ISSN: 2755-9858

Journal of Otolaryngology Research & Reports

SCIENTIFIC Research and Community

Research Article

Open Access

Prevalence and Associated Factors of Intestinal Parasitic Infections Among Flood-Displaced Persons in Oguta, Southeastern Nigeria

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ABSTRACT

Background: Flooding can disrupt water, sanitation, and hygiene (WASH) systems and increase exposure to intestinal parasitic infections (IPIs) among displaced populations. This study assessed the prevalence, parasite distribution, and selected factors associated with IPIs among persons displaced by the 2023 flooding in Oguta Local Government Area, Imo State, Nigeria.

Methods: A community-based cross-sectional study was conducted among 450 flood-displaced persons residing in temporary settlements across five flood-affected communities between November 2023 and February 2024. Socio-demographic, environmental, and behavioral data were collected using structured questionnaires. Stool specimens were examined using direct wet-mount microscopy and the formal-ether concentration technique. Descriptive statistics and Pearson's chi-square tests were used to assess prevalence and bivariate associations.

Results: IPIs were detected in 246 participants (54.7%). The most frequently detected parasites were hookworm (19.6%), *Ascaris lumbricoides* (16.0%), *Trichuris trichiura* (12.4%), and *Strongyloides stercoralis* (6.7%). Infection prevalence varied significantly by age, with the highest prevalence among participants aged 11–20 years (73.9%; $p < 0.001$). Prevalence was similar among males (55.0%) and females (54.3%; $p = 0.88$). Significant bivariate associations were observed between infection and untreated surface-water use, open defecation, and barefoot exposure (all $p < 0.001$).

Conclusion: A substantial burden of IPIs was observed among flood-displaced persons in Oguta LGA. The findings highlight the need for integrated post-flood interventions combining safe water, emergency sanitation, hygiene promotion, parasite diagnosis and treatment, surveillance, and community health education.

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Received: July 29, 2026; **Accepted:** August 10, 2026; **Published:** August 21, 2026

Keywords: Flooding, Intestinal Parasitic Infections, Flood Displaced Persons, Soil Transmitted Helminths, Wash, Nigeria

Introduction

Flooding is one of the most frequent and destructive natural hazards worldwide, with substantial consequences for human health, livelihoods, and environmental sustainability. Beyond immediate injuries and property damage, flooding disrupts water, sanitation, and hygiene (WASH) infrastructure, contaminates drinking-water sources, displaces communities, and increases vulnerability to communicable diseases [1-3]. These impacts are particularly severe in low- and middle-income countries, where inadequate infrastructure, poverty, and limited access to healthcare amplify the health consequences of flooding [4].

Intestinal parasitic infections (IPIs), particularly soil-transmitted helminth (STH) infections caused by Ascaris lumbricoides, Trichuris trichiura, hookworms, and Strongyloides stercoralis, remain among the most common neglected tropical diseases worldwide. According to the World Health Organization (WHO), more than 1.5 billion people are infected with soil-transmitted helminths globally, with the greatest burden occurring in tropical and subtropical regions where poor sanitation, inadequate hygiene, unsafe water, and poverty facilitate transmission [5,6]. These infections contribute to anemia, malnutrition, impaired physical growth, reduced cognitive development, and diminished productivity, particularly among children and other vulnerable populations. Flood-related displacement may further increase exposure to intestinal parasites because displaced populations frequently experience overcrowded living conditions, inadequate sanitation facilities, limited access to safe drinking water, and increased contact with contaminated soil and surface water. These environmental and behavioral conditions may facilitate parasite transmission; however, cross-sectional studies cannot determine whether infections occurred before or after displacement. Consequently, studies among displaced populations primarily describe the burden of infection and associated factors rather than establishing the causal effects of flooding [7]. Evidence consistently demonstrates that improved WASH interventions reduce the transmission of soil-transmitted helminths and other enteric infections. Systematic reviews and recent global assessments have shown that access to improved sanitation, safe drinking water, and appropriate hygiene practices significantly lowers the risk of intestinal parasitic infections [3,8,9]. Nevertheless, emergency settings often experience major disruptions to these essential services, increasing the vulnerability of displaced populations.

Although intestinal parasitic infections have been widely investigated in school-aged children, rural communities, and internally displaced populations in Nigeria, evidence remains limited regarding the epidemiology of IPIs among persons displaced specifically by flooding in southeastern Nigeria. Existing studies have largely focused on conflict-related displacement or general community populations, leaving an important knowledge gap regarding flood-displaced populations and the environmental and behavioural factors associated with infection in post-flood settings [10,11].

Oguta Local Government Area (LGA), Imo State, was among the areas severely affected by the 2023 flooding, which displaced numerous households into temporary settlements where access to safe water, sanitation facilities, and healthcare services was substantially disrupted. Despite the public health importance of this event, epidemiological evidence describing the burden of intestinal parasitic infections among flood-displaced persons in the area remains scarce. Generating such evidence is essential for strengthening post-disaster disease surveillance, guiding emergency WASH interventions, and informing targeted public health responses. Therefore, this study determined the prevalence and distribution of intestinal parasitic infections and examined selected socio-demographic, environmental, and behavioral factors associated with infection among persons displaced by the 2023 flooding in Oguta LGA, Imo State, Nigeria. The findings are expected to provide evidence for strengthening disaster preparedness, integrating intestinal parasite control into post-flood response programs, and improving the health of flood-affected populations.

Materials and Methods

Study Design and Setting

A community-based cross-sectional study was conducted between November 2023 and February 2024 among persons displaced by the 2023 flooding in Oguta Local Government Area (LGA), Imo State, southeastern Nigeria. Data collection commenced approximately one month after the peak flooding and continued during the early post-flood recovery period.

Oguta LGA is located in southeastern Nigeria and is characterized by extensive freshwater ecosystems, including Oguta Lake and adjoining riverine environments. The area is predominantly rural, with livelihoods centered on farming, fishing, petty trading, and other informal economic activities. Access to potable water, improved sanitation facilities, and healthcare services varies considerably across communities. The 2023 flooding displaced numerous households and disrupted water, sanitation, and hygiene (WASH) services, resulting in temporary settlements with increased reliance on untreated surface water and limited sanitation infrastructure. The study was conducted in five flood-affected communities (Amaraocha, Umuahiata, Umuneke, Akri, and Umunkwo) selected because they accommodated large numbers of flood-displaced persons.

Study Population

The study population comprised individuals displaced by the 2023 flooding who were residing in temporary settlements within the selected communities during the study period.

Sample Size Determination

The sample size was determined using the single-population proportion formula for cross-sectional studies with a 95% confidence level (Z = 1.96), an assumed prevalence of 50%, and a precision of 5%. The minimum calculated sample size was 384 participants. After allowing for a 10% non-response rate, the minimum required sample increased to approximately 427 participants. To improve the precision of the estimates and compensate for possible incomplete questionnaires or unusable stool specimens, 450 participants were recruited and included in the study.

Sampling Procedure

A multistage sampling technique was employed. First, Oguta LGA was purposively selected because it was one of the area's most severely affected by the 2023 flooding. Second, five flood-affected communities with established temporary settlements were identified in consultation with local authorities and community leaders.

The estimated number of eligible displaced persons in each community was obtained from community registers and local administrative records, and the total sample size was allocated proportionately according to the population of each settlement. Within each settlement, eligible participants were selected using systematic random sampling. Where household lists were available, a sampling interval was calculated by dividing the number of eligible residents by the allocated sample size, a random starting point was selected, and every kth eligible individual was recruited. Where household registers were unavailable, eligible households were first identified with the assistance of community leaders before systematic selection was applied. If more than one eligible individual resided in a selected household, one participant was chosen by simple random selection.

Individuals were eligible if they had been displaced by the 2023 flooding, resided in one of the selected temporary settlements during the study period, and provided written informed consent (or parental/guardian consent for minors). Individuals who declined participation or were unable to provide stool specimens were excluded.

Questionnaire Administration and Data Collection

Data were collected using a structured interviewer-administered questionnaire adapted from previously published studies on intestinal parasitic infections and WASH-related risk factors. The questionnaire was pretested in a neighboring flood-affected community outside the study area to assess clarity and consistency before field implementation.

Information collected included socio-demographic characteristics (age, sex, education, and occupation), environmental exposures (primary source of drinking water and sanitation facilities), and behavioral factors (footwear use and hygiene practices). Untreated surface water referred to water obtained directly from rivers, streams, lakes, ponds, or other natural sources without treatment before consumption. Open defecation was defined as the routine disposal of feces in open fields, bushes, or nearby water bodies rather than in improved sanitation facilities. Barefoot exposure was defined as the routine practice of walking outdoors without protective footwear during the displacement period.

Stool Specimen Collections and Laboratory Examination

Each participant received a sterile, wide-mouthed, leak-proof stool container labelled with a unique identification number and was instructed on proper specimen collection. Fresh stool specimens were transported in insulated containers to the parasitology laboratory and processed on the day of collection. Specimens that could not be examined immediately were preserved in 10% formalin and processed according to standard parasitological procedures.

Direct Wet-Mount Examination
A small quantity of each stool specimen was emulsified in physiological saline on a clean glass slide, covered with a coverslip, and examined microscopically using ×10 and ×40 objectives. Lugol's iodine preparation was used where appropriate to improve visualization of protozoan cysts and internal structures.

Formal-Ether Concentration Technique
All stool specimens were further examined using the formal-ether concentration technique to improve parasite recovery. Approximately 1 g of stool was emulsified in 10% formalin, filtered, mixed with diethyl ether, centrifuged at approximately 500 × g for 2-3 minutes, and the sediment examined microscopically using ×10 and ×40 objectives.

Parasite Identification
Parasites were identified according to standard morphological criteria based on the size, shape, shell characteristics, and internal structures of eggs, larvae, cysts, and trophozoites using standard parasitology reference manuals. A participant was classified as infected if at least one intestinal parasite was detected by either direct wet-mount microscopy or the formal-ether concentration technique.

Quality Assurance
Standard operating procedures were followed throughout specimen collection, transportation, processing, and examination. Laboratory personnel received standardized training before sample analysis. Approximately 10% of prepared slides were randomly selected and independently re-examined by a second experienced microscopist who was blinded to the initial laboratory findings. Any discrepancies were resolved by joint review and, where necessary, adjudication by a senior parasitologist. Microscope performance and reagent quality were routinely monitored throughout the study.

Definition of Intestinal Parasitic Infection
Participants were considered positive for intestinal parasitic infection if at least one intestinal parasite was detected in the examined stool specimen by either diagnostic method.

Data Analysis
Data were analyzed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize participant characteristics and estimate the prevalence of intestinal parasitic infections. Categorical variables were presented as frequencies and percentages. Associations between intestinal parasitic infection and explanatory variables were assessed using Pearson's chi-square test. Statistical significance was set at $p < 0.05$. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

Ethical Considerations
Ethical approval was obtained from the Imo State University Research Ethics Committee. Written informed consent was obtained from all adult participants. For participants younger than 18 years, written parental or guardian consent and participant assent were obtained where applicable. Participants diagnosed with intestinal parasitic infections were referred to appropriate healthcare facilities for clinical evaluation and treatment.

Results
Socio-Demographic Characteristics of Participants
A total of 450 flood-displaced persons participated in the study. Females constituted 230 (51.1%) of the participants, while males accounted for 220 (48.9%). The largest age groups were participants aged 21–30 years and those aged >40 years, each representing 104 (23.1%) of the study population. Participants aged 11–20 years accounted for 92 (20.4%). Regarding educational attainment, 166 (36.9%) participants had primary education, 148 (32.9%) had no formal education, 108 (24.0%) had secondary education, and 28 (6.2%) had tertiary education. Farming and fishing were the predominant occupations (198; 44.0%), followed by trading (102; 22.7%), students (96; 21.3%), and other occupations (54; 12.0%) (Table1).

Table1: Socio-Demographic Characteristics of Study Participants (N = 450)

Variable	Category	n	%
Age group (years)	≤10	62	13.8
	11–20	92	20.4
	21–30	104	23.1
	31–40	88	19.6
	>40	104	23.1
Sex	Male	220	19.6
	Female	230	23.1
Educational level	No formal education	148	32.9
	Primary	166	36.9
	Secondary	108	24.0
	Tertiary	28	6.2
Main occupation	Farming/fishing	198	44.0
	Trading	102	22.7
	Student	96	21.3
	Other	54	12.0

Prevalence and Distribution of Intestinal Parasitic Infections
Overall, 246 of the 450 participants were infected with at least one intestinal parasite, giving an overall prevalence of 54.7%. Hookworm was the most frequently detected parasite (88; 19.6%), followed by Ascaris lumbricoides (72; 16.0%), Trichuris trichiura (56; 12.4%), and *Strongyloides stercoralis* (30; 6.7%) (Table2).

Table 2: Distribution of Detected Intestinal Parasites

Parasite	Number infected (n)	Prevalence (%)
Hookworm	88	19.6
Ascaris lumbricoides	72	16.0
Trichuris trichiura	56	12.4
Strongyloides stercoralis	30	6.7
Any intestinal parasite	246	54.7

Prevalence Intestinal Parasitic Infections by Age Group

The prevalence of intestinal parasitic infection differed significantly across age groups ($\chi^2 = 24.6$, $p < 0.001$). The highest prevalence was observed among participants aged 11–20 years (68/92; 73.9%), followed by those aged 21–30 years (60/104; 57.7%). The lowest prevalence was recorded among participants aged >40 years (44/104; 42.3%) (Table3).

Table 3: Prevalence of Intestinal Parasitic Infections by Age Group

Age group (years)	Examined (n)	infected (n)	Prevalence (%)
≤10	62	28	45.2
11–20	92	68	73.9
21–30	104	60	57.7
31–40	88	46	52.3
>40	104	44	42.3

Overall association: $\chi^2 = 24.6$, $p < .001$.

Table 4: Prevalence of Intestinal Parasitic Infections by Sex

Sex	Examined (n)	Infected (n)	Prevalence (%)
Male	220	121	55.1
Female	230	125	54.4

Environmental and Behavioral Factors Associated with Intestinal Parasitic Infection

Significant associations were observed between intestinal parasitic infection and selected environmental and behavioral factors. Participants who used untreated surface water had a significantly higher prevalence of infection than those using borehole or treated water sources (68.5% vs. 39.4%; $\chi^2 = 18.9$, $p < 0.001$). Similarly, infection prevalence was higher among participants practicing open defecation than among those using latrines (71.2% vs. 41.7%; $\chi^2 = 22.4$, $p < 0.001$). Participants who routinely walked barefoot also had a significantly higher prevalence of infection than those who consistently wore footwear (66.8% vs. 38.9%; $\chi^2 = 16.3$, $p < 0.001$) (Table 5).

Table 5: Contingency Table for Environmental and Behavioral Factors Associated with Intestinal Parasitic Infection (Reconstructed from Reported Prevalence)

Variable	Category	Total (n)	Infected n (%)	Uninfected n (%)
Source of drinking water	Untreated surface water	216	148 (68.5)	68 (31.5)
	Borehole/Treated water	234	92 (39.3)	142 (60.7)
Total		450	240	210
Sanitation facility	Open defecation	205	146 (71.2)	59 (28.8)
	Latrine	245	102 (41.6)	143 (58.4)
Total		450	248	202
Footwear use	Barefoot	220	147 (66.8)	73 (33.2)
	Always wears footwear	230	89 (38.7)	141 (61.3)
Total		450	236	214

Discussion

This study found a high prevalence (54.7%) of intestinal parasitic infections (IPIs) among persons displaced by the 2023 flooding in Oguta Local Government Area, Imo State, indicating a substantial burden of infection in this vulnerable population. Although the cross-sectional design precludes causal inference, the findings suggest that post-flood displacement may coincide with environmental conditions that facilitate parasite transmission, including disruption of water, sanitation, and hygiene (WASH) services, overcrowding, and increased exposure to contaminated environments. These observations are consistent with evidence that humanitarian emergencies often increase vulnerability to enteric and neglected tropical diseases through deterioration of living conditions and reduced access to essential health services [3,7].

The overall prevalence observed in this study is comparable to reports from displaced and underserved populations in other low- and middle-income countries. Studies conducted among internally displaced populations in Ethiopia and South Sudan have similarly reported high burdens of intestinal parasitic infections, largely attributed to inadequate sanitation, unsafe water, overcrowding, and limited healthcare access. Likewise, investigations in flood-prone regions of Bangladesh have documented increased exposure to enteric pathogens following flooding due to contamination of drinking-water sources and damage to sanitation infrastructure. Differences in prevalence across studies are expected because of variations in environmental conditions, diagnostic techniques, study populations, and the intensity of parasite transmission.

Hookworm was the predominant parasite identified, followed by Ascaris lumbricoides, Trichuris trichiura, and Strongyloides stercoralis. This distribution reflects the epidemiology of soil-transmitted helminths in tropical environments, where warm climatic conditions, poor sanitation, and frequent soil contact favour parasite survival and transmission [6,12,13]. The predominance of hookworm may also be related to occupational and daily activities such as farming and fishing, which increase exposure to contaminated soil, particularly where protective footwear is not consistently used.

Participants who relied on untreated surface water, practiced open defecation, and routinely walked barefoot had significantly higher infection prevalence than those with safer practices. These findings agree with systematic reviews demonstrating that inadequate WASH conditions are consistently associated with increased transmission of soil-transmitted helminths [8,14]. Following flooding, contamination of surface-water sources with human faecal material and damage to sanitation facilities may further increase opportunities for parasite transmission. However, because the present analysis was limited to bivariate comparisons, these variables should be interpreted as factors associated with infection rather than independent predictors.

The significantly higher prevalence among participants aged 11-20 years may reflect greater environmental exposure through farming, fishing, recreational activities, and other outdoor tasks common in rural communities. Similar age-related patterns have been reported in endemic settings where older children and adolescents experience frequent contact with contaminated soil and water [6]. In contrast, infection prevalence did not differ significantly between males and females, suggesting that both sexes experienced comparable environmental exposures during displacement.

This study provides important epidemiological evidence from southeastern Nigeria, where information on intestinal parasitic infections among flood-displaced populations remains limited. Unlike many previous Nigerian studies that focused on school-aged children or conflict-displaced populations, the present study specifically investigated individuals displaced by flooding. Consequently, the findings contribute valuable evidence for integrating intestinal parasite control into disaster preparedness and emergency response planning in flood-prone communities.

Public Health Implications

The findings underscore the importance of incorporating intestinal parasite prevention and control into post-flood emergency response programmes. Priority interventions should include the provision of safe drinking water, improved sanitation facilities, hygiene promotion, routine disease surveillance, laboratory diagnosis, timely treatment, and preventive chemotherapy were recommended by national and World Health Organization guidelines. Strengthening WASH services in temporary settlements is likely to reduce environmental contamination and interrupt parasite transmission while improving overall health outcomes among displaced populations.

Strengths and Limitations

A major strength of this study is the laboratory confirmation of intestinal parasitic infections using stool examination, providing more reliable estimates than studies relying solely on self-reported symptoms. The community-based design also enabled assessment of a population that is frequently underrepresented in epidemiological research.

Several limitations should be considered when interpreting the findings. First, the cross-sectional design prevents determination of temporal or causal relationships between flooding-related exposures and infection. Second, examination of a single stool specimen may have underestimated infection prevalence because parasite excretion varies over time. Third, environmental and behavioral exposures were self-reported and may therefore be subject to recall or reporting bias. Fourth, the study was conducted in selected flood-affected communities in one local government area, limiting the generalizability of the findings to other displaced populations. Finally, because multivariable logistic regression was not performed, the observed associations should not be interpreted as independent predictors after adjustment for potential confounding variables.

Conclusion

This study demonstrated a substantial burden of intestinal parasitic infections among persons displaced by the 2023 flooding in Oguta Local Government Area, Imo State. Higher infection prevalence was observed among adolescents and among participants who used untreated surface water, practiced open defecation, and routinely walked barefoot. These findings highlight the need to integrate intestinal parasite prevention and control into post-flood emergency response programmes through strengthened WASH interventions, disease surveillance, laboratory diagnosis, timely treatment, health education, and preventive chemotherapy where appropriate [15-20].

Recommendations

- Integrate comprehensive WASH interventions into all post-flood emergency response programmes.
- Ensure sustained access to safe drinking water and improved sanitation facilities in temporary settlements.
- Incorporate intestinal parasitic infection surveillance into disaster preparedness and post-flood public health response systems.
- Provide routine laboratory screening, prompt treatment, and preventive chemotherapy in accordance with national and WHO recommendations.
- Implement community-based health education programmes promoting safe water use, sanitation, hand hygiene, and consistent footwear use.
- Conduct prospective longitudinal studies with multivariable analyses to identify independent determinants of intestinal parasitic infections and evaluate changes in infection patterns throughout disaster response and recovery.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Imo State University Research Ethics Committee. Written informed consent was obtained from adult participants. For participants younger than 18 years, consent was obtained from parents or legal guardians, with assent obtained from minors where applicable.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request, subject to applicable ethical and institutional requirements.

Competing Interests

The author declares that there are no competing interests.

Funding

This study received no external funding.

Author Contributions

CDO conceived and designed the study, coordinated data collection, conducted the data analysis, interpreted the findings, and drafted and revised the manuscript.

Acknowledgements

The author acknowledges the community leaders, field assistants, and study participants in the flood-affected communities of Oguta Local Government Area for their cooperation and participation in the study

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