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Full Length Research Article

PARASITOLOGICAL ASSESSMENT OF WATER AND ENVIRONMENTAL CONDITIONS ASSOCIATED WITH FOOD VENDING IN CALABAR, NIGERIA

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ABSTRACT
Food vending plays a vital role in the urban food supply in Calabar, Nigeria, yet the safety of water used by vendors remains a major public health concern. This study assessed the parasitological contamination of water and environmental hygiene conditions associated with food vendors across four locations in Calabar Metropolis. A total of 120 water samples (before and after customer hand-washing) were collected and analyzed using the sedimentation technique, while structured questionnaires and observational checklists captured vendors' hygiene practices and environmental conditions. Results showed an overall parasite contamination prevalence of **31.7%**, with higher contamination before hand-washing (35.0%) than after (28.3%). Anantigha (56.7%) and 8th Mile (43.3%) recorded the highest contamination levels. Three parasite species—*Ascaris lumbricoides* (15.8%), *Entamoeba histolytica* (10.0%), and *Giardia lamblia* (5.3%)—were identified. Many vendors relied on water from unknown sources (51.4%), and environmental assessment revealed significant fly presence (65.7%) and proximity to refuse dumps (17.1%). Despite most vendors wearing protective clothing, sanitation gaps persisted. The findings demonstrate considerable parasitic risks associated with water used by food vendors in Calabar and highlight the need for improved hygiene practices, regulated water sources, routine monitoring, and strengthened public health education to reduce transmission.

Keywords: Food Vendors, Parasites, Water Contamination, Hand Washing.

INTRODUCTION

Foodborne illness affects approximately 600 million people annually, causing 420,000 deaths, with the majority occurring in low and middle-income countries, and the loss of 33 million healthy life years (WHO, 2020). Also, 1.8 million people die from diarrheal disease alone, with a great proportion of these cases attributed to contamination of food and drinking water (WHO, 2021). The total productivity loss associated with food-borne disease in low- and middle-income countries is estimated to cost U.S. $95.2 billion per year, and the annual cost of treating food-borne illness is estimated at U.S. $15 billion (World Bank, 2018). In many developing nations, the informal food sector, dominated by street food vendors, poses significant challenges to food safety due to hygiene lapses, inadequate regulatory oversight, and poor infrastructure (Okojie & Isah, 2018). Food vendors often fail to comply with food safety standards, thereby increasing the risk of foodborne illness (Eze *et al*., 2020). Non-adherence to food safety standards can stem from several factors, including limited knowledge of proper hygiene practices, inadequate training in food safety, poor enforcement of regulatory guidelines, and economic constraints that discourage investment in clean, safe equipment (Chukwuma *et al*., 2020). Consumers are also largely unaware of food safety standards and rely more on sensory perception rather than microbiological safety when judging food safety. Food quality can never be guaranteed when the items used for food preservation, consumption, and service are unhygienic. Therefore, they should be cleaned each time they are used. Additionally, the environment where food is prepared plays a vital role in safety/ quality. Well-ventilated and properly lighted units of food premises ensure good work practices. Food needs to be handled properly to safeguard human health. Contamination anywhere along the food chain can have far-reaching effects and sometimes fatal consequences.

Food handlers play a major role throughout the chain of food production, processing, packaging, storage, and preparation. Hence, any knowledge gaps in food hygiene among food handlers pose a serious challenge to food safety. Globally, poor knowledge and practice of food hygiene have been observed among some commercial and domestic food handlers (OECD, 2015). Studies in many towns in Nigeria indicate that a significant proportion of food vendors have poor food hygiene practices (Okojie & Isah, 2018; Egwari *et al*., 2020). The educational level of food vendors was reported to be significantly related to their food safety and hygiene practices (Faremi *et al*., 2018).
Calabar is a city known for its vibrant culture and diverse cuisine. The city relies heavily on food vendors who provide accessible and affordable meals to residents and tourists alike. Adherence to food hygiene practices cannot be overemphasized to ensure that food is safe, wholesome, and fit for human consumption, thereby protecting the public from health and foodborne challenges (Atalay *et al*., 2022). This study was therefore aimed at assessing the parasitological status of water and environmental conditions associated with food vending in Calabar.

MATERIALS AND METHODS

Description of the study area

This study was conducted in Calabar, the capital city of Cross River State, Nigeria. Calabar is located in southern Nigeria and has a population of approximately 371,022, according to the 2006 census (National Population Commission, 2006). The city is known for its rich cultural heritage and is home to various ethnic groups, including the Efik and Ekin people (Akpabio *et al.,* 2004). Calabar has a tropical rainforest climate, with high temperatures and humidity throughout the year. The city has a mix of urban and rural areas, with varying levels of access to healthcare and sanitation facilities (Akpabio *et al.,* 2004).

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Calabar is a growing global tourist destination that offers active, vibrant day and night life, with a significant concentration of food vendors, eateries, and bars. There are varieties of rich local cuisines.

Study design
The research was conducted in Calabar Metropolis, the capital of Cross River State, Nigeria. These areas are known for high levels of food vending activity by both stationary and mobile vendors. The metropolis was delineated into four sampling areas, namely, (i) Calabar Municipal, (ii) 8th Mile Axis, (iii) Calabar South, and (iv) Anantigha Axis.
The target population included street food vendors, stationary food vendors in markets, food handlers in schools and eateries, and mobile food hawkers. The estimated vendor population in Calabar Metropolis was 2,000-3,000 individuals.

Sample Size Determination
Sample size was determined using the Taro Yamane formula (Yamane, 1967):
n= N1 + N(e) 2 n= 1N+N(e) 2
Where: n = sample size, N = total population (3,000), e = margin of error (0.05)
This gave the sampling size estimate of 353 respondents, but 360 questionnaires were administered.

Methods of Data Collection
Data collection was carried out using three methods: (i) through the use of structured questionnaires, (ii) through the use of an observation/ Inspection checklist, (iii) through the collection and laboratory analysis of samples.

Use of a structured questionnaire: Data were collected using a questionnaire comprising three sections (A, B, C). Section A bothered on demographics (age, gender, education level, *et cetera*), Section B had questions investigating the knowledge, aptitudes and awareness of food safety (e.g., foodborne diseases, hand-washing *et cetera*), Section C enquired about practices and general attitudes towards hygiene (for example, how often they wash utensils, wear protective clothing, the willingness to use gloves, aprons). The questionnaire was validated and pre-tested among 20 food vendors in Akamkpa, which is outside the study area.
Data was collected through face-to-face administration of questionnaires (with interpretation in local dialects when necessary). A total of 360 questionnaires were administered, and 355 were completed and returned, representing 98.6% compliance.

Use of Observation/Inspection checklist: The observation checklist was used to verify hygienic practices and general sanitation, the presence of flies, and proximity to refuse dumps, toilets, and suck-ways.

Collection of samples.
Water from the food vendors was allowed to settle before the supernatant was carefully decanted and the remainder collected into well-labelled sample containers, fixed with drops of Lugol's iodine, stored in coolers packed with ice blocks, and transported to the Biology Laboratory.

Laboratory analysis of samples
The water samples were analyzed using the Sedimentation technique (Cheesbrough, 2009). Identification of the parasites was carried out microscopically using standard parasitological identification keys and atlases based on the morphology of eggs, cysts, oocysts, larvae, and adult parasites (Garcia, 2007).

Data Analysis
Quantitative data were coded and entered into SPSS version 25. The following analyses were performed: Descriptive statistics: Frequency tables, percentages, and mean scores. Inferential statistics: Chi-square tests to determine associations between knowledge and practices, ANOVA for differences among different vendor types, and logistic regression to predict the likelihood of good practices based on knowledge level

Ethical Considerations
Approval was obtained from the Ethical Committee, Faculty of Biological Science, University of Cross River State, Calabar. Informed consent was obtained from all participants. Participants were assured of confidentiality and anonymity. Data was used strictly for academic purposes.

RESULTS

Parasite contamination of water used by food vendors in Calabar in relation to locations.
Parasite contamination of water served to customers by food vendors in Calabar is presented in Table 1. The prevalence of parasite contamination was 31.7%. The prevalence of parasite contamination in water used by customers to wash their hands before use was 35.0%, while after use it was 28.3%. The difference in prevalence was not statistically significant ($\chi 2 = 0.42$, $df = 1$, $p > 0.05$). Prevalence was highest (56.7%) in Anantigha, followed by 8th Mile axis (43.3%), and lowest in Calabar Municipal (26.7%). Using the Chi-square test for heterogeneity, the differences in prevalence between the locations were not statistically significant ($x^2 = 3.82$, $df = 3$, $p < 0.05$).

Table 1. Parasite contamination of water used by food vendors in Calabar in relation to locations

Location	Number Collected		Number Positive (%)		Total Prev (%)
	(Before)	(After)	(Before)	(After)	
Calabar Municipal	15	15	5 (33.3)	3 (20.0)	8 (26.7)
Calabar South	15	15	7 (46.7)	3 (20.0)	10 (33.3)
Eight Mile Axis	15	15	8 (53.3)	5 (33.3)	13 (43.3)
Anantigha Axis	15	15	11 (73.3)	6 (40.0)	17 (56.7)
Total	**60**	**60**	**21 (35.0)**	**17 (28.3)**	**38 (31.7)**

Parasite species composition
The contribution of parasite species in the contamination of water served to customers by food vendors in Calabar is presented in Table 2. Three parasite species were found: Ascaris lumbricoides (15.8%), Entamoeba histolytica (10.0%), and Giardia *lamblia*

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(6.7%). The differences in prevalence between the parasite species were statistically significant (x^2 = 11.76, df = 2, p < 0.05).

Table 2. Prevalence of parasite species contamination of water served by food vendors in Calabar

Parasite Species	Number Collected		Number Positive (%)		Total Prev (%)
	(Before)	(After)	(Before)	(After)	
A. lumbricoides	60	60	12 (20.0)	7 (11.7)	19 (15.8)
E. histolytica	60	60	6 (10.0)	6 (10.0)	12 (10.0)
G. lamblia	60	60	3 (5.0)	4 (6.7)	7 (5.3)
Total	**60**	**60**	**21 (35.0)**	**17 (28.3)**	**38 (31.7)**

Socio-demographic characteristics of customers of food vendors in Calabar.

The socio-demographic characteristics of food vendors' customers are presented in Table 3. A significantly higher percentage of males (59.1%) than females (40.9%) were customers. The highest prevalence of customers (43.8%) was among those with the highest level of education. In terms of food vendor type, restaurants were the most common (60.9%), followed by buka (small restaurants) at 30.4%. Mobile vendors were relatively few (8.5%).

Table 3. Socio-demographic characteristics of customers of food vendors

Parameter	Grouping	Number, (%)
Sex	Male	210 (59.2)
	Female	145 (40.8)
Age Group (years)	21–30	115 (32.4)
	31–40	159 (44.8)
	≥41	81 (22.8)
Education	Primary	54 (15.2)
	JSS	47 (13.2)
	SSS	98 (27.6)
	Tertiary	156 (43.9)
Type of Food Vendor	Restaurant	216 (60.8)
	Buka	109 (30.7)
	Mobile	30 (8.5)

Qualities of the food vendor environment and services provided in Calabar

The qualities of the environment and services provided by the food vendor are presented in Table 4. Only 17.1% of them were located close to refuse dumps. In all, it was observed that a highly significant percentage of them (69.5%) were kitted with head gears and coveralls while cooking and serving (x^2 = 16.00, df = 1, p < 0.001); and only a significant few (17.1%) were located quite close to refuse dumps (x^2 = 43.34, df = 1, p < 0.001). However, a statistically significant majority (65.7%) of the food vendors reported a problem with house flies (Musca domestica) as a nuisance ($\chi 2$ = 9.7, df = 1, p < 0.001). The presence of human faeces in the environment, including that of babies, was observed in only 18.0% of them. A significant majority were free of this (x^2 = 16.0042.76, df = 1, p < 0.001).

Table 4. Qualities of the food vendor environment and services provided in Calabar

Parameters	Yes, (%)	No, (%)
Are the cooks properly kitted with headgear and coveralls?	73 (69.5)	32 (30.4)
Is the food vending location close to the refuse dump?	18 (17.1)	87 (82.8)
Presence of flies	69 (65.7)	36 (34.2)
Presence of human faeces, including that of babies	19 (18.0)	86 (81.9)

Sources of water served by food vendors

The sources of water served by vendors are presented in Table 5. Three sources of water served to customers to wash their hands before eating were observed, namely, tap water (33.3%), water from an unknown source (51.4%), and sachet water (15.2%). Water from unknown sources was significantly more common ($\chi 2$ = 20.62, df = 1, p < 0.001). Water served for drinking was significantly more likely to be sachet water than bottled water ($\chi 2$ = 30.94, df = 1, p < 0.001).

Table 5. Sources of water served customers by food vendors

Parameter	Frequency, (%)
Sources of water served for hand washing before eating	
Tap water	35 (33.3)
Water in a jug from an unknown source	54 (51.4)
Sachet water	16 (15.2)
Source of drinking water served	
Sealed sachet water	81 (77.1)
Sealed bottled water	24 (22.85)

DISCUSSION

Food vending is central to the nutritional and socio-economic life of urban populations in developing countries such as Nigeria (WHO, 2020; Mazi *et al.,* 2023). However, the safety of water used by food vendors remains a critical public health concern. This study revealed that 31.7% of water samples served to customers were contaminated with parasites, indicating frequent exposure to gastrointestinal infections. The prevalence closely aligns with findings from Ghana and Kenya, where contamination rates ranged between 29% and 37% (Osei *et al*., 2018). These results reflect a wider regional challenge of unsafe water in informal food environments (Adamu *et al*., 2019).

Globally, unsafe food and water cause more than 600 million illnesses annually (WHO, 2023). In sub-Saharan Africa, poor water quality, inadequate sanitation, and weak hygiene systems (the WASH triad) sustain transmission of parasitic infections (Prüss-Ustün *et al*., 2019; Amoah *et al*., 2021). Nigerian studies similarly link consumption of food and water from informal vendors to outbreaks of diarrhoeal and parasitic diseases (Adebayo *et al*., 2018; Eze *et al*., 2020). Although prevalence decreased slightly from 35.0% before handwashing to 28.3% after, the lack of a significant difference suggests that contamination primarily

originates from the water source and storage environment rather than from users themselves (Opara *et al.,* 2017).

Street food vending is a major livelihood activity in Calabar, yet many vendors operate without access to clean water or proper sanitation (Edet *et al.,* 2019). The finding that 51.4% of hand-washing water originated from unknown sources highlights infrastructural gaps. While past studies in Cross River State addressed helminth contamination of vegetables (Effiong *et al.,* 2016; Udoh & Ume, 2018) and microbial quality of street foods (Ekpo *et al.,* 2021), few explored parasitological contamination of vendor water, making this study an important local contribution.
Contamination likely resulted from the use of open storage containers, repeated reuse of water, and exposure to faecal matter (Okon *et al.,* 2020). Parasites detected (*Ascaris lumbricoides* (15.8%), *Entamoeba histolytica* (10.0%), and *Giardia lamblia* (6.7%)) indicate faeco-oral contamination and unsafe sanitation (Cheesbrough, 2006; WHO, 2017). Environmental observations showed high fly abundance (65.7%) and proximity to refuse dumps (17.1%), both of which increase transmission risk (Adeyemo *et al.,* 2020). Flies are known mechanical carriers of parasitic cysts and eggs (Graczyk *et al*., 2017).

Most customers were males (59.1%) and aged 31–40 years (44.7%), reflecting the typical pattern of street-food consumption among working-class adults in Nigeria (Okojie & Isah, 2018). Surprisingly, individuals with tertiary education formed the largest group (43.8%), a trend attributed to convenience rather than hygiene awareness (Nwabor *et al*., 2019; Ene-Obong *et al*., 2020). Although restaurants accounted for the majority of vending sites (60.9%), contamination still occurred, particularly where water sources and waste management were inadequate.
Despite most vendors wearing appropriate clothing (69.5%), environmental vectors such as flies remain major drivers of contamination (Ezekiel *et al*., 2019; Kuo *et al*., 2019). Only 17.1% of vending sites were near visible refuse, yet even minimal exposure to waste can introduce high numbers of helminth eggs (WHO, 2017). Findings align with Yentumi *et al*. (2020), who reported that run-off water from adjacent waste areas contaminates food environments in tropical cities.

Water sources included tap water (33.3%), sachet water (15.2%), and unknown sources (51.4%). Drinking water was mostly sachet (77.1%) and bottled water (22.9%). Heavy reliance on unregulated water supplies mirrors trends in other Nigerian cities (Adamu *et al*., 2019). Even tap water may be contaminated due to infrastructural leakage, and sachet water quality varies widely, with studies reporting microbial and parasitic contamination in several samples (Onyekwere *et al*., 2019; Egwari *et al*., 2020).

Recontamination during storage and handling remains a major issue, as vendors commonly reuse water and store it in open containers (Okon *et al*., 2020). Communal handwashing bowls have been shown to increase the risk of parasitic transmission fivefold (Opara *et al*., 2017).

The presence of *A. lumbricoides*, *E. histolytica*, and *G. lamblia* in vendor water signals risks of malnutrition, dehydration, and reduced productivity (CDC, 2022; WHO, 2023). These parasites are responsible for a substantial proportion of gastrointestinal illnesses in Nigeria (FMOH, 2020). Working adults exposed at vending sites can transmit infections to households, perpetuating community-level risk (Udoh & Ume, 2018).
Parasite survival characteristics—such as resistance of *Ascaris* eggs and *Giardia* cysts to mild chlorination—make control challenging (Farthing, 2016). Weakness across all components of the WASH framework explains persistent contamination (Prüss-Ustün *et al*., 2019).

The results reflect gaps in the achievement of SDG 6 (Clean Water and Sanitation) and SDG 3 (Good Health and Well-Being). Over 25% of Nigeria's urban population still relies on unimproved water sources (UNICEF/WHO JMP, 2022), making interventions in vendor environments essential. It is therefore recommended that municipal authorities ensure reliable access to treated water for vendors and enforce policies such as the National Food Safety Policy of 2014 and the National Water Supply and Sanitation Policy of 2018 (Okoruwa & Onuigbo-Chatta, 2021). Regular inspection, laboratory testing, waste management, and public health education are required to reduce contamination and improve food safety in Calabar.

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