2009; Zou, 2004). Statistically significant was considered at $p\text{-value} < 0.05$.

Results

Demographic information

Majority of participants were females 2,106 (59.1%). Most respondents were aged 18–45 years, including those aged 18–30 years (33.5%) and 31–45 years (34.9%). Two-thirds resided in rural areas 2,402 (67.4%). Representation covered all national zones, with the Central zone contributing the largest share 747(20.9%), followed by the Southwest Highlands 430 (12.1%), Northern 401 (11.3%), Southern Highlands 374 (10.5%), Eastern 321 (9.0%), Western 322 (9.0%), Unguja 333 (9.3%), Pemba 249 (7.0%), Lake 221 (6.2%), and Southern 167 (4.7%). Most participants were married or cohabiting 2,301 (64.5%). Education levels were low, dominated by primary education 1,667 (46.8%) and no formal schooling 1,188 (33.3%). The workforce was largely self-employed 2,097 (64.3%). About one-third were overweight or obese 1,044 (31.0%). Depression was reported by 593 (16.8%). Alcohol use 595 (16.7%) and smoking 287 (8.1%) were uncommon. Most reported high physical activity 3,336 (93.6%), while leisure-time activity was limited 954 (26.8%) (Table 1). However, these results are unweighted.

Table 1: Demographic and behavioral characteristics of the study participants

Variables	Categories	n(%)
Sex	Male	1459(40.9)
	Female	2106(59.1)
Age group	18-30yrs	1196(33.5)
	31-45yrs	1243(34.9)
	46-69yrs	1126(31.6)
Location	Rural	2402(67.4)
	Urban	1163(32.6)
Zone	Western	322(9.0)
	Northern	401(11.3)
	Central	747(20.9)
	Southern Highlands	374(10.5)
	Southern	167(4.7)
	Southwest Highlands	430(12.1)
	Lake	221(6.2)
	Eastern	321(9.0)



	Unguja	333(9.3)
	Pemba	249(7.0)
Marital Status	Never married	645(18.1)
	Married/cohabiting	2301(64.5)
	Separated/divorced/widowed	619(17.4)
Education level	No formal	1188(33.3)
	Primary	1667(46.8)
	Secondary	540(15.1)
	College	170(4.8)
Occupation	Employed	221(6.8)
	Self employed	2097(64.3)
	Others	944(28.9)
BMI Categories	Not Obese/overweight	2325(69.0)
	Obese/overweight	1044(31.0)
Depression status	Not depressed	2943(83.2)
	Depressed	593(16.8)
Current drinker	Non drinker	2970(83.3)
	Drinker	595(16.7)
Smoking Status	Noncurrent smoker	3274(91.9)
	current smoker	287(8.1)
Physical Activity	Insufficient	98(83.2)
	Sufficient	131(3.7)
	High	3336(93.6)
Leisure Physical Activity	No	2611(73.2)
	Yes	954(26.8)

Note: Unweighted results

Prevalence of fruits and vegetable consumption

The consumption of zero or fewer than five servings per day exceeded 90% across all age groups, with no notable sex differences. Rural participants showed a slightly higher tendency to either not consume fruits and vegetables or to consume fewer than the recommended five servings per day. (Figure 1). The mean servings of fruits and vegetables for urban (2.51) was significantly higher than that of rural (1.97) area ($p < 0.001$) Figure 2.

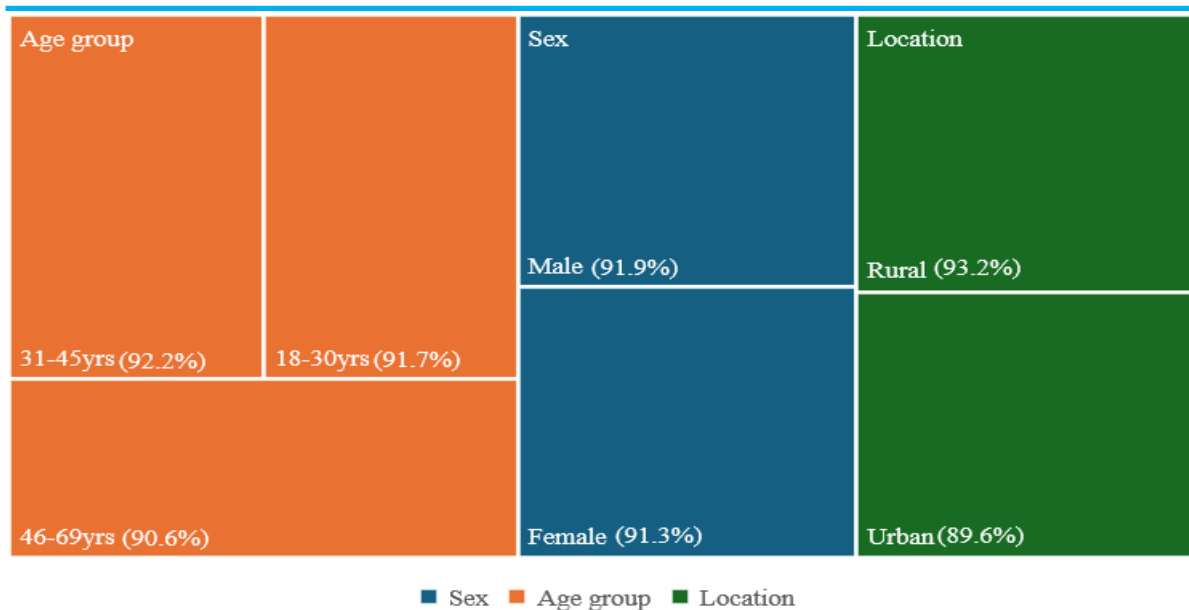


Figure 1: Prevalence of consuming 0 or <5 servings per day among individuals aged 18-69 years disaggregated by age, sex and location

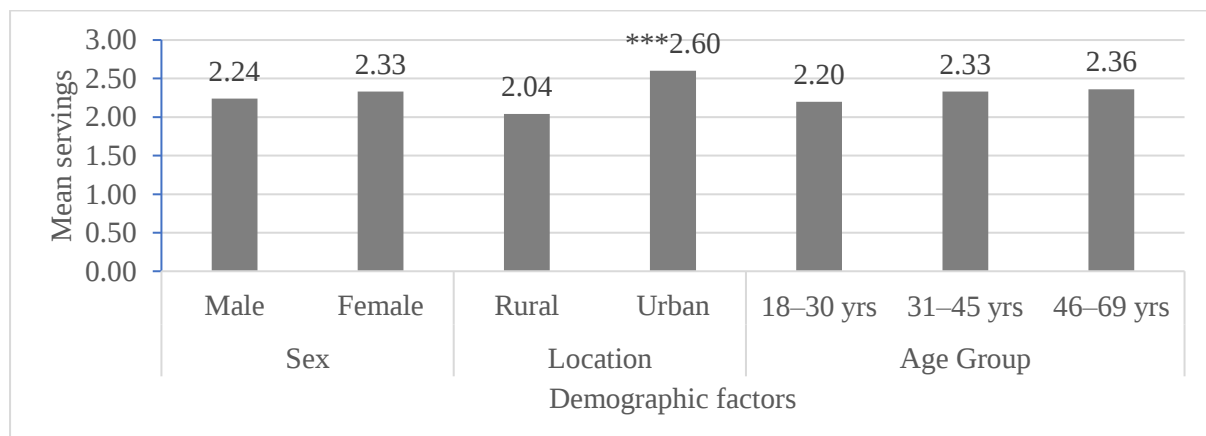


Figure 2: Average consumption of fruits and vegetables by age and sex (*P-value < 0.001)**

Association between demographic characteristics and prevalence of fruits and vegetable consumption

Overall, 92.4% (n=3262) consumed zero or fewer than five servings per day. Across all subgroups, inadequate intake (0 or <5 servings/day) remained very high. Sex showed minimal difference: males at 91.9% (n=1334) and females at 91.3% (n=1928). Age groups were similarly comparable, ranging from 90.6% (46-69 years, n=1064) to 92.2% (31-45 years, n=1131). Rural residents had a slightly higher prevalence at 93.2% (n=2221) compared to 89.6% in urban areas (n=1041) with marked variation appear across zones. The highest proportions were in the Southwest Highlands at 99.6% (n=405), Pemba at 99.7% (n=232), Western at 95.5% (n=285), and Eastern at 95.7% (n=294). The Lake zone showed the lowest estimate at 73.8% (n=220). Marital status showed little variation, from 90.7% among separated/divorced/widowed (n=574) to 92.4% among the never married (n=584). By education, those with no formal schooling had 93.0% (n=1090), while secondary and college groups had lower proportions at 85.3% (n=484) and 85.3% (n=148) respectively. Employment categories remained consistent, with 91.6% among employed (n=221), 91.3% among self-employed (n=2097), and 92.1% among others (n=944). BMI categories were similar, with 91.7% (n=2158) among non-

overweight and 91.1% (n=960) among overweight/obese. Physical activity categories remained uniformly high, ranging from 95.6% (n=85) in insufficient activity to 91.2% (n=3059) in high activity. Those without leisure physical activity had 93.1% (n=2392) compared to 88.2% (n=870) among those engaged in leisure activity (Table 2).

Table 2: Association between demographic characteristics and prevalence of consuming 0 or <5 servings per day among individuals aged 18-69 years

Variable	Categories	Total	0 or <5 servings, % (95%CI)	P-Values
Sex	Male	1334	91.9(88.1-94.6)	0.7726
	Female	1928	91.3(87.7-93.9)	
Age group	18-30yrs	1067	91.7(87.2-94.8)	0.805
	31-45yrs	1131	92.2(88.9-94.6)	
	46-69yrs	1064	90.6(86.0-93.8)	
Location	Rural	2221	93.2(90.3-95.3)	0.1218
	Urban	1041	89.6(84.6-93.1)	
Zone	Western	285	95.5(93.3-97.0)	<0.001
	Northern	353	88.3(81.6-92.8)	
	Central	692	88.0(81.7-92.3)	
	Southern Highlands	305	90.9(76.6-96.8)	
	Southern	159	92.9(85.7-96.6)	
	Southwest Highlands	405	99.6(97.3-99.9)	
	Lake	220	73.8(58.8-84.7)	
	Eastern	294	95.7(91.4-97.9)	
	Unguja	317	91.5(98.1-99.9)	
	Pemba	232	99.7(98.1-99.9)	
Marital Status	Never married	584	92.4(88.3-95.1)	0.8556
	Married/cohabiting	2104	91.5(88.8-93.6)	
	Separated/divorced/widowed	574	90.7(81.2-95.7)	
Education level	No formal	1090	93.0(88.8-95.8)	0.0665
	Primary	1540	92.4(89.0-94.7)	
	Secondary	484	85.3(77.1-90.9)	
	College	148	85.3(77.1-90.9)	
Occupation	Employed	221	91.6(83.9-95.7)	0.9073
	Self employed	2097	91.3(88.1-93.7)	
	Others	944	92.1(87.6-95.0)	
BMI Categories	Not obese/overweight	2158	91.7(88.9-93.8)	0.7913
	Obese/overweight	960	91.1(86.1-94.4)	
Depression status	Not depressed	2688	91.1(88.6-93.2)	0.5147
	Depressed	547	92.8(86.9-96.1)	
Physical Activity	Insufficient	85	95.6(89.3-98.2)	0.0612
	Sufficient	118	96.1(90.6-98.5)	
	High	3059	91.2(88.6-93.3)	
Leisure Physical Activity	No	2392	93.1(90.2-95.2)	0.0356
	Yes	870	88.2(83.2-91.8)	
Overall	Overall	3262	92.4(90.5-94.4)	

Factors associated with poor dietary intake

Factors associated with inadequate dietary intake are presented in Table 3. In multivariable analysis, only place of residence, geographical zone, and leisure-time physical activity remained independently associated with inadequate intake. Rural residence was associated with a modest but statistically significant increase in the likelihood of inadequate consumption in both unadjusted (uPR = 1.05, 95% CI: 1.02–1.07) and adjusted models (aPR = 1.04, 95% CI: 1.01–1.06). Substantial regional variation persisted after adjustment, with all geographical zones exhibiting higher prevalence ratios compared to the Lake zone, ranging from aPR = 1.14 in the Central zone to aPR = 1.28 in the Southwest Highlands. Additionally, participants who reported no engagement in leisure-time physical activity had a higher probability of inadequate dietary intake (aPR = 1.04, 95% CI: 1.02–1.07). In contrast, sex, age, marital status, occupation, education, body mass index, and depression were not significantly associated with inadequate intake after adjustment.

Table 3: Factors associated with prevalence of consuming 0 or <5 servings per day among individuals aged 18-69 years

Variable	Categories	uPR,95%CI	P-Value	aPR,95%CI	P-value
Sex	Male	Ref			
	Female	1.00(0.98-1.02)	0.68		
Age group	18-30yrs	Ref			
	31-45yrs	1.00(0.97-1.02)	0.61		
	46-69yrs	1.00(0.98-1.03)	0.733		
Location	Rural	1.05(1.02-1.07)	<0.001	1.04(1.01-1.06)	0.005
	Urban	Ref		Ref	
Zone	Western	1.19(1.1-1.28)	<0.001	1.19(1.11-1.29)	<0.001
	Northern	1.15(1.06-1.24)	<0.001	1.19(1.1-1.28)	<0.001
	Central	1.13(1.05-1.22)	0.001	1.14(1.06-1.23)	0.001
	Southern Highlands	1.19(1.11-1.29)	<0.001	1.2(1.11-1.29)	<0.001
	Southern	1.17(1.08-1.27)	<0.001	1.19(1.1-1.3)	<0.001
	Southwest Highlands	1.27(1.19-1.37)	<0.001	1.28(1.19-1.37)	<0.001
	Lake	Ref		Ref	
	Eastern	1.22(1.14-1.32)	<0.001	1.23(1.15-1.33)	<0.001
	Unguja	1.16(1.08-1.26)	<0.001	1.19(1.1-1.29)	<0.001
	Pemba	1.27(1.18-1.36)	<0.001	1.27(1.18-1.37)	<0.001
Marital Status	Never married	0.99(0.96-1.02)	0.489		
	Married/cohabiting	1.00(0.97-1.02)	0.8		
	Separated/divorced/widowed	Ref			
Occupation	Employed	Ref		Ref	
	Self-employed	1.03(0.99-1.08)	0.17	0.99(0.94-1.04)	0.64
	Others	1.04(1.00-1.09)	0.066	0.99(0.94-1.04)	0.722
Education level	No formal	1.04(1.01-1.08)	0.012	1.03(1.00-1.07)	0.083
	Primary	1.03(1.00-1.06)	0.06	1.03(0.99-1.06)	0.148
	Secondary	Ref		Ref	
	College	0.96(0.90-1.03)	0.261		
BMI Categories	Not obese/overweight	Ref		Ref	
	Obese/overweight	0.98(0.96-1.00)	0.072	0.98(0.96-1.00)	0.122



Depression status	Not depressed	Ref		Ref	
	Depressed				
Leisure Physical Activity	No	1.05(1.03-1.08)	<0.001	1.04(1.02-1.07)	0.001
	Yes	Ref		Ref	

Discussion

According to the findings of this study, there is a serious shortage of fruits and vegetables consumption among Tanzanian adults, as over 90% of the sampled individuals did not reach the minimum level of consumption of 5 servings per day as recommended (Msambichaka et al., 2018). This pattern of poor nutrition spanned almost all socioeconomic and demographic categories, which means that the problem is deep-rooted and widespread across the population and not limited to only specific high-risk groups. Such uniformity suggests that the causes of poor diets are deeply linked to systemic issues such as the high price of vegetables and fruits and the infrequent supply in local markets, which are typical features in low and middle-income countries (Kagaruki et al., 2022; Miller et al., 2016; Odukoya et al., 2022). In fact, this major deficiency is consistent with worldwide evaluations, which stress that systemic barriers generally have more effect on individual demographic characteristics in determining eating habits in developing countries (Mahama Saaka, 2014).

Even though the general dietary deficit showed little change, several striking differences were revealed when location and type of residence were taken into consideration. For one thing, people living in rural areas had a slightly higher likelihood of not meeting their dietary needs than their urban counterparts, and this result could be related to problems with food supply chains as well as the seasonal nature of produce in rural markets (Ismail et al., 2013). In fact, although rural life is widely thought to offer better access to fresh food, the reality of farming just for food and money shortages often means that the actual availability and consumption may be limited (Mendez & Popkin, 2004; Popkin, 2014). Moreover, drastic differences between regions, such as the comparatively low rates of deficiency in the Lake zone in contrast to the very marked inadequacies of Pemba and the Southwest Highlands, highlight the role of local agricultural production systems and cultural food environments in influencing nutritional levels (Kagaruki et al., 2022).

One major behavioural element that correlated with a good diet in this research was being active in one's free time physically. Those not doing such exercises were, according to the findings, more likely to have lower F&V intake. This link may be interpreted as people who do physical exercises not only having a healthier lifestyle but also being more health literate or having better access to healthy foods (Rabel et al., 2019). Nevertheless, the relatively small magnitude of this connection suggests that individual lifestyle decisions by themselves are unable to explain the large dietary differences. This, in turn, points towards the importance of changing the structural environment rather than only focusing on individual behaviour change (Pettigrew et al., 2021). The current work shows that some factors generally considered as predictors of high diet quality, e.g., level of income, education, and body mass index, do not have a direct relation to fruit and vegetable consumption after other factors have been accounted for. This is only one instance of the several contradictions of common beliefs here that increased wealth or education inevitably results in making better nutritional choices in all situations (Msambichaka et al., 2018). In fact, in Tanzania, where food systems are frequently limited, and diets mainly consist of traditional staples, even those with a higher economic standing might find it difficult to obtain a wide variety of nutrients (Hough & Sosa, 2015). Hence, this is a clear indication that the shift in public health should be towards the modification of the food system so that the healthy food options are not only inexpensive but also available to everyone, no matter their individual status (Abbaftati et al., 2020). Considering the clinical and public health perspectives, it is quite worrisome that these deficits in

diet are so widespread, as there is a well-known association between low consumption of fruits and vegetables and an increased risk of developing life-threatening non-communicable diseases such as cardiovascular diseases and several types of cancers (Afshin et al., 2019). The findings illustrate a rather unusual epidemiologic situation in Tanzania, where, at least on the surface, people are physically active at work, but their poor nutrition seems to cancel out the health benefits of physical activity (Msambichaka et al., 2018). If the country continues to urbanize rapidly and with accompanying lifestyle changes, the inability to raise dietary quality is likely to make the diet-related NCDs a bigger problem for the country (Amunga et al., 2024).

In conclusion, these findings emphasize the necessity for comprehensive, multi-sectoral initiatives to enhance fruit and vegetable consumption across Tanzania. Effective interventions must go beyond simple education and prioritize the strengthening of national food systems, including improvements in the production and distribution of fresh produce. By integrating nutrition-focused policies with broader health promotion efforts and tailoring them to address specific regional barriers, it may be possible to achieve more equitable improvements in diet quality across the entire population.

Strengths and limitations

Strengths

This analysis used nationally representative Tanzania STEPS Survey data collected using a standardized WHO STEPS protocol and a rigorous three-stage stratified cluster sampling design, supporting generalizability of findings to Tanzanians aged 18–69 years in both mainland Tanzania and Zanzibar. Electronic data capture (ODK-based eSTEPS), daily field monitoring, centralized data cleaning, and the application of survey weights strengthen data quality and the validity of the reported population estimates.

Limitations

A cross-sectional study design precludes establishing temporal relationships between exposures and outcomes, thereby limiting causal inference regarding patterns of fruit and vegetable consumption. Consequently, observed associations should be interpreted as correlational rather than causal. In addition, the frequency of consumption per week and the number of daily servings of fruits and vegetables were self-reported, which may be subject to recall bias and social desirability bias. These biases can lead to over- or under-reporting of intake and may introduce differential or non-differential misclassification, potentially attenuating or inflating the observed associations and estimates of fruit and vegetable consumption.

Ethical Considerations

General ethical principles were strictly observed to protect participants' rights, dignity, and safety. Ethical approval was obtained from the National Health Research Ethics Committee with reference number NIMR/HQ/R.8a/Vol.IX/4248 for mainland Tanzania, and from the Zanzibar Health Research Ethics Committee and the Second Vice President's Office for Zanzibar. The study adhered to the Declaration of Helsinki principles and ensure respect for persons, beneficence, and justice throughout all stages of implementation. Participation was voluntary, with written informed consent obtained after clear explanation of study objectives, procedures, risks, and benefits in Swahili or local language. Participants could decline or withdraw at any time without consequence. Confidentiality was maintained by conducting interviews and measurements in private settings. Phone numbers were collected for follow-up (Steps 2 and 3). Data were anonymized at collection, by separating identifying information from the rest of the questionnaire by assigning a unique ID. Data were securely stored and accessed only by authorized personnel. Culturally appropriate



procedures were applied throughout the study. Permission to publish findings was sought from NIMR.

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Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Contributions

GBK, FEH, OSU, CK, VM, GTM, BS, OMS, ZSA, MMM, AN, NK, HN, SL, SGC, RN, KMK, SKA, KAK and MTM designed the study and wrote the manuscript. GBK, FEH, and MTM were involved in finalizing the method section. All authors participated in writing, reviewing, and approval of the manuscript. All authors read and approved the manuscript.

Abbreviations

aPR- Adjusted Prevalence Ratio
EA-Enumeration Area
BMI-Body Mass Index
LMICs-Low- and Middle-Income Countries
MET-Metabolic Equivalent Task
NCDs-Non-communicable Diseases
NIMR-National Institute for Medical Research
OCGS-Office of the Chief Government Statistician
uPR- Unadjusted Prevalence Ratio
WHO -World Health Organization

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