

**Original Article****Open Access****Food safety knowledge and hygiene practices among food handlers in Nnewi metropolis, southeast Nigeria***¹Okwuanaso, C. B., ²Onyemelukwe, N. F., and ¹Ofodile, C, A.¹Department of Medical Microbiology and Public Health, Faculty of Medical Laboratory Science, Nnamdi Azikiwe University, Nnewi Campus, Nnewi, Nigeria²Department of Medical laboratory Science, Collage of Health Sciences and Technology, University of Nigeria, Enugu Campus, Nigeria*Correspondence to: cb.okwuanaso@unizik.edu.ng; +2348030820722; ORCID: [0000-0003-4125-7155](https://orcid.org/0000-0003-4125-7155)**Abstract:**

Background: Food-borne illnesses are a major cause of morbidity and death worldwide, and food safety and hygiene play a critical role in maintaining and improving consumer health. One significant factor in the prevalence of food-related illnesses associated with unclean food is the way food vendors handle their inventory. As a result, this study evaluated the level of food handlers' adherence to cleanliness and safety standards, as well as the variables affecting them in the city of Nnewi. This study evaluated degree of safety and hygiene practices, as well as the factors influencing them, among food handlers in the Nnewi metropolis.

Methodology: A cross-sectional study of 428 consenting food handlers was carried out in Nnewi metropolis utilizing quantitative data gathering methodologies and non-probability method of sampling. A well-structured and pre-tested questionnaire was interviewer-administered to collect information on sociodemographic characteristics, food safety and hygiene practices, knowledge of food safety, and observational checklists that covered cleaning, sanitation and personal hygiene. Evaluation of safety and hygiene practices was done using a four-point scale of responses from participants, with scores equal and above the 50th percentile classified as good practices, while scores less than the 50th percentile as poor practices Data were analyzed using Minitab version 21.2 and SPSS version 27.0. P value < 0.05 was considered significant.

Results: The mean age of the 428 food handlers who responded, was 33.89±10.29 years, with female preponderance (83.4%, n=357). A total of 217 (50.7%) respondents were adjudged to be of good practices of food safety while 211 (49.3%) were of bad practices. Statistical analysis showed that food safety and cleanliness habits were significantly associated with age, marital status, and gender ($p < 0.05$). The presence of running water and the type of vending establishment (branded and unbranded) were also significantly associated with food safety practices while factors such as education level of respondents, prior training in food safety, knowledge of food safety policy in Nigeria, and duration of employment as food handlers, were not significantly associated with food safety practices ($p > 0.05$).

Conclusion: The data indicate that certain demographic factors significantly impact food safety practices, pointing to potential areas for intervention, such as enhancing training and monitoring, particularly among younger, married, and less-educated food handlers, and ensuring the presence of running water in the vending premises. Food safety and cleanliness standards need to be raised because maintaining and enhancing health depends on food's wholesomeness and maximum safety.

Keywords: Socio-demographic, food safety and hygienic practices, food handlers, Nnewi

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Copyright 2025 AJCEM Open Access. This article is licensed and distributed under the terms of the Creative Commons Attribution 4.0 International License <http://creativecommons.org/licenses/by/4.0/>, which permits unrestricted use, distribution and reproduction in any medium, provided credit is given to the original author(s) and the source. Editor-in-Chief: Prof. S. S. Taiwo**Connaissances en matière de sécurité alimentaire et pratiques d'hygiène chez les manipulateurs d'aliments dans la métropole de Nnewi, au sud-est du Nigéria***¹Okwuanaso, C. B., ²Onyemelukwe, N. F., et ¹Ofodile, C, A.¹Département de Microbiologie Médicale et de Santé Publique, Faculté des Sciences de Laboratoire Médical, Université Nnamdi Azikiwe, Campus de Nnewi, Nnewi, Nigéria²Département des Sciences de Laboratoire Médical, Collège des Sciences de la Santé et de la Technologie, Université du Nigéria, Campus d'Enugu, Nigéria*Correspondance à: cb.okwuanaso@unizik.edu.ng; +2348030820722; ORCID: [0000-0003-4125-7155](https://orcid.org/0000-0003-4125-7155)

Résumé:

Contexte: Les maladies d'origine alimentaire sont une cause majeure de morbidité et de décès dans le monde, et la sécurité alimentaire et l'hygiène jouent un rôle essentiel dans le maintien et l'amélioration de la santé des consommateurs. Un facteur important dans la prévalence des maladies liées à la nourriture et associées à des aliments impurs est la façon dont les vendeurs de nourriture gèrent leur inventaire. En conséquence, cette étude a évalué le niveau d'adhésion des manipulateurs d'aliments aux normes de propreté et de sécurité, ainsi que les variables qui les affectent dans la ville de Nnewi. Cette étude a évalué le degré de pratiques de sécurité et d'hygiène, ainsi que les facteurs qui les influencent, parmi les manipulateurs d'aliments dans la métropole de Nnewi.

Méthodologie: Une étude transversale de 428 manipulateurs d'aliments consentants a été menée dans la métropole de Nnewi en utilisant des méthodologies de collecte de données quantitatives et une méthode d'échantillonnage non probabiliste. Un questionnaire bien structuré et pré-testé a été administré par l'intervieweur pour recueillir des informations sur les caractéristiques sociodémographiques, les pratiques de sécurité et d'hygiène alimentaires, la connaissance de la sécurité alimentaire et des listes de contrôle d'observation couvrant le nettoyage, l'assainissement et l'hygiène personnelle. Français L'évaluation des pratiques de sécurité et d'hygiène a été réalisée à l'aide d'une échelle de réponses à quatre points des participants, les scores égaux et supérieurs au 50e percentile étant classés comme de bonnes pratiques, tandis que les scores inférieurs au 50e percentile étant classés comme de mauvaises pratiques. Les données ont été analysées à l'aide de Minitab version 21.2 et SPSS version 27.0. Une valeur de $p < 0,05$ a été considérée comme significative.

Résultats: L'âge moyen des 428 manipulateurs d'aliments qui ont répondu était de $33,89 \pm 10,29$ ans, avec une prépondérance de femmes (83,4%, $n=357$). Au total, 217 (50,7%) des répondants ont été jugés comme ayant de bonnes pratiques de sécurité alimentaire tandis que 211 (49,3%) avaient de mauvaises pratiques. L'analyse statistique a montré que les habitudes de sécurité alimentaire et de propreté étaient significativement associées à l'âge, à l'état matrimonial et au sexe ($p < 0,05$). La présence d'eau courante et le type d'établissement de vente (de marque ou non) étaient également significativement associés aux pratiques de sécurité alimentaire, tandis que des facteurs tels que le niveau d'éducation des répondants, la formation préalable en sécurité alimentaire, la connaissance de la politique de sécurité alimentaire au Nigéria et la durée de l'emploi en tant que manipulateurs d'aliments n'étaient pas significativement associés aux pratiques de sécurité alimentaire ($p > 0,05$).

Conclusion: Les données indiquent que certains facteurs démographiques ont un impact significatif sur les pratiques de sécurité alimentaire, ce qui met en évidence des domaines d'intervention potentiels, tels que l'amélioration de la formation et du suivi, en particulier chez les manipulateurs d'aliments plus jeunes, mariés et moins instruits, et la garantie de la présence d'eau courante dans les locaux de vente. Les normes de sécurité alimentaire et de propreté doivent être renforcées car le maintien et l'amélioration de la santé dépendent de la salubrité et de la sécurité maximale des aliments.

Mots-clés: Sociodémographie, sécurité alimentaire et pratiques d'hygiène, manipulateurs d'aliments, Nnewi

Introduction:

Given that food-borne illnesses are major global causes of illness and death, food safety and cleanliness are crucial in promoting and maintaining consumer health (1). According to estimates from the World Health Organisation (WHO), there are over 600 million food-borne illnesses worldwide, resulting in approximately 420,000 deaths and a loss of approximately 33 million Healthy Life Years (HLYs) per year (2). This would have a significant negative impact on population health and place a significant social strain on the communities and their healthcare system (3,4). Poor food handling procedures by food handlers have been identified as the primary cause of the spread of various food-related disorders according to the Food and Agricultural Organization (FAO) (5). A food handler is an employee of a food business that handles food at any capacity (6).

Food safety issues in Africa typically focus on illnesses associated with inadequate hygiene, as per the findings of other researchers (7). There is more evidence that food-borne illnesses and outbreaks of foodborne diseases in sub-Saharan Africa are often link-

ed to inadequate hygiene practices by food handlers at vending establishments (8). Absence of necessary services and infrastructure, such as access to clean drinking water, the transient nature of street-vended food, and a lack of awareness of fundamental food safety practices, can all contribute to serious health issues for the community (7).

Despite government efforts through the National Agency for Food and Drug Administration and Control (NAFDAC) to improve food supply safety, food safety is still a serious concern Nigeria. The public's ignorance of food hygiene, the government's disorganized approach to food safety regulation, and the implementation of food safety policy by law have all contributed to the aggravation of this issue (9). In order to guarantee safety of food, food handlers are now under more pressure because it is predicted that temperature changes caused by climate change will impact the risks related to food production, storage, and distribution (10).

Food handlers face the challenge of maintaining food safety, as they are often unaware of their responsibilities to ensure appropriate personal and environmental cleanliness, along with fundamental food hygiene

procedures, when purchasing, preparing, and selling food (10). Owing to their direct contact with customers and the simplicity of achieving food safety control measures, they play a vital role in effectively lowering the risk of food-borne illnesses. The purpose of the study was to evaluate the degree of cleanliness and food safety practices, as well as the factors influencing them, among food vendors in the city of Nnewi, southeast Nigeria.

Materials and method:

Study area:

This study was conducted in Nnewi, Nnewi North LGA, Anambra State, Nigeria. Nnewi is a metropolitan city made up of four quarters; Otolo, Uruagu, Umudim, and Nnewichi. Nnewi is located at latitude 6.0167N and longitude 6.9167E, with a land area of 2,789 km³ and a population of approximately 2 million (11,12). Owing to the existence of numerous major and small-scale enterprises, vehicle production companies, and the automobile market, Nnewi, the second largest city in the State of Anambra, is known as 'Japan in Africa' (11). There is a common belief that the population of Nnewi Metropolis exceeds two million.

Temperatures in the North and South vary from 25°C to 35°C, with annual rainfalls of 1400 mm and 2500 mm, respectively. In terms of location, trading is the primary employment of the Nnewi residents. Undoubtedly, Nnewi's industrial activities have significantly advanced the city. This is largely due to the fact that Nnewi's success in the motorcycle replacement parts industry has drawn a sizeable population, which has made the city a centre for numerous other economic ventures as there is a sizeable customer base.

Study design and ethical approval:

This was a descriptive cross-sectional survey designed with a structured questionnaire. The Ministry of Health in Anambra State granted ethical clearance prior to the study's launch. All participants provided their consents and were assured of confidentiality.

Sample size:

The Leslie Fischer's formula for calculating sample size in populations larger than 10000, $n = Z^2 pq / d^2$ (13), was used to calculate the sample size, where n is the estimated minimum sample size, Z is the 95% confidence interval level of significance (1.96), q is the complementary probability (1-p), d is the study's precision set at 0.05, and p is the proportion of food handlers (54.0%, 0.54) who adhere to proper food safety and hygiene in a previous study (14). The calculated

sample size was 382, but this was adjusted to 428 after correcting for attrition.

Inclusion and exclusion criteria:

All food handlers who had static food vending establishments (which are easy to find) and who had worked in branded or unbranded restaurants for at least six months, and provided their agreement to participate in the study, were included in the study. Those under the age of eighteen and had not handled food for up to six months were excluded from the study.

Sampling technique:

A non-probability sampling technique were used to recruit all the food handlers within the study area, who complied with the inclusion criteria.

Data collection and pre-test:

The study employed a semi-structured questionnaire that was administered by an interviewer. It included four sections; (i) sociodemographic characteristics, (ii) food safety and hygiene practices, (iii) knowledge and attitudes regarding food safety, and (iv) observational checklists that covered cleaning, sanitation and personal hygiene.

The data collection tool was pretested before the study started with ten percent (10%) of the estimated minimum sample size in another town (Awka) in the state. Ten (10) data collectors were trained for the study.

Response evaluation and grading of food safety and hygiene practices:

Fifteen stem questions were used to evaluate the practices of food sanitation and cleanliness. For each response that was answered correctly, a mark of two was given; for responses that were rated on a four-point scale, the best response received four marks. Scores equal and above 50th percentile were classified as good practices, while scores less than 50th percentile cut-off were classified as poor practices for food safety and hygiene practices, respectively. The results were plotted on a percentile graph.

Statistical analysis:

Data were analyzed using Minitab version 21.2 and SPSS version 27.0. Association of socio-demographic and other factors with food safety and practices was determined using Chi square test. $P < 0.05$ was considered significant.

Results:

Sociodemographic characteristics of the study participants/respondents:

The mean age of the study participants was 33.9 ± 10.3 years and majority ($n=330$, 77.1%) were 40 years and younger, while 357 (83.4%) were females. The marital

status of the respondents showed almost similar proportions between unmarried (n=206, 48.1%) and married (n=222, 51.9%), with a majority (n=267, 62.4%) having a secondary level of educational attainment.

A total of 351 (82.0%) of the food vendors had been in the business for more than 10 years, while 77 (18.0%) had been vending food for less than 10 years.

Food safety and hygiene practices among the study participants:

Table 2 shows the frequency of food

safety and hygiene practices among the respondents. Attendance and non-attendance of training in food safety practices were reported among 43 (10.0%) and 385 (90.0%) respondents respectively.

The practice of hand washing before and after handling food was reported every time among 93 (21.7%), often among 125 (29.2%), rarely among 210 (49.1%) and not at all among 0 (0%) respondents.

Table 1: Socio-demographic characteristics of the respondents

Characteristics	Frequency	Percentage (%)
Age range (years)		
15 - 20	25	5.8
21 - 25	59	13.8
26 - 30	123	28.7
31 - 35	76	17.8
36 - 40	47	11.0
41 - 45	34	7.9
46 - 50	24	5.6
51 - 55	21	4.9
56 - 60	12	2.8
61 - 65	7	1.6
Mean age ± SD (years)	33.9 ± 10.3	
Gender		
Female	357	83.4
Male	71	16.6
Marital status		
Single	206	48.1
Married	222	51.9
Educational attainment		
No formal education	60	14.0
Post-primary	42	9.8
Post-secondary	267	62.4
Tertiary	59	13.8
Duration of food vending (years)		
1 - 5	45	10.5
6 - 10	32	7.5
11 -15	182	42.5
16 - 20	169	39.5
Type of restaurants		
Branded	162	37.9
Unbranded	266	62.1
Total	428	100.0

Table 2: Frequency of food safety and hygiene practices among the respondents

Practice	Frequency	Percentage (%)
Training in food safety		
Yes	43	10.0
No	385	90.0
Availability of running water		
Yes	177	41.4
No	251	58.6
Hand washing before and after handling food		
Every time	93	21.7
Often	125	29.2
Frequently	210	49.1
Rarely	0	0
Not at all		
Sanitizing utensils before and after use		
Every time	182	42.5
Often	147	34.4
Rarely	99	23.1
Not at all	0	0
Use of cooking apron and hand gloves		
Every time	64	14.9
Often	153	35.8
Rarely	162	37.9
Not at all	49	11.4
Covering of injuries when handling food		
Every time	94	22.0
Often	138	32.2
Rarely	183	42.8
Not at all	13	3.0
Covering of hair		
Yes	192	44.9
No	236	55.1
Absence from work when sick		
Yes	208	48.6
No	220	51.4
Knowledge of food safety policy in Nigeria		
Yes	31	7.2
No	397	92.8
Level of practice		
Good	217	50.7
Poor	211	49.3

Running water was available in the restaurants where 177 (58.6%) of the respondents work while running water was not available where 251 (41.41%) work. A total of 182 (42.5%) respondents always sanitized their utensils before and after use, while 0 (0.0%) had not at any time sanitized their utensils before and after use. Only 64 (14.9%) participants responded that they use suitable cooking aprons and gloves when preparing food every time, 153 (35.8%) often, 162 (37.9%) rarely and 49 (11.4%) not at all.

A total of 94 (21.9%) respondents usually covers their cuts and wounds during food handling every time, 138 (32.2%) often, 183 (42.8%) rarely and 13 (3.0%) not at all. In terms of food safety and hygiene, 217 (50.7%) respondents had good practices, while 211 (49.3%) had poor practices.

Factors associated with food safety and hygiene practices among the respondents:

Table 3 shows the socio-demographic and other factors associated with food safety and hygiene practices among the respondents. In the table, gender, age and marital status were socio-demographic factors significantly associated with food safety and hygiene practices ($p < 0.05$). Specifically, good practice of food safety was significantly higher among respondents in the age groups 36-40 years (70.2%) and 46-50 years (62.5%) and bad practice was significantly higher among age groups 51-55 years (85.7%), 61-65 years (71.4%) and 41-45 years (70.6%), compared to other age groups ($p = 0.0004$).

With respect to marital status, good practice of food safety was significantly higher among married respondents (124/222,

55.9%) than single unmarried respondents (93/206, 45.1%) ($p=0.03$). Also, with gender, good practice of food safety was significantly higher among female respondents (189/357, 52.9%) than the male respondents (28/71, 39.4%) ($p=0.05$).

Other factors significantly associated ($p<0.05$) with food safety practices are the type of vending premises/restaurants and availability of running water at the restaurants. Good practice of food safety was significantly higher among respondents from branded vending premises (99/162, 61.1%) than among respondents from unbranded premi-

ses (118/226, 44.4%) ($p=0.001$). Similarly, good practice of food safety was significantly higher among respondents who had running water in their restaurants (101/177, 57.1%) than respondents who had no running water in their restaurants (116/251, 46.2%) ($p=0.03$).

In contrast, there were no statistically significant associations of food safety practice with factors such as education level of respondents ($p=0.432$), prior training in food safety ($p=0.2$), knowledge of food safety policy in Nigeria ($p=0.853$), and duration of employment as food handlers ($p=0.717$).

Table 3: Association of socio-demographic characteristics of respondents with practice of food safety and hygiene

Factors	Good Practice (%)	Bad Practice (%)	p value
Total (n=428)	217 (50.7)	211(49.5)	
Gender			
Male (n=71)	28 (39.4)	43 (60.6)	0.05*
Female (n=357)	189 (52.9)	168 (47.1)	
Age group (years)			
15 – 20	12 (48.0)	13 (52.0)	0.0004*
21 – 25	27 (45.8)	32 (54.2)	
26 – 30	70 (56.9)	53 (43.1)	
31 – 35	40 (52.6)	36 (47.4)	
36 – 40	33 (70.2)	14 (29.8)	
41– 45	10 (29.4)	24 (70.6)	
46– 50	15 (62.5)	9 (37.5)	
51– 55	3 (14.3)	18 (85.7)	
56 – 60	5 (41.7)	7 (58.3)	
61 – 65	2 (28.6)	5 (71.4)	
Marital status			
Single (n=206)	93 (45.1)	113 (54.9)	0.03*
Married (n=222)	124 (55.9)	98 (44.1)	
Educational level			
No formal education	28 (46.7)	32 (53.3)	0.432
Primary	26 (61.9)	16 (38.1)	
Secondary	135 (50.6)	132 (49.4)	
Tertiary	28 (47.5)	31 (52.5)	
Duration of food vendors			
1 - 5 years	25 (55.6)	20 (44.4)	0.717
5 – 10 years	18 (42.9)	14 (57.1)	
10 – 15 years	93 (51.1)	89 (48.9)	
16 --20 years	81 (47.9)	88 (52.1)	
Type of restaurants			
Branded (n=162)	99 (61.1)	63 (38.9)	0.001*
Unbranded (n=266)	118 (44.4)	148 (55.6)	
Availability of running water			
Available (n=177)	101 (57.1)	76 (42.9)	0.03*
Not available (n=251)	116 (46.2)	135 (53.8)	
Prior training in food safety			
Yes (n=43)	26 (60.5)	17 (39.5)	0.2
No (n=385)	191 (49.6)	194 (50.4)	
Knowledge of food safety policy of Nigeria			
Yes (n=31)	15 (48.4)	16 (51.6)	0.853
No (n=397)	202 (50.9)	195 (49.1)	

*=statistically significant

Discussion:

The survey respondents in this study were a very youthful group of food vendors; the highest number of these vendors ($n=123$, 28.7%) were in the 26–30 years age bracket. This finding aligns with that of an earlier Nigerian study (14). Of all the respondents, 83.4% were females, which is in line with the tendency that cooking is a feminine activity in modern African settings, however, this is not to suggest that men do not work as food vendors. This conclusion is also consistent with that of a previous study conducted in Nigeria (15).

The findings from this study shows that age, marital status, gender, type of restaurants and availability of running water were significantly associated with food safety practices ($p<0.05$). Specifically, age groups respondents in age groups 51-55 years had higher frequency of bad practices (85.7%) compared to other age groups. This suggests that targeted training on food safety should be for older food handlers. In term of marital status, significantly higher number ($p=0.03$) of married respondents had good safety food safety practices (55.9%, $n=124$) compared to unmarried respondents (44.1%, $n=98$), possibly reflecting differences in responsibilities or time constraints affecting their performance at work.

There was significantly higher number of male gender with poor/bad practices of food safety and hygiene ($p=0.05$), indicating that females tend to have better food safety practices. Respondents in restaurants where there is availability of running water ($p=0.03$) and those in branded restaurants ($p=0.001$) had significantly higher practices of food safety and hygiene which suggests that these factors significantly impact on the practice of food safety and are fundamental to the practice of good food safety.

In this survey, 76.2% of the food handlers were educated beyond primary level, which is similar to the finding of another Nigerian study (16). The handling and selling of food require basic level of literacy, as certain situations may require compliance with basic standards for food safety and sanitation. Therefore, completing a basic education is crucial. Like most professions where skills and abilities tend to increase with time, the length of food vending may sporadically, but not consistently have an impact on food safety and hygiene standards. More respondents in this survey had worked in the food industry for over five years, which agrees with the results of another research conducted in Nigeria (17).

A crucial tactic for enhancing and promoting safe food-handling procedures is

periodic training on food safety and hygiene practices. Considering the significance of this training, 90.0% of the respondents in our study had not participated in any such training in the two years prior to the study. These findings align with those of previous research conducted in Malaysia, Nigeria, and India, where 73.2%, 88.5%, and 100.0% of food handlers, respectively, reported not having received any current training of food safety and hygiene practices (17,18,19). This may indicate that food safety and hygiene training are not prioritized by business owners and are likely not being properly implemented by the appropriate authorities.

However, in our study, factors such as education, duration of food vending, prior training in food safety and knowledge of food safety policy did not show significant associations with food safety practices ($p=0.432$, 0.717, 0.2 and 0.853 respectively). Although these factors were expected to be significant, they were not in this study, possibly due to the approach of the food handlers in implementing their knowledge and non-enforcement of food safety practices by regulatory bodies. The expected standard for food handlers is appropriate food safety and hygiene practices. Nevertheless, the expectation was barely met in our study, with only about half of the respondent food handlers (50.7%) having good practice of food safety and hygiene. Our results agree with those researches carried out in Nigeria and India (20,21), but lower compared to studies conducted in Malaysia and in another geographical zone of Nigeria (22,23). The discrepancy in results may be due to the different environments in which these investigations were conducted, but more significantly, to variations in the facilities and structures available for handling food, as well as previous participation in training in this area.

Only 21.7% participants in this study indicated washing their hands every time, before and after handling food, which contrast the finding of a research conducted in Northwest Ethiopia and Nigeria (14,24), where majority of the participants were reported to wash their hands every time before and after handling food. The lack of hand washing stations and access to water in the majority (58.6%) of the vending establishments in Nnewi metropolis, may be the cause of our findings.

Most of the respondents (92.8%) in our study had neither knowledge of the food safety policy of Nigeria nor engage in implementing this policy, which is an implication of the negligence and non-implementation of food safety policy in the Nnewi metropolis. The role of education, training and implementation of the food safety in Nigeria in impro-

ving safe food handling practices cannot be overemphasized. On the other hand, other elements may also contribute to the safety and wholesomeness of prepared food when they are carefully considered and incorporated into food safety improvement interventions.

Conclusion:

Food safety and hygiene practices need to be improved since wholesomeness and food safety are crucial for maintaining and advancing health. This can be achieved by implementing and enforcing the food safety policy, which includes, but is not limited to, access to water supplies within the vending facilities and training on food safety and hygiene practices.

To enhance public health, there is need for enforced implementation of food safety policy in Nigeria. Further research is required to develop strategy for guaranteeing ongoing quality enhancement in safe food handling procedures.

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Contributions of authors:

OCB designed the study, OCB wrote the protocol; OCA and OCB contributed to the literature search; OCA and OCB performed the statistical analysis of data; OCB, ONF and OCA contributed in discussion; OCB produced the initial manuscript draft; OCB supervised the work; OCB wrote the final manuscript; ONF and OCA proofread the manuscript and all authors approved the final manuscript submitted for publication.

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Conflict of interest

Authors declare no conflict of interest.

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