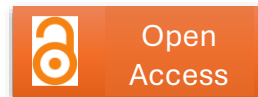




Original Research Article



Prevalence of Intestinal Parasite among Diarrheic Children in Katsina State, Nigeria

Murja Nakano Rafindadi^{1*}, Abdulhamid, Ahmed², Mohammed Suleiman², Balogun Joshua Babalola³ and Jelani Ismaila⁴

¹Department of Biology, School of Secondary Education (Sciences), Federal College of Education Katsina, Nigeria

²Department of Biological Sciences, Umaru Musa Yar'adua University, Katsina

³Department of Animal and Environmental Biology, Federal University Dutse, Nigeria

⁴Department of Chemical Pathology, School of Medical Laboratory Sciences, Usmanu Danfodiyo University Sokoto, Nigeria

Corresponding Author's Email Address: daramurja@gmail.com

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Abstract

This study was conducted to investigate the relative prevalence of intestinal parasites among children with diarrhoea in Katsina State, Nigeria. The study design was cross-sectional descriptive study. A total of 332 children with diarrhoea were selected using multistage sampling techniques. Stool samples were collected and examined using direct wet mount, formal-ether concentration, and modified Zeihel-Neelsen staining techniques. Socio-demographic data were collected using structured questionnaires administered to the parents. Data were analyzed using descriptive tools, including multiple response and frequency analysis. The results obtained showed a high prevalence (31.6%), with females being more infected (79.0%) than males (21.0%). *Giardia lamblia* (23.3%) was observed to be the commonest intestinal parasite in childhood diarrhoeic stool, followed by *Ascaris lumbricoides* (17.2%), hookworms (17.2%), *Strongyloides stercoralis* (8.6%), *Hymenolepis nana* (10.3%), *Entamoeba histolytica* (7.8%), *Taenia species* (2.6%), *Toxoplasma* (1.7%) and 0.9% *Schistosoma mansoni* and *Enterobium vemicularis* been the least. Conclusively, a high prevalence of intestinal protozoan parasitic infection was reported in this study, and the findings therefore suggest the need for a collaborative effort among educational and health authorities to control the infection in the study area.

Keywords

Childhood diarrhoea, *Giardia lamblia*, Intestinal parasites, Katsina

INTRODUCTION

Protozoa are microscopic, unicellular eukaryotes that possess a relatively complex internal structure and engage in complex metabolic activities (Verma, 2021). Some protozoa have structures for propulsion or other types of movement. The Protozoa are considered a subkingdom of the kingdom Protista, although in the classical system, they were placed in the kingdom Animalia (Pitt and Barer, 2012). Most species are free-living, but all higher animals are infected with one or more species of protozoa (Robert, 1996). Infections range from asymptomatic to life-threatening, depending on the species and strain of the parasite, as well as the host's resistance (Shaikh *et al.*, 2012).

Although diarrhoea is caused by bacteria, viruses, and parasites responsible for the majority of

infections that are transmitted most commonly by the faecal-oral route through water, food, and person-to-person transmission (Kelly 2015; Liu *et al.*, 2016), the most common intestinal protozoan parasites are *Giardia lamblia*, *Entamoeba histolytica*, and *Cryptosporidium species*. The diseases caused by these intestinal protozoan parasites are known as amoebiasis, giardiasis, and cryptosporidiosis, respectively, and are associated with moderate to severe diarrhea (Kotloff *et al.*, 2013; Bauhofer *et al.*, 2020).

Transmission of intestinal protozoa spreads by the fecal-oral route involving the ingestion of contaminated food, soil, and water with oocysts or by direct contact with infected individuals or animals (Ryan *et al.*, 2018) through person-to-person (Chen *et al.*, 2002). *Toxoplasma* is the only pathogenic fecal-oral transmitted protozoa that has not been

associated with gastroenteritis (Potes-Morales *et al.*, 2023).

Intestinal parasitic infections are one of the neglected tropical diseases (NTDs) that thrive in areas of poverty (WHO, 2012). It has been revealed that more than three billion people are infected with intestinal parasites, with children being more susceptible and constitute the greatest risk population and can contribute to malnutrition (Anvari, 2014; Hadiza *et al.*, 2019).

Intestinal parasitic infections are endemic in certain parts of Nigeria due to poor hygiene practices and pollution, leading to the contamination of food and water (Damen *et al.*, 2011). In semi-urban and rural communities where the dwellers are generally poor, uneducated, and lack basic amenities like potable water supply and good sanitary facilities, intestinal parasitic infections cause major health problems (Okon and Oku 2001; Okon *et al.*, 2003). Soil-transmitted helminth infections, especially hookworm infection, which causes childhood and maternal anaemia, result in the greatest disability and the highest burden of neglected tropical diseases (Hotez *et al.*, 2009). These infections cause iron-deficiency anaemia, growth retardation in children, intestinal obstruction and some other physical and mental health problems (Thomas, 2014). The helminths *Trichuris trichiura*, *Ascaris lumbricoides*, and the hookworms cause infections in 800, 1,400, and 1,200 million people, respectively, worldwide (Houmsou *et al.*, 2010).

The protozoan *Giardia lamblia* is the most commonly isolated intestinal parasite worldwide that can survive outside the body (for example, in soil) for weeks to months (Gerdes *et al.*, 2023). The infection rates were reported to be between 20% and 40% in developing countries, especially among children (Hajare *et al.*, 2022). Giardiasis often occurs in the setting of waterborne outbreaks and is an important cause of chronic diarrhea in travelers returning from developing countries (Rayhan *et al.*, 2023). The symptoms of Giardiasis in humans are extremely variable. Some people may present with an asymptomatic form, while others may experience acute or chronic diarrhea, which damages the intestinal mucosa and results in malabsorption of nutrients, particularly fat, cholecystitis, and weight loss (Hadiza *et al.*, 2019). *Entamoeba histolytica* is an anaerobic parasitic amoebozoan, part of the genus *Entamoeba* (Santos and Nozaki, 2022). Predominantly infecting humans and other primates, causing amoebiasis. *E. histolytica* is estimated to infect about 35-50 million people worldwide (Lin *et al.*, 2022). *E. histolytica* infection is estimated to kill more than 55,000 people each year (Ghosh *et al.*, 2019).

Single, double, and triple infections have been found in children (Zhang *et al.*, 2016). Surveys of the prevalence of intestinal parasites are necessary, so as to suggest appropriate control measures (Wani *et al.*, 2008). Most studies of this nature conducted in Nigeria were done in other areas, particularly in the southern part of the country (Uwaezuoke *et al.*, 2006; Awolaju and Morenikeji, 2009; Akingbade *et al.*, 2013), with little from the northern part of the country (Biu and Dauda, 2008; Damen *et al.*, 2011; Shehu *et al.*, 2013; Yusuf *et al.*, 2017).

Intestinal protozoan parasitic infections remain one of the major public health problems in tropical regions, especially among developing countries such as Nigeria. However, there is not enough epidemiological data available in this respect in many parts of the country. Hence, the study objective is to assess the prevalence of intestinal protozoan parasitic infections among diarrheic children in Katsina State, Nigeria.

MATERIALS AND METHODS

Study Area

This study was carried out in Daura, Dutsinma, Funtua, Malumfashi, and Katsina Local Government Area in the three senatorial zones of Katsina State, Nigeria (Figure.1). Katsina State comprises 36 LGAs with a total area of about 24,235 km² (9,341 sq.mi). It has a projected population of 5,801,584 (NPC 2006). Katsina State is situated in the extreme northern part of the country, with two emirate councils: Katsina and Daura. It shares a common border with Jigawa and Kano State to the East, Kaduna State to the South, and Zamfara State to the West, and the Niger Republic to the North. Katsina has an estimated 6 million people living, according to a 2006 national census (NPC/FGN, 2007), and comprises mostly Hausa and Fulani. Katsina State's economy is largely driven by agriculture, with a significant portion of the population engaged in farming and livestock rearing. Key agricultural products include guinea corn, millet, maize, cotton, and groundnuts. The state also has a significant livestock industry, with cattle, goats, and sheep widely raised. Beyond agriculture, there are also mining activities, particularly for solid minerals.

Study Design

The study design was designed as a descriptive cross-sectional study.

Study Population

These were children aged less than 5 years, who attended a selected hospital from the three

senatorial zones of Katsina State primarily due to acute diarrhoea.

Sample Size Determination

With the aid of a statistical formula for descriptive study ($N = Z^2pq / L^2$) by Weller (2015) and a prevalence of diarrhoea (38.45%) observed in a previous study by Bichi *et al.* (2012), a minimum sample size of 363 was calculated, however, a total of 332 subjects were recruited.

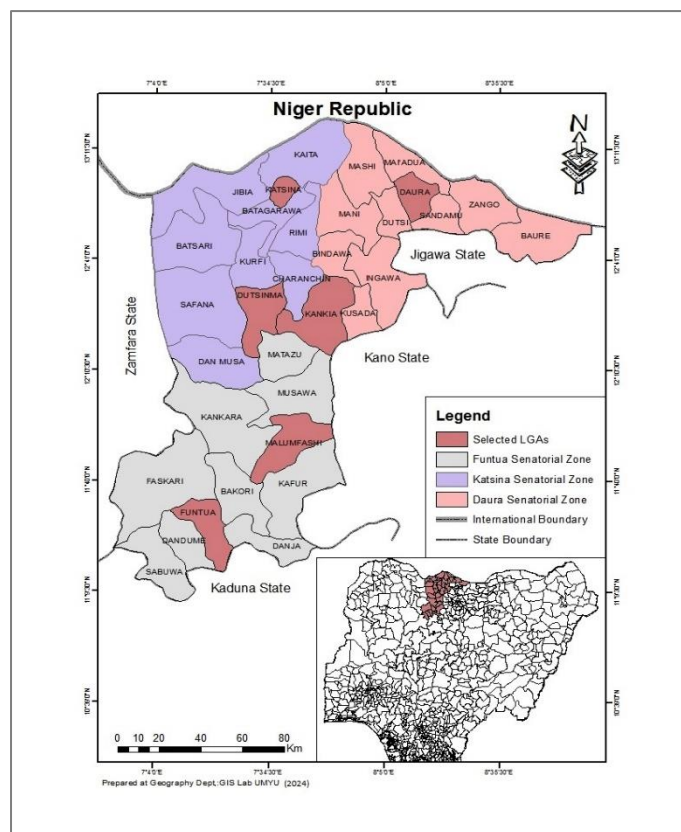


Figure 1: Map of Katsina State showing the study area in the three Senatorial Zones.

Ethical Considerations

Written assent was obtained from mothers and their participation was voluntary. It was emphasized to every mother that she is free to withdraw from the study at any stage she is no longer comfortable. The protocol for this study was approved and ethical clearance was given by the ethical committees of Katsina State of Ministry of Health (MOH/ADM/SUB/1152/1/932) and permission was also obtained from the State Hospital Services Management Board for the inclusion of hospitals in each Senatorial Zones in the state (KHSMB/S.185/VOL.1B).

Subjects Selection

A multistage sampling technique was used to select study participants. The three LGAs in the senatorial zone were stratified by districts and two or more hospitals were randomly selected from each

LGAs by a balloting procedure. Three hundred thirty-two (332) children with diarrhoea were then selected from seven Hospitals in Katsina State using a convenience sampling approach.

Inclusion Criteria

Children under the age of five years with diarrhoea and those without history of antimicrobial therapy in the preceding two weeks were involved.

Exclusion Criteria

Children without diarrhoea and with history of antimicrobial therapy in the preceding two weeks were exempted from the research.

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Stool Sample Collection and Processing

Sample Collection

A single stool sample, approximately 15 g of solid stool or 10 g of fluid/diarrhoeal fresh stool samples, uncontaminated with urine, was collected by parents and guardians from each subject at the selected hospitals and placed into pre-labeled, clean, disposable plastic specimen bottles. Each sample was then divided into two portions (one portion was preserved in 10% buffered formalin, whilst the other was unpreserved with any reagent). The specimens were transported to various microbiology laboratory departments, and unpreserved stool samples were processed within 48 hours for wet preparation. To check consistency of the stool was directly observed, classified, and recorded by the study nurse as loose, semi-formed, formed, mucoid, slimy, or watery, and Ziehl-Neelsen staining technique). The rest of the samples that were preserved in a tightly closed container, were refrigerated at 2-8°C to prevent desiccation for molecular studies (Cheesbrough, 2010).

Laboratory Analysis of Faecal Samples

Macroscopic examination

The faecal specimens were examined macroscopically before processing to check for colour, consistency, and constituents (e.g., blood, mucus, pus, and parasites).

Microscopic examination

The stool samples were analyzed using parasitological methods, specifically the saline and iodine wet mount method, as described by Cheesbrough (2010).

Saline and iodine wet mount method

A drop of normal saline (0.85% NaCl solution) was placed at the centre of the left and right half of a clean, grease-free glass slide, already marked with the respective PIDN. An applicator stick was used to pick up a small portion of the stool sample (approximately 2 mg), and it was emulsified in normal saline and placed on the slide. The presence of motile trophozoites under a light microscope using a x10 objective lens to focus and a 40x objective lens to magnify. The method was repeated using iodine preparation as described by WHO (1991).

Concentration of parasites

One gram (1 g) of a fresh stool sample was mixed with 7 ml of formalin in a clean 15 ml conical centrifuge tube. The sample was dissolved and mixed thoroughly with an applicator stick in a centrifuge tube. The resulting suspension was filtered through a sieve (cotton gauze) into a beaker, and the filtrate was then poured back into the same tube. The debris trapped on the sieve was discarded. After 3 mL of diethyl ether was added to the mixture and hand-shaken, the content was centrifuged at 2,000 rpm for 3 minutes at room temperature, approximately 20-30 degrees Celsius. The supernatant was poured away, and the tube was replaced in its rack. Lugol iodine was used to stain the sediments as described by Ochei and Kolhatkar (2007). The smears stained with the modified Ziehl-Neelsen (MZN) method were considered with a microscope to identify *Cryptosporidium* oocysts as previously described by Cheesbrough (2010).

Identification of parasites

The entire area under the cover slip was systematically examined under x10 and x40 objective lenses for the presence of egg/larvae of helminthes and the protozoa trophozoite eggs/larvae, ova and cysts of different parasites with the aid of standard morphological keys such as size, shape, thickness of the egg, colour and identification guide provided in Cheesbrough (2006).

Data analysis

The data generated were analyzed using descriptive tools, such as multiple response and frequency tools, in Statistical Package for the Social Sciences (SPSS) Version 26.0. Spatial analysis was performed using ArcGIS 10.4.1.

RESULTS

Socio-demographic Profile of the Respondents

A total of 332 children infected with diarrhoea were enrolled in the study. Table 1 shows that almost half of the respondents were aged 18–29 years (44.3%), and women over the age of 40 years were the least in proportion (13.6%). Less than one-third of the respondents (29.7%) had a post-secondary level of education, and 39.2% were traders. The majority of infants infected with diarrhoea were aged between 1 and 11 months, and more than half (51.2%) of the infants were female. The results also show that about 86.4% of infants were still breastfeeding at the time data were collected. Only 13.6% of the infants were pre-lacteally fed using infant milk.

Distribution of Intestinal Parasites among Study Participants

Table 2 and Figures 2-11 (2, 3, 4, 5, 6, 7, 8, 9, 10 & 11) presents the distribution of intestinal parasites in the study population. The overall prevalence of 34.9% of intestinal protozoan was recorded among children infected with diarrheal disease. However, *G. lamblia* had the highest level of infection at 23.3%, followed by *Ascaris lumbricoide* and Hookworms at 17.2% respectively. However, *Schistosoma mansoni* and *Enterobium vamicularis* had lowest level of infestation at 0.9%.

Prevalence of Intestinal parasites in under-five children Diarrhoea across gender in Katsina

The results obtained showed that females were highly infected (80.17%) compared to males (19.83%) (Table 3).

DISCUSSION

The findings of this study indicate that both helminths and protozoans are causative organisms of childhood diarrhoea in Katsina State. The overall prevalence of parasitic infections among childhood diarrhea subjects was high in Katsina State. The observed prevalence is relatively higher than previous findings of 28.9% by Ekpenyong and Eyo (2008) in Enugu State, 17.5% reported by Muhammad et al. (2014) in Maiduguri, 26.0% by Badamasi and Liadi (2017) in Malumfashi town of Kastina, 26.63% obtained by Usip and Ita (2017) in Akwa Ibom State, 27.26% was obtained in Nassarawa Keffi (Adebambo et al., 2023), and 14.9% in Idim Ita of Cross River State, Nigeria by Francisca et al. (2024).

Table 1: Demographics of Diarrheic Children in Katsina State

Demographic features	n	% (percentage)
Mothers age (years)		
18-29	147	44.3
30-39	140	42.2
40-49	45	13.6
Educational status group		
None	96	28.9
Primary	87	26.2
Secondary	109	32.8
Tertiary	40	12.0
Occupation		
Trader	130	39.2
Farmer	82	24.7
Civil Servant	40	12.0
None	80	24.1
Infant gender		
Male	162	48.8
Female	170	51.2
Infant age (years)		
0 - < 1	122	36.7
1 - < 2	106	31.9
2 - < 3	56	16.9
3 - < 4	27	8.1
4 - < 5	21	6.3
Infan feeding		
Breast milk	287	86.4
Infant milk	45	13.6

n=number, %=percentage. <= less than

Table 2: Occurrence of intestinal protozoans in childhood diarrhoea subjects

Protozoans	Positive counts	Percentage (%)
<i>Giardia lamblia</i>	27	23.3
<i>Strongyloides stercoralis</i>	10	8.6
<i>Ascaris lumbricoids</i>	20	17.2
<i>Hymenolepsis nana</i>	12	10.3
<i>Shistosoma mansoni</i>	1	0.9
Hookworm	20	17.2
<i>Enterobium vamicularis</i>	1	0.9
<i>Entermoeba histolytica</i>	9	7.8
<i>Taxoplasma</i>	2	1.7
<i>Taenia species</i>	3	2.6
Overall	105	31.6

Table 3: Frequency of intestinal parasites in diarrhoea children by gender in Katsina

Subjects	Number infected	Infection rate (%)
Male	23	21.0
Female	93	79.0
Total	105	100

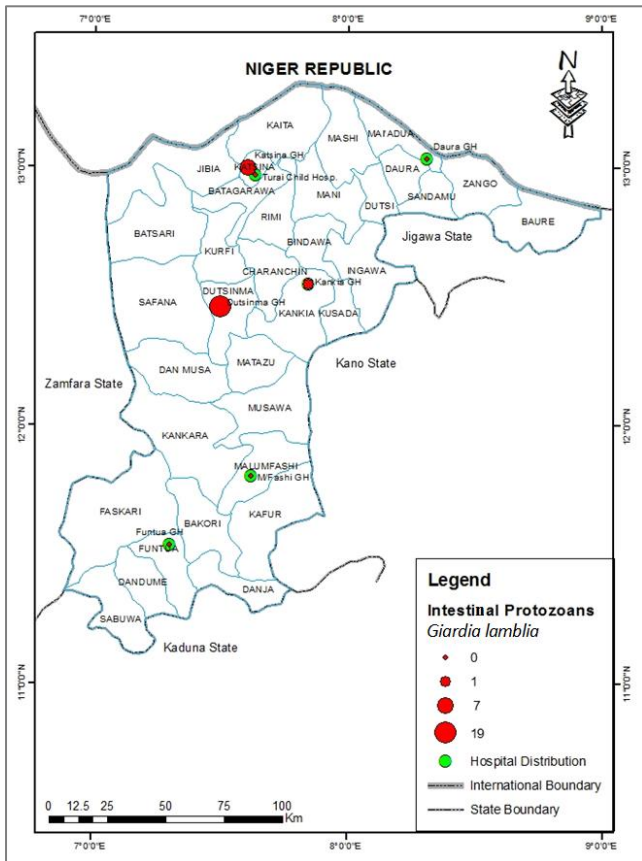


Figure 2: Occurrence of *Giardia lamblia* in diarrheic stool across Katsina State

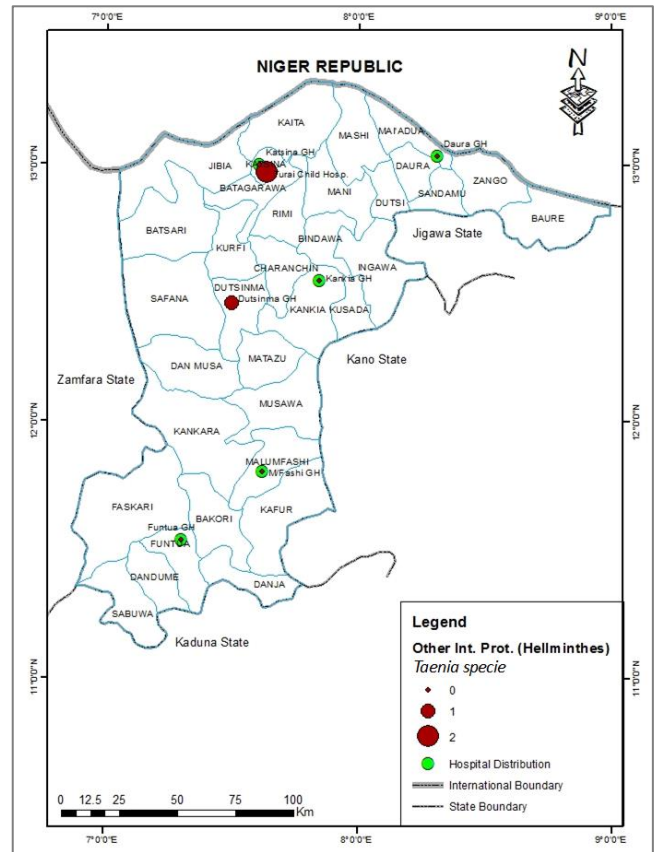


Figure 4: Occurrence of *Taenia specie* in diarrheic stool across Katsina State

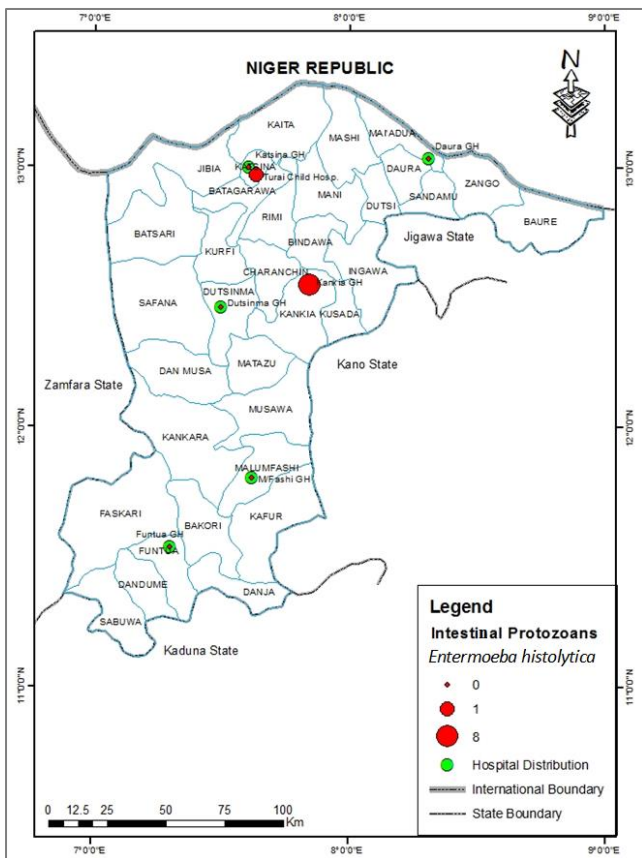


Figure 3: Occurrence of *Entamoeba histolytica* in diarrheic stool across Katsina State

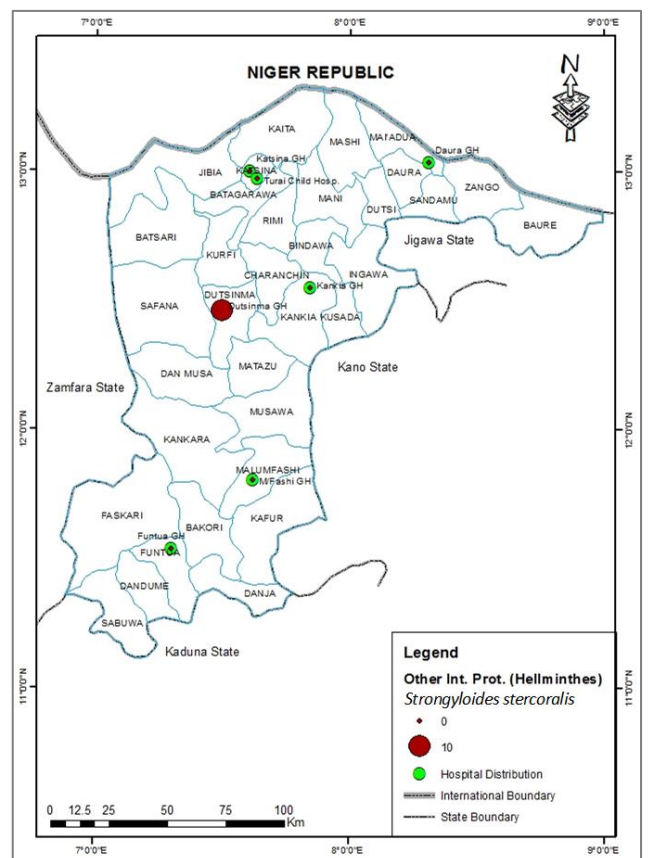


Figure 5: Occurrence of *Strongyloides stercoralis* in diarrheic stool across Katsina State

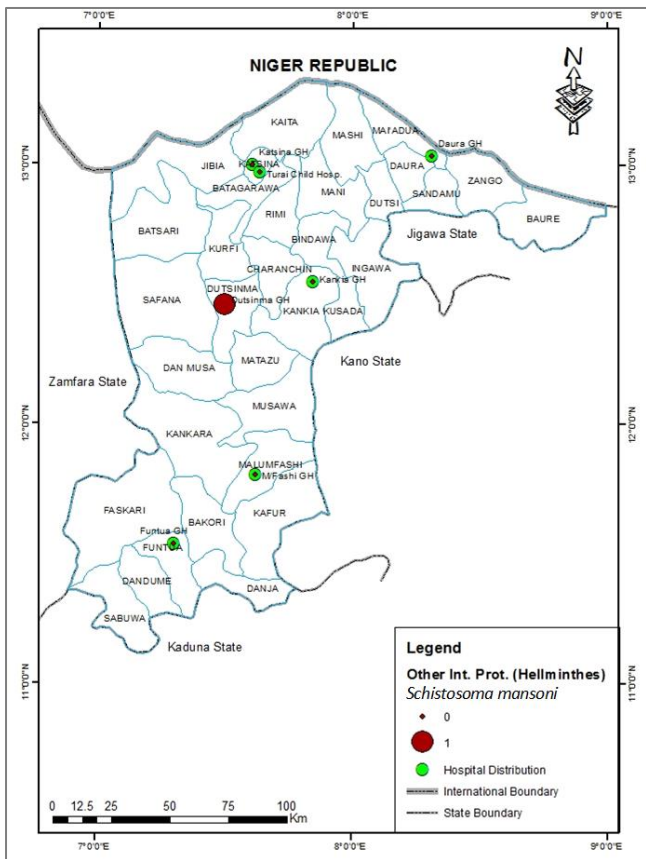


Figure 6: Occurrence of *Schistosoma mansoni* in diarrhetic stool across Katsina State

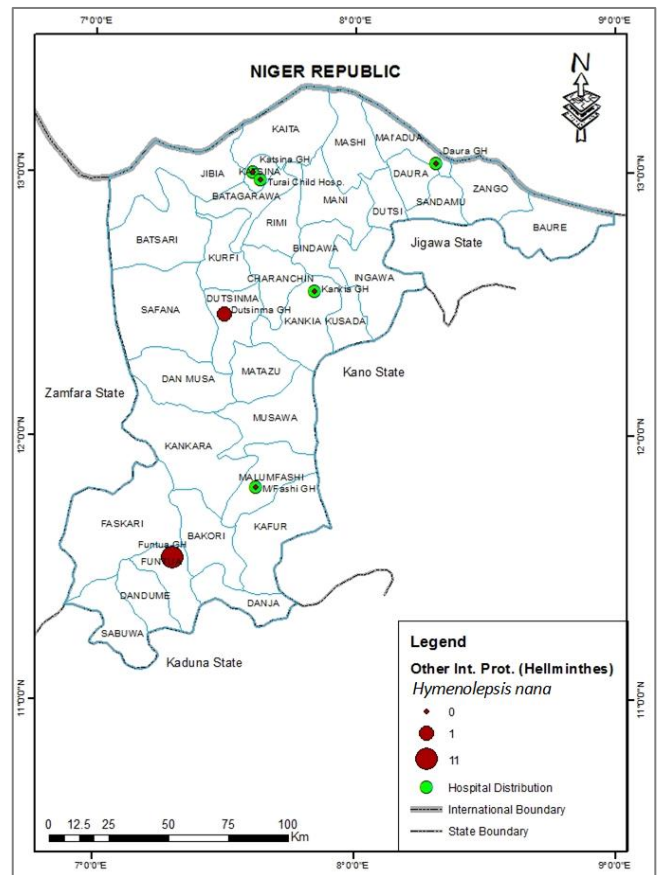


Figure 8: Occurrence of *Hymenolepis nana* in diarrhetic stool across Katsina State

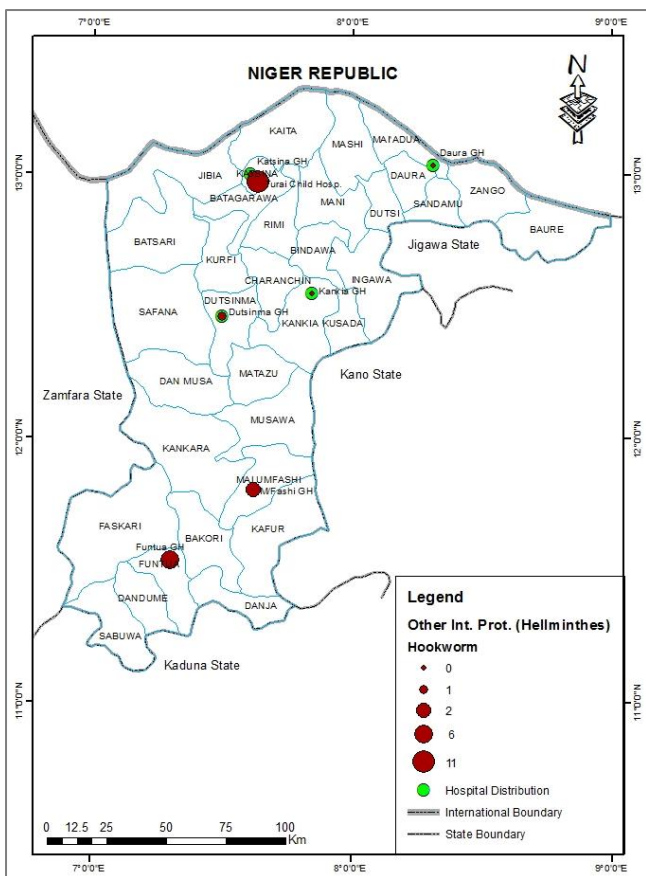


Figure 7: Occurrence of *Hookworm* in diarrhetic stool across Katsina State

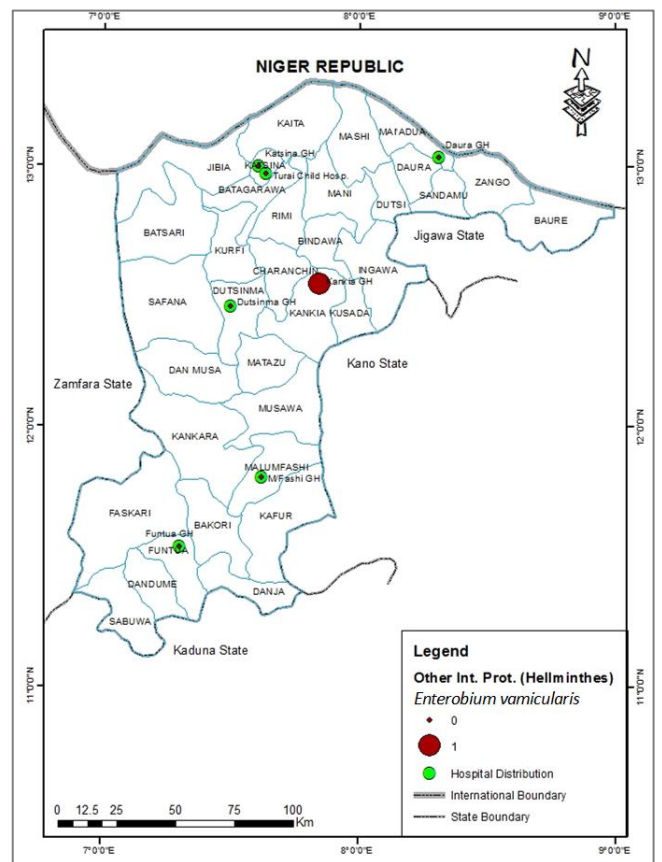


Figure 9: Occurrence of *Enterobium vamicularis* in diarrhetic stool across Katsina State

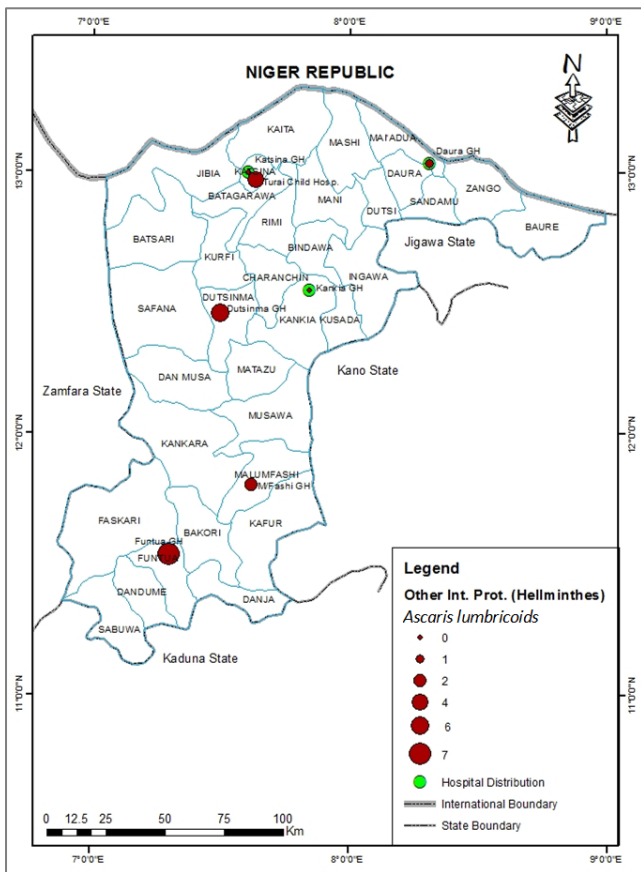


Figure 10: Occurrence of *Ascaris lumbricoides* in diarrheic stool across Katsina State

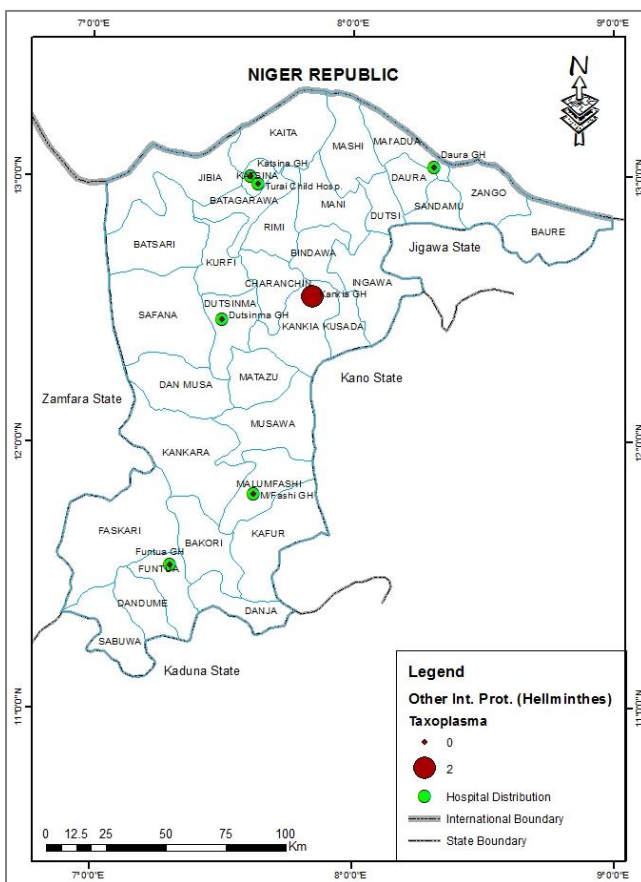


Figure 11: Occurrence of *Taxoplasma* in stool across Katsina State

On the other hand, the prevalence observed in this study was lower than the findings from Akwa Ibom (47.0%) by [Usip et al. \(2023\)](#), in Ekemkpon, Cross River State (41.0%) by [Francisca et al. \(2024\)](#), 50.6% observed in Uga-Anambra State ([Igbinsosa et al., 1996](#)), 63.49% in Dustinma-Katsina State by [Manir et al. \(2017\)](#) and 66.7% in Aniocha, Delta State ([Houmsou et al., 2010](#)). The number of children with the analyzed samples indicated a high prevalence of intestinal parasites in the study area. We speculate that, environmental conditions support the transmission of wide range of parasites in the study area. The disparity in the prevalence of intestinal parasites in this study compared to previous studies could have been due to poor personal hygiene conditions, inadequate environmental sanitation, and contaminated food and water sources.

In this study, *G. lamblia* was observed to be the most common intestinal parasite in childhood diarrheal stool, followed by *A. lumbricoides*, hookworms, *Strongyloides stercoralis*, *Hymenolepis nana*, *Entamoeba histolytica*, *Taenia species*, *Toxoplasma*, and *Schistosoma mansoni*, with *Enterobius vermicularis* being the least common. In spite of the similar environmental conditions for development and similar transmission patterns, there was a predominance of *G. lamblia* in this study, which was not in consonance with reports conducted in the same region where 2.5% observed by [Badamasi and Liadi \(2017\)](#) in Malumfashi town of Katsina and 3.75% reported by [Hadiza et al. \(2019\)](#) in Kaduna, suggesting different geographic distribution for this protozoan.

Giardia lamblia is a major causative agent of diarrheal diseases in humans with a worldwide distribution ([Santin, 2020](#)). The protozoans are the most commonly isolated intestinal parasite throughout the world that can survive outside the body (for example, in soil) for weeks to months ([Gerdes et al., 2023](#)). The infection rates were between 20-40% as reported in developing countries, especially in children ([Hajare et al., 2022](#)) through faecal-oral routes. Giardiasis often occurs in the setting of waterborne outbreaks and is an important cause of chronic diarrhea in travelers returning from developing countries ([Rayhan et al., 2023](#)). The symptoms of Giardiasis in humans are extremely variable. Some people may present with an asymptomatic form, while others may experience acute or chronic diarrhea, which damages the intestinal mucosa and results in the malabsorption of nutrients, particularly fat, leading to cholecystitis, impaired childhood growth, and weight loss ([Donowitz et al., 2016](#)). The observed cases among children were indicative of fecal-oral transmission, which may be related to the non-washing of fecally contaminated hands by the

children after using their toilets. Unless prior infections were protective for giardiasis, one would expect to see a higher rate of giardiasis in developing countries where the living standard of the society is very low

The present study also revealed a total prevalence of *Ascaris lumbricoides* and *Strongyloides stercoralis*, which were lower than 21.4% in Dutsinma by Manir *et al.* (2017), 3.75% by Hadiza *et al.* (2019) in Kaduna, and 22.19 % in Uyo, Akwa Ibom by Usip *et al.* (2023). The *Strongyloides stercoralis* infection was unexpectedly low, with 0.5% in findings of Badamasi and Liadi (2017) in Malumfashi town and 3.97% (Manir *et al.*, 2017) in Dutsinma, and 4.49% (Usip *et al.*, 2023) in Uyo, Akwa Ibom, contrary to the Hadiza *et al.* (2019) reports in Kaduna.

The variation in prevalence depends on the socioeconomic conditions of the study subjects, the rate of effective contact between individuals, and the numbers eventually infected. The presence of *Ascaris lumbricoides* infection may be attributed to high levels of unhygienic practices through contamination of their hands with polluted soil which often contain the infective eggs of the parasites among under-five children which embrace transmission. The prevalence of *Strongyloidiasis stercoralis* could be as a result of children not wearing protective clothing even as a cover while playing outside and within the school premises indicating regular bare body contact with soil by the children, through which cysts/larvae of the parasite bear through the skin which is in lined with Thomas *et al.* (2014) report.

The present study also revealed a total prevalence of hookworms and *Schistosoma mansoni*, which is higher than the 13.9% and 1.98% prevalence detected as reported by earlier by Manir *et al.* (2017). This may be attributed to the incident of hookworm infestation, which is directly related to exposure to soil where infective filariform larvae live and penetrate human skin, mostly the feet of humans. Its presence thus depicts indiscriminate bush defecation, and that most of the infected children walk around barefooted on infected soil. This observation agrees with an earlier observation made by Obiukwu *et al.* (2009). Hookworm, which causes childhood and maternal anaemia, results in the greatest disability and the highest burden of neglected tropical diseases (Hotez *et al.*, 2009). These infections cause iron-deficiency anaemia, growth retardation in children, intestinal obstruction, and some other physical and mental health problems (Thomas *et al.*, 2014).

The occurrence of *Hymenolepis nana*, *Entamoeba histolytica*, *Taenia specie* and *Enterobium*

vamicularis was not unexpected as they were earlier reported by Badamasi and Liadi (2017) in Malumfashi town, except *Taxoplasma* seen in samples of the current study, were indicative of a poor sanitary environment, indiscriminate disposal of waste, and an unhygienic way of life might have been predisposing factors. The only case of *Taenia* species may have resulted from ingestion of undercooked beef infected with the parasite Waldram (2017).

CONCLUSION

Giardia, *Lambliia*, *Ascaris lumbricoides*, hookworms, *Strongyloides stercoralis*, *Hymenolepis nana*, *Entamoeba histolytica*, *Taenia species*, *Taxoplasma*, *Schistosoma mansoni*, and *Enterobium vamicularis* were found in the stool of childhood diarrheic stool in Katsina State. *Giardia lamblia* were the most common pathogenic intestinal protozoa detected in children with diarrhoea in Katsina. The results obtained highlight the importance of further exploring the relationship between caregivers' education levels and children's nutritional status in relation to infections with *G. lamblia* in children under five years of age.

RECOMMENDATIONS

The results obtained highlight the importance of inculcating in children the importance of maintaining proper personal hygiene through an adequate and clean water supply, and avoiding direct contact with soils and floors, as this will reduce the risk of infection from cysts/larvae of parasites.

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