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Original Article

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Socio-environmental determinants of parasitic intestinal infections among children: a cross-sectional study in Nigeria

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ABSTRACT

Background: Intestinal parasitic infections are a major public health problem among school-aged children, especially those residing in rural areas. These infections predispose the children to several other health problems. This study assesses intestinal parasitic infections among school children in a rural area in Nigeria and their socioenvironmental determinants.
Methods: This cross-sectional study included 250 primary school-age children from three randomly selected schools in Elemere, a poor rural area in Kwara State, Nigeria. A semi-structured questionnaire was used to record the socio-demographic data, and stool samples were microscopically examined for intestinal parasites.
Results: The overall prevalence of intestinal parasites was 23.6% (59/250). Of the infected children, the most common parasite was *Ascaris lumbricoides* 50.8% (30/59), followed by *Giardia lamblia* 28.8% (17/59), *Entamoeba* spp.16.9% (10/59) and *Dipylidium caninum* in 3.4% (2/59). Rural domicile was associated with parasitic infections (P= 0.036) compared to a semi-urban or urban residence. Compared to younger age groups, children in the higher age groups had 64% (95% confidence interval,0.15–0.90;P= 0.03) lesser parasitic infections.
Conclusion: Intestinal parasitic infections are common in school children in the studied area, and may be associated with unclean water sources, poor hygiene, and economic conditions. General health education should emphasize cleanliness, personal hygiene and sanitation to prevent and control parasitic intestinal infections among schoolchildren in these communities.

Keywords: Intestinalparasites; Children; Risk factors; Prevalence; Rural health; Nigeria

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Conflict of Interest
The authors declare that they have no competing interests.

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INTRODUCTION

Intestinal parasitic infections (IPIs) are widespread, especially in developing countries. About a third of the world's population is infected with one or more parasites, most of whom are children.[1] The World Health Organization (WHO) estimates that 3.5 billion people are exposed to IPIs and 450 million are clinically affected; more than half of them are children, with 39 million disability-adjusted life years (DALYs). They cause over 33% of deaths worldwide.[2] IPIs represent a major public health burden in less developed countries due to their high morbidity and mortality. The WHO considers many parasitic intestinal infections as neglected tropical diseases (NTDs).[3]

Ascaris lumbricoides, the most common helminth, infects 819 million people worldwide, followed by *Trichuris trichiura,* which infects 464.6 million people, and hookworms *Necator americanus* and *Ancylostoma duodenale* that infect 438.9 million people.[1] *Giardia duodenalis* and *Entamoeba histolytica* infect about 200 and 500 million people, respectively.[1] In Ethiopia, the prevalence rate of IPI in children has been estimated to be as high as 48% (95% confidence interval [CI], 42%–53%). Most of these infections are in children under 5 years of age in sub-Saharan Africa and are caused by *A. lumbricoides*, hookworm species, *T. trichiura*, *Cryptosporidium* species, *E. histolytica,* and *G. duodenalis*.[4]

Thus, IPIs are a significant public health problem in Africa, perhaps because they are not considered to contribute to the adverse conditions that perpetuate poverty.[5] IPIs are associated with low socioeconomic status and social inequalities, which consequently lead to financial hardship in the family and community.[2] People of all ages are exposed to IPI; however, children are the most affected group due to poor hygiene practices and undeveloped immunity. IPI has been associated with malabsorption, weight loss, anemia, poor growth rate (stunting), learning disabilities, and intellectual disability in children.[2,6] Millions of preschool and school-age children are at risk of parasitic infections and need clean water, sanitation and regular deworming.[2]

In previous studies, *E. histolytica*, *G. lamblia*, *N. americanus*, *A. duodenale*, *A. lumbricoides* and *T. trichiura* are known to be common parasitic enteric infections in north-central Nigeria.[7] The disease is especially common in young children due to poor environmental conditions, and vary greatly with season and age.[7] IPIs in children are more common in regions with limited or no access to safe drinking water, and sanitation and adequate housing conditions.[4] Understanding socio-environmental and economic factors linked to IPIs is paramount for effective prevention and health policy. This study investigated the association between IPI in children under 12 and socioeconomic determinants such as household water and sanitation in north-central Nigeria.

METHODS

Study design, setting and participants

A cross-sectional study was conducted to determine parasitic intestinal infections among children under 12 years from 3 public primary schools in Elemere, Kwara State, Ilorin, Nigeria. A random sampling technique method was used to select participants between September 2021 and February 2022. The sample size of 250 was determined with the following assumption: 95% confidence level, 5% margin of error and prevalence of intestinal

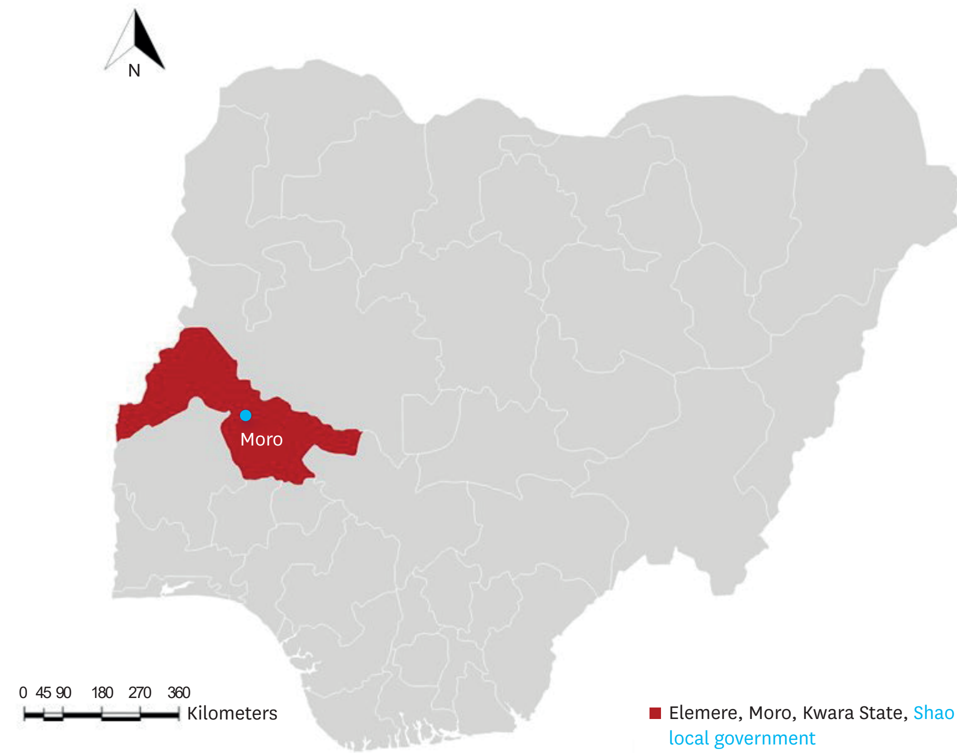

Fig. 1. Map showing the study location (Elemere) in Nigeria.

parasites in Nigeria (23.95%).[8] Samples from 250 participants who met the inclusion criteria were included.

Elemere is a small town located at an elevation of 304 meters above sea level with a population of 138,367 as shown in **Fig. 1**. The three primary schools were selected based on the low standards of living of the children, unhealthy eating habits, improper disposal of waste, and low level of personal hygiene. Selection bias was reduced by ensuring that the criteria used to recruit and enroll participants were the same throughout the investigation. Male and female participants were selected from classes 3 to 6 and between 4 to 12 years old. Exclusion criteria were the intake of anti-parasitic medication in the last 6 months, any recorded immunodeficiency, malignancy or any other parasitic infections, those in classes below primary three and/or outside the age bracket of 4–12 years, and children who were apprehensive of syringes and whose parents did not allow their wards to provide stool samples.

Data collection and measured variables

Data were collected by administering a semi-structured questionnaire. The questionnaires were sent home to the parents, who were asked to help fill out the form. The children returned the questionnaire in class. Demographic variables such as age, sex, class, domicile, type of toilet use, source of drinking water, educational status and parents' occupation were recorded. The quality and completeness was done by a field epidemiology training student who received an intensive data collection training course on data collection. The mothers of the selected participants were interviewed to acquire data for this study, and this was obtained by using a pretested semi-structured questionnaire consisting of sociodemographic details of the participants, their eating habits, the type of toilet used by them, and their hand washing practices.[9]

Stool sample collection

The children were given 3 wide mouth screw-capped sterile bottles. The children or their parents were instructed to collect early morning stool samples without water, urine and other contaminants on three alternate days. The stool samples were properly labeled with each participant's identification details, along with the date and time of specimen collection. The stool specimens were transported to the laboratory in leak-proof bags for further processing.

Laboratory testing method

Stool samples were immediately examined macroscopically and microscopically by skilled laboratory personnel under a light microscope to detect the presence of parasitic ova, cysts and/or trophozoites of intestinal parasites using standard techniques. In case of an inevitable delay, the samples were stored in the refrigerator for examination the following day. The samples were observed in both direct saline-iodine mounts and sedimentation using the formol-ether technique. The direct saline-iodine method was done by picking a small amount of unpreserved stool mixed with a few drops of normal saline for motility and iodine for contrast, and observed under low- and high-power with Köhler illumination.

The specimen was mixed with formalin, strained through gauze, and centrifuged for formol-ether sedimentation concentration. Ethyl acetate was then added to extract debris and fat, leaving parasites in the sediment. The sediment was re-suspended and examined. All laboratory analysis of the samples was performed at the Medical Microbiology Laboratory of the Department of Medical Laboratory Science, Kwara State University, Ilorin, Nigeria by skilled laboratory personnel.

Data analysis

All data were encoded into Microsoft Excel 2016 spreadsheets. Data were analyzed using STATA (StataCorp, College Station, TX, USA). Descriptive statistics were used to determine the characteristics of the study participants. Multiple regression analysis was used to determine an association between parasitic infection and study participants' socio-environmental factors, such as drinking water source and type of toilet use. The difference was considered statistically significant with a P-value <0.05.

Ethical consideration

Before the commencement of the study, permission was sought and obtained from the elders of the communities, school authorities, parents, head teachers, and proprietors of the respective schools. Ethical approval was also obtained from the Ministry of Health, Ilorin, Kwara State, Nigeria (reference number MOH/KS/EU/777/570). The approval for this research study was granted based on the assurance that the information provided by the respondents would be confidential and not used for any other purpose than academic research and that the parents of children positive for any intestinal parasitic infection will be informed and treated appropriately. We ensured that the ethical principles were observed throughout the research study. The participants' consent was supported by their parents' approval, and the participation was voluntary.

RESULTS

Demographic data

A total of 250 school children aged 4 to 12 years were included in this study. Of the 250 participants, 139 (55.6%) were within the age group 7–9 years, with 133 (53.2%) women and 117 (48.8%) males. The majority of the individuals (72.8%, 182/250) drank water from wells, 46% (115/250) used pit latrines and 64% (160/250) resided in rural areas. Of them, 74% (185/250) of the parents had informal education while 76.7% (192/250) of the parents were traders. The descriptive statistics for the study population are provided in **Table 1**.

Laboratory results

The total prevalence of intestinal parasites was 23.6% (59/250) (**Table 2**). The most common parasite was *A. lumbricoides* which was found in 50.8% (30/59) of the children, followed by *G. lamblia* in 28.8% (17/59), *Entamoeba* spp. in 16.9% (10/59), and *Dipylidium caninum* in 3.4% (2/59) of the children. No other parasites were found in this cohort.

Table 1. Demographic characteristics of study participants

Variables	Frequency	Percentage (%)
Age group		
4–6 years	55	22.0
7–9 years	139	55.6
10–12 years	56	22.4
Sex		
Male	117	48.8
Female	133	53.2
Class		
Primary 1	21	8.4
Primary 2	41	16.4
Primary 3	103	41.2
Primary 4	44	17.6
Primary 5	41	16.4
Source of drinking water		
Well water	182	72.8
River water	45	18.0
Bore-hole water	23	9.2
Type of toilet use		
Pit latrine	115	46.0
Bucket latrine	61	24.4
Open defecation	70	28.0
Water closet	4	1.6
Domicile		
Rural	160	64.0
Semi urban	88	35.2
Urban	2	0.8
Parent’s educational status		
Formal	65	26.0
Informal	185	74.0
Parent’s occupation		
Trading	192	76.8
Civil servant	58	23.2
Total	250	100.0

Table 2. Prevalence of intestinal parasitic infection

Variables	Frequency	Percentage (%)
Present	59	23.6
Absent	191	76.4
Total	250	100.0

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Association of socio-environmental factors

There was a statistically significant association between the residences (domiciliary conditions) and having an IPI. A child had a higher chance of infection when living in a rural area than a semi-urban or urban area (*P* = 0.036) (**Table 3**).

Logistic regression was used to analyze the relationship between the socio-environmental factors of the study participants and the probability of having an IPI (**Table 4**). It was found that the odds of having a parasitic infection decreased by 64% (95% CI, 0.15–0.90; *P* = 0.03) for children in the 10–12-year age group compared to the lower age groups. It was also observed that the female sex had a 14% (95% CI, 0.15–0.90) lower chance of having an IPI, while there was a 45% (95% CI, 0.68–3.06) higher chance of having an IPI when using river water, 19% (95% CI, 0.61–2.30) when using open defecation, 49% (95% CI, 0.64–3.48) when parents had an informal or no education, and 34% (95% CI, 0.57–3.15) when parents working in government jobs.

DISCUSSION

This study examines IPIs and their relationship with socioeconomic factors in remote north-central Nigeria. The overall prevalence of IPI was found to be 23.6%. This is lower than the

Table 3. Association between socio-environmental variables and IPI

Variables	Prevalence of IPI (n = 59)	Percentage (%)	*P*-value	Remarks
Age group			0.063	NS
4–6 years	19	32.2		
7–9 years	31	52.5		
10–12 years	9	15.3		
Sex			0.476	NS
Male	30	50.8		
Female	29	49.2		
Class			0.077	NS
Primary 1	9	15.3		
Primary 2	9	15.3		
Primary 3	21	35.6		
Primary 4	14	23.7		
Primary 5	6	10.2		
Source of drinking water			0.219	NS
Well water	38	64.4		
River water	13	22.0		
Bore-hole water	8	13.6		
Type of toilet use			0.190	NS
Pit latrine	30	50.8		
Bucket latrine	9	15.3		
Open defecation	18	30.5		
Water closet	2	3.4		
Domicile			0.036	S
Rural	38	64.4		
Semi urban	19	32.2		
Urban	2	3.4		
Parent's educational status			0.427	NS
Formal	13	22.0		
Informal	46	78.0		
Parent's occupation			0.912	NS
Trading	45	76.3		
Civil servant	14	23.7		
Total	59	100.0		

IPI = intestinal parasitic infection; NS = not significant; S = significant.

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Table 4. Multiple logistic regression analysis of the association between parasitic intestinal infection and socioenvironmental factors of study participants (n = 250)

Variable	aOR (95% CI)	*P*-value
Age of the participants: base 4–6 years		
7–9 years	0.52 (0.25–1.06)	0.07
10–12 years	0.36 (0.15–0.90)	0.03
Sex: base Male		
Female	0.86 (0.47–1.58)	0.63
Source of drinking water: base Well water		
River water	1.45 (0.68–3.06)	0.33
Sanitation behavior: base Pit latrine		
Open defecation	1.19 (0.61–2.30)	0.61
Parent's educational level: base Formal		
Informal or no education	1.49 (0.64–3.48)	0.36
Parents occupation: base Business		
Working in government	1.34 (0.57–3.15)	0.50

aOR = adjusted odds ratio; CI = confidence interval.

results reported from North Ethiopia (33.5%),[10] Jimma Ethiopia (83%),[11] Eastern Wollega (64.9%),[12] and Nigeria (52%).[13] In contrast, our present prevalence was higher than other regions, such as Kashmir (18.02%),[14] and Saudi Arabia (6.2%).[15] These differences in the prevalence of intestinal parasites could be attributed to differences in environmental and personal hygiene, toilet use, drinking water source, area of residence, parent's educational status, and behavioural factors such as playing with sand and unhygienic behaviour.[16]

A. lumbricoides was the most common parasite detected in about half of the children. This is much higher than the earlier reports of *A. lumbricoides* in rural communities in Abia State (10.5%),[17] in the southwestern (21%) and south-southern (13%) parts of Nigeria,[18] and slightly lesser than that of the western Amazon region (52.2% to 68.2%).[19] In particular, the prevalence of *A. lumbricoides* in our study (>50%) is more than four times the threshold indicated by the WHO.[20] Such a high level of helminthic infections among children in these schools calls for prompt control efforts. The differences in the prevalence of ascariasis in Abia State, Nigeria may be related to differences in the children's outdoor playing habits and other socio-environmental factors in the 2 communities; however, the reasons need to be explored in future studies. We did not find hookworms or *T. trichiura* in our sampled children, which was surprising. Soil-transmitted infections (STH) coexist and are expected to be present in some proportions in any given population of tropical and subtropical regions of the world, especially with a high prevalence of any one of them. The small sample size of the study population and other limitations of the methodology, such as not performing the microscopic examination in field settings and not using the Kato-Katz method, may have contributed to the apparent absence of the other STH. It is preferred to perform a stool examination as early as possible when looking for hookworms, and transport and storage may miss its detection, while *Strongyloides stercoralis* has a very poor sensitivity of detection when only microscopy is used. However, the exact reasons for this odd finding need to be explored in future studies.[21]

G. lamblia was the second most prevalent intestinal parasitic infection present in 28.8% of the participants. The prevalence of *G. lamblia* in our study is greater than the 11.5% reported in the rural and 8.6% in urban areas of Benue State, Nigeria.[18] *Entamoeba* spp. was the third most prevalent IPI that infects 16.9% of children in our study. This is far lower than the prevalence of 51% in rural areas and slightly lower than 29% in urban areas in Benue State, Nigeria.[18] *D. caninum* was found in 2 children in our study population. *D. caninum* is a rare zoonotic parasite that affects household pets, with most human cases recorded in children. The finding of this rare IPI in our study population could be incidental and a result of the small sample size.[22]

We found a significant association between the domiciliary conditions of the residence and having an IPI. As expected, rural children had a higher chance of having a parasitic infection than those in a semi-urban or urban area. A logistic regression was performed to determine the relationship between the socioenvironmental factors and the probability of having an IPI. Higher age groups of 10–12 years had 64% lesser odds of having a parasitic infection compared to the lower age groups. This is expected, as with increasing age, hygiene behavior and sanitation practices improve. Also, concomitant immunity is acquired with repeated infection exposures as the children grow older. Other important observations were not statistically significant due to the small sample size. Female children were observed to have a 14% lower chance of having an IPI, possibly due to more indoor activities and better sanitation leading to lesser exposure than male children. On the contrary, there were higher chances of IPI observed with certain socio-environmental factors, such as using river water (45%), using open defecation (19%), and having parents with informal or no education (49%). Peculiarly, there were a higher chance of IPI in children whose parents were working in government jobs (34%), however, the reasons for this are not clear and need to be explored. Perhaps, an exploration of the water supplies of the government accommodations may provide an insight into this observation. These observations are important as they can guide strategies that can be implemented for the control of these infections.

In conclusion, this study found a high prevalence of parasitic intestinal infections. Ascariasis was the most common IPI and was observed to occur four times more than the WHO threshold criteria. In these settings, general public orientation and health education that emphasize personal hygiene, sanitation, and a clean environment are necessary to prevent IPI among school children. Government schools in rural and urban settlements should adopt the policy of washing hands with soap and clean water. Finally, preventive chemotherapy should be adopted to control and eliminate IPI among school children in Nigeria effectively.[23]

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