Original Article

Distribution of Parasitic Infections among Pupils in Kwara State, Nigeria

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Abstract

Background: Parasitic infections pose a significant health burden among school-age children in Nigeria. **Aim and Objective:** This study aimed to investigate the distribution of parasitic infections among pupils in Kwara State, Nigeria. **Materials and Methods:** A total of 638 pupils from various primary schools in Kwara Central, Kwara South, and Kwara North senatorial districts were included in the study. Stool, blood, and urine samples were collected from each participant, and appropriate preservation methods were employed. Parasite identification was carried out using microscopy, staining techniques, and concentration methods described in previous studies. **Results:** The results revealed an overall prevalence of 19.4% among the pupils, with 80.6% found to be uninfected. The most common parasitic infections were *Ascaris lumbricoides* (55.6%), *Schistosoma mansoni* (11.2%), *Plasmodium* (10.5%), *Entamoeba histolytica* (8.9%), Hookworm (8.1%), *Fasciola gigantica* (4.0%), and *Schistosoma haematobium* (1.6%). Further analysis focused on the age distribution of parasitic infections. Among pupils aged 1–5 years, *Plasmodium* infection had a prevalence of 23.1%. In the 6–10 years age group, *A. lumbricoides* (59.4%), *S. mansoni* (74%), *E. histolytica* (45.5%), Hookworm (30.0%), *F. gigantica* (20%), and *Plasmodium* (61.5%) were prevalent. Among pupils aged 11–15 years, *A. lumbricoides* (40.6%), *S. mansoni* (28.6%), *E. histolytica* (54.5%), Hookworm (70.0%), *F. gigantica* (60.0%), *Plasmodium* (15.4%), and *S. haematobium* (1.6%) were observed. Pupils aged 16–20 years showed a lower prevalence of parasitic infections, with *F. gigantica* (20%) being the only detected parasite. **Conclusion:** The findings highlight the varying distribution of parasitic infections among different age groups, emphasizing the need for age-specific interventions. The high prevalence of certain parasites, such as *A. lumbricoides*, *S. mansoni*, and *Plasmodium*, indicates the importance of implementing targeted deworming programs, improved sanitation, hygiene practices, and malaria prevention strategies. These measures can effectively reduce the burden of parasitic infections and promote the health and well-being of pupils in Kwara State, Nigeria.

Keywords: Distribution, Kwara state, parasitic infections, pupils

Introduction

Parasitic infections remain a significant global health issue, particularly in tropical and subtropical regions.[1] In Nigeria, parasitic infections are widespread due to various factors such as poor sanitation, inadequate healthcare infrastructure, and limited access to safe drinking water.[2,3] Among the most vulnerable populations are school-aged children, who often experience high rates of parasitic infections. Kwara State, located in North-central Nigeria, has its unique set of challenges regarding parasitic infections among pupils.[4-6] This scientific background information aims to shed light on the distribution of parasitic infections among pupils in Kwara State, highlighting the prevalence, types, and impact of these infections.[4-6]

Malaria: Malaria is the most common parasitic infection in Nigeria, and Kwara State is no exception. It is caused by *Plasmodium* parasites transmitted through the bite of infected female *Anopheles mosquitoes*. Malaria poses a significant burden on the health and well-being of pupils, leading to increased school absenteeism and reduced academic performance.[4-6]

Common intestinal parasites include the following. In Kwara State, Soil-transmitted helminths (STH): infections, including roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and hookworm (*Necator americanus*

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and *Ancylostoma duodenale*), are prevalent.[4-6] These parasites are transmitted through contaminated soil and poor hygiene practices, leading to intestinal symptoms, nutritional deficiencies, and impaired growth and development in affected pupils. Kwara State also experiences a significant burden of Schistosomiasis, caused by *Schistosoma* parasites.[4-6] The infection is acquired through contact with freshwaters infested with intermediate host snails. Schistosomiasis leads to anemia, organ damage, and impaired cognitive function, affecting the educational outcomes of pupils. Although the prevalence of lymphatic filariasis in Kwara State has decreased in recent years due to ongoing control programs, it still remains a concern. The infection is transmitted by mosquitoes and can cause severe swelling of the limbs (elephantiasis) and hydrocele, resulting in physical disabilities and social stigma among affected pupils.[1,2]

Transmission Routes and Risk Factors of parasitic infections include the following. To begin with, poor sanitation and hygiene[7-9] due to inadequate access to clean water and sanitation facilities is a major contributing factor to the spread of parasitic infections in Kwara State.[7-11] Lack of proper handwashing practices, open defecation, and contaminated water sources increase the risk of transmission.[7-11] Another factor is environmental factors.[7-11] Kwara State's tropical climate and favorable conditions for mosquito breeding contribute to the high prevalence of malaria and other mosquito-borne parasitic infections. Stagnant water bodies, such as ponds and rivers, serve as breeding grounds for mosquitoes and intermediate host snails.[7-9] Finally socioeconomic factors[7-11] can contribute to the distribution of parasitic infections. Poverty and limited access to healthcare services are significant risk factors for parasitic infections. Pupils from low-income households often lack resources for preventive measures, such as mosquito nets, proper hygiene practices, and regular deworming.[7-11]

Parasitic infections have a detrimental impact on the health and education of pupils in Kwara State. The infections can lead to anemia, malnutrition, impaired cognitive development, and reduced physical fitness, ultimately affecting school attendance, concentration, and academic performance. Moreover, the burden of parasitic infections further exacerbates existing socioeconomic inequalities, hindering the overall development of affected pupils.[7-11]

Efforts to combat parasitic infections in Kwara State require a multifaceted approach. improved sanitation and hygiene through investments in water and sanitation infrastructure, along with health education programs promoting proper hygiene practices, are crucial for reducing the transmission of parasitic infections.[7-11] Vector Control: malaria prevention strategies, such as the distribution of insecticide-treated bed nets, indoor residual spraying, and larval source management, can effectively reduce the mosquito population and malaria transmission. Mass Drug Administration (MDA)[7-11] by regular deworming campaigns targeting STH and schistosomiasis are essential to control the prevalence of these infections among pupils. MDA programs should be integrated into school health programs to ensure broad coverage.[3-7] Raising awareness among pupils, teachers, parents, and the community about parasitic infections, their transmission routes, and preventive measures is crucial for sustainable control.[7-11] Parasitic infections remain a significant health challenge among pupils in Kwara State, Nigeria. The high prevalence of malaria, STH infections, schistosomiasis, and lymphatic filariasis has adverse effects on the health and education of affected pupils. Implementing comprehensive interventions, including improved sanitation, vector control,[7-11] MDA, and health education, is necessary to reduce the burden of parasitic infections and improve the overall well-being and educational outcomes of pupils in Kwara State.[3-8]

This work was therefore designed to determine the distribution of parasitic infections among pupils in Kwara state, Nigeria.

Materials and Methods

Study area

The Oke-Suna LGEA primary school, Karuma School, and Pake primary school are situated in the Kwara central senatorial district. Similarly, the Central LGEA primary schools in Lafiagi, Tsaragi, and Lade are located in the Kwara North senatorial district, while the Saint Cyprian LGEA primary schools Offa, Bishop Smith School Offa, and Apostolic primary schools Offa are found in the Kwara South senatorial district. The samples collected for the study were processed in hospitals representing each of the three senatorial districts of Kwara State, namely General Hospital Lafiagi in Kwara North, Specialist Hospital in Sobi, Central Hospital in Ilorin, and South Hospital in Offa.

Kwara State, with its capital in Ilorin, is positioned in Western Nigeria. It covers a total area of 36,825 km^2 and falls within the North Central Geographical Zone, often referred to as the Middle Belt, covering an area of 14,218 m^2. The state's vegetation predominantly consists of Savannah and Forest, and its geographical coordinates are approximately 8°3'N 5°0°E. The population of Kwara State is primarily composed of Yorubas, with notable Nupe, Bariba, and Fulani minorities. The majority of the population consists of farmers, traders, artisans, and civil servants. The staple foods in Kwara State include Eba (garri), pounded yam, yam, local rice, and tuwo. As per the Nigerian 2006 census, the population of Kwara State was recorded to be 2.37 million people. This demographic, which has seen significant population growth and socioeconomic development through immigration, constitutes approximately 1.69% of the country's total population. The major economic crops in the state include yam, corn (maize), sorghum, millet, onions, beans, sugar cane, and rice.

Study population

Pupils of both Public and Private primary schools in Kwara Central, Kwara South, and Kwara North in Nigeria.

Sample size

The sample size used for this work was 638 which included Kwara Central (152); Kwara South (263) and Kwara North (223).

Sample collection

Stool, venous blood, and terminal urine samples were collected from each of the 638 subjects from the designated foci which included Kwara Central (152); Kwara South (263); and Kwara North (223). The sample was collected into clean universal containers, EDTA, and lithium heparin bottles after informed consent and preserved accordingly for further analysis.

Analysis of samples for identification of parasites

1. Hemoparasites were identified in the blood using the thick – Giemsa staining technique and thin blood film by Leishman staining as described by Monica[12]
2. Parasites in sputum after sample concentration were identified as described by Monica[12]
3. Parasites in urine after sample concentration were identified using the method described by Monica[12]
4. Parasites in stool after sample concentration were identified using the method described by Monica.[12]

Ethical consideration

Permission/approval was obtained from the ethical and research committee of Kwara State Ministry of Health and proper permission was obtained from Kwara State Ministry of Education. The copy of ethical approval is attached [Appendixes 1-3] in this project.

Statistical analysis

Data collected were analyzed using a statistical package of New York, US, IBM SPSS 21.0 to determine mean and proportion.

Results

The results obtained in this work showed the following distributions of parasitic infections among pupils in Kwara State: 19.4% (124 / 638) overall prevalence; 80.6% (514) not infected; with 55.6% (69 / 124) *Ascaris lumbricodes*; 11.2% (14 / 124) *Schistosoma mansoni*; 10.5% (13 / 124) *Plasmodium*; 8.9% (11 / 124) *Entamoeba histolytica*; 8.1% (10 / 124) Hookworm; 4.0% (5 / 124) *Fasciola gigantical* and 1.6% (2 / 124) *Schistosoma haematobium* [Figures 1 and 2].

However, the age distribution of parasitic infections among primary school pupils in Kwara State as a proportion of the overall 124 pupils infected with parasites showed the following proportions in pupils aged 1–5 years - 23.1% *Plasmodium* infection; 6–10 years - 59.4% *A. lumbricoides*, 74% *S. mansoni*, 45.5% *E. histolytica* 30% Hookworm, 20% *Facsiola gigantica*, 61.5% *Plasmodium* and 0% *S. haematobium*; in pupils aged 11–15 years distribution of parasitic infection include: 40.6% *A. lumbricoides*, 28.6% *S. Mansoni*, 54.5% *E. histolytica*, 70% Hookworm, 60% *Faciola gigantica*, 15.4% *Plasmodium* and 1.6% *S. haematobium*. While in pupils between 16 and 20 years the pattern includes: 0% *A. lumbricoides*, 0% *S. Mansoni*, 0% *E. histolytica*, 0% *Hookworm*, 20% *Faciola gigantica*, 0% *Plasmodium* and 0% *S. haematobium* [Table 1].

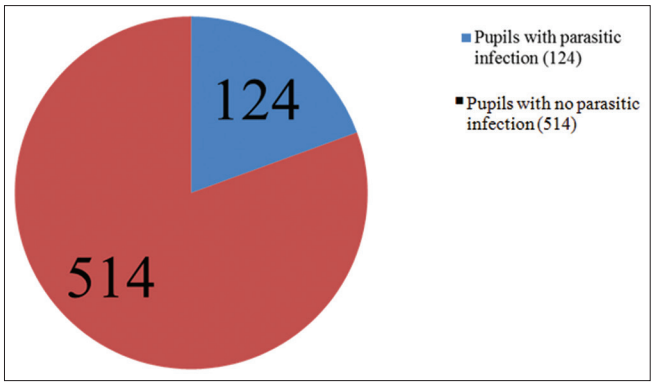


Figure 1: Parasitic infection distribution among participants

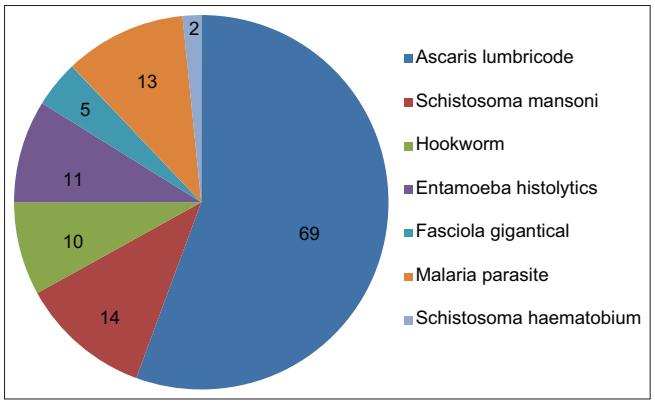


Figure 2: Distribution of parasites among primary school pupils in Kwara State

Age distribution as a proportion of total pupils infected with the respective parasite species: in pupils aged 1–5 years *A. lumbricoides* 0 (0%); *S. mansoni* 0 (0%); *E. histolytica* 0 (0%); Hookworm 0 (0%); *Faciola gigantica* 0 (0%); *Plasmodium* 3 (23.1%) and *S. haematobium* 0 (0%); in pupils aged 6–10 years: *A. lumbricoides* 41 (59.4%), *S. mansoni* 10 (74%), *E. histolytica* 5 (45.5%), Hookworm 3 (30.0%), *Faciola gigantica* 1 (20%), *Plasmodium* 8 (61.5%) and *S. haematobium* 0 (0%); in pupils aged 11–15 years: *A. lumbricoides* 28 (40.6%), *S. mansoni* 4 (28.6%), *E. histolytica* 6 (54.5%), Hookworm 7 (70.0%), *Faciola gigantica* 3 (60.0%), *Plasmodium* 2 (15.4%), and *S. haematobium* 2 (100%) and finally in pupils aged 16–20 years: *A. lumbricoides* 0 (0%), *S. mansoni* 0 (0%), *E. histolytica* 0 (0%), Hookworm 0 (0%), *Faciola gigantica* 1 (20.0%), *Plasmodium* 0 (0%) and *S. haematobium* 0 (0%) [Table 1].

Distribution of the proportion of the total number of pupils infected by parasite Species based on age 3 (2.42%) 1–5 years; 68 (54.84%) 6–10 (years); 52 (41.94%) 11–15 (years); and 1 (0.81%) 16–20 (years) [Table 1].

Table 1: Age distribution of parasitic infections among primary school pupils in Kwara State

Parasite species	1–5 (years), *n* (%)	6–10 (years), *n* (%)	11–15 (years), *n* (%)	16–20 (years), *n* (%)
Ascaris lumbricoides	0	41 (59.4)	28 (40.6)	0
Schistosoma mansoni	0	10 (74)	4 (28.6)	0
Entamoeba histolytical	0	5 (45.5)	6 (54.5)	0
Hookworm	0	3 (30.0)	7 (70.0)	0
Fasciola gigantica	0	1 (20)	3 (60.0)	1 (20.0)
Malaria parasite	3 (23.1)	8 (61.5)	2 (15.4)	0
Schistosoma haematobium	0	0	2 (100)	0
Total (*n*=124)	3 (2.42)	68 (54.84)	52 (41.94)	1 (0.81)

Discussion

Parasitic infections pose a significant public health challenge globally, particularly in developing countries. Understanding the prevalence and distribution of these infections among vulnerable populations, such as school-aged children, is crucial for implementing effective control and prevention strategies. The study conducted in Kwara State aimed to assess the distribution of parasitic infections among pupils. The results revealed an overall prevalence of 19.4% (124 / 638) and specific proportions for various parasites. This overall prevalence was higher than the prevalence reported by Aliyu *et al*.[4]

The overall prevalence of parasitic infections in the studied population was determined to be 19.4% (124 / 638). This means that approximately 19.4% of the pupils in the sample were infected with at least one of the examined parasites. The prevalence provides an overview of the burden of parasitic infections in the area and serves as a starting point for further analysis.[3-7]

The study identified several specific parasites and their respective proportions within the infected population. The most prevalent parasite observed was *A. lumbricoides*, accounting for 55.6% (69 / 124) of the cases. *S. mansoni* was the second most common, with a prevalence of 11.2% (14 / 124). *Plasmodium* accounted for 10.5% (13 / 124) of the infections, while *E. histolytica*, Hookworm, *F. gigantica*, and *S. haematobium* had prevalence rates of 8.9% (11 / 124), 8.1% (10 / 124), 4.0% (5 / 124), and 1.6% (2 / 124), respectively.

These findings have several implications in terms of public health and the well-being of the affected population.[3-7] The high prevalence of *A. lumbricoides* indicates a significant burden of intestinal parasitic infections in the studied pupils.[3-7] This may be attributed to factors such as poor sanitation, inadequate hygiene practices, and limited access to clean water sources.[7-11] The presence of *S. mansoni* suggests a potential risk of waterborne transmission, highlighting the importance of improving water and sanitation infrastructure in the region.[7-11]

The identification of *Plasmodium* infections signifies the presence of malaria, a mosquito-borne disease. Malaria remains a major health concern in many tropical regions, including Nigeria.[5-11] The relatively high prevalence of *Plasmodium* among the studied pupils underscores the need for effective malaria control strategies, such as insecticide-treated bed nets, indoor residual spraying, and prompt diagnosis and treatment.[5-11]

The detection of *E. histolytica* infections indicates the risk of amoebiasis, an intestinal infection that can lead to severe complications if left untreated. Measures to promote personal hygiene, including handwashing with clean water and proper disposal of human waste, are essential to prevent the spread of this parasite.

The presence of Hookworm infections suggests a possible soil-transmitted helminthiasis. These infections typically occur due to walking barefoot on contaminated soil or through direct contact with contaminated surfaces.[5-11] Implementation of regular deworming programs, wearing protective footwear, and maintaining clean surroundings can help reduce the transmission of Hookworm infections.[5-11]

The identification of *F. gigantica* infections implies the presence of liver fluke infestations. These parasites are usually acquired by consuming contaminated water or raw aquatic plants. Efforts to enhance food safety practices, such as thorough cooking and proper water treatment, can contribute to preventing *F. gigantica* infections.[5-11]

Finally, the detection of *S. haematobium* infections indicates a potential risk of urinary schistosomiasis. This parasitic infection occurs through contact with contaminated freshwater sources. Initiatives such as improving access to safe water and promoting behavior change regarding water-related activities can help mitigate the transmission of *S. haematobium*.[5-11]

The study also examined the age distribution of parasitic infections among primary school pupils in Kwara State. The proportions of infections varied across different age groups, providing insights into the dynamics of parasitic transmission in the population.[3-5]

For pupils aged 1–5 years, *Plasmodium* infection had the highest proportion (23.1%), indicating a higher vulnerability to malaria in this age group. No infections of *S. haematobium* were reported among these younger pupils.

Among pupils aged 6–10 years, *A. lumbricoides* had the highest proportion (59.4%), followed by *S. mansoni* (74%), *E. histolytica* (45.5%), Hookworm (30%), *F. gigantica* (20%), and *Plasmodium* (61.5%). Notably, no cases of *S. haematobium* infection were reported in this age group. For pupils aged

11–15 years, *A. lumbricoides* had a proportion of 40.6%, *S. mansoni* (28.6%), *E. histolytica* (54.5%), Hookworm (70%), *F. gigantica* (60%), and *Plasmodium* (15.4%).

The age-specific distribution of parasitic infections provides insights into the epidemiology and potential risk factors associated with different parasites. The higher prevalence of *Plasmodium* infections among younger pupils suggests a greater vulnerability to malaria in this age group. This may be due to factors such as lower immunity levels, increased exposure to mosquito bites, and limited access to preventive measures such as bed nets and antimalarial medications.[3-7]

The age group of 6–10 years demonstrated the highest proportions of *A. lumbricoides*, *S. mansoni*, and *Plasmodium* infections. These findings may be associated with specific behaviors or environmental exposures during this stage of childhood development, such as increased outdoor activities, closer interaction with contaminated water sources, and inadequate hygiene practices.[3-9]

The following were obtained considering the proportion of age groups infected by the total number of respective parasite species.

The age group of 11–15 years showed a relatively higher prevalence of Hookworm, *E. histolytica*, and *F. gigantica* infections. The high infection rates of Hookworm and *F. gigantica* may be linked to engagement in agricultural activities or closer contact with contaminated soil or livestock. The prevalence of *E. histolytica* infections may be influenced by factors such as poor sanitation and suboptimal personal hygiene practices.[6,7,9,11]

In pupils within age 1–5 years, there were no reported cases of *A. lumbricoides*, *S. mansoni*, *E. histolytica*, Hookworm, *F. gigantica,* or *S. haematobium* infections. However, 23.1% of pupils tested positive for *Plasmodium*, indicating the presence of malaria in this age range. Absence of most parasite infections except for *Plasmodium* (malaria): In this age range, there were no reported cases of common parasite species such as *A. lumbricoides*, *S. mansoni*, *E. histolytica*, Hookworm, *F. gigantica*, or *S. haematobium*. However, 23.1% of pupils tested positive for *Plasmodium*, indicating the presence of malaria in this age group. This highlights the importance of targeted malaria control strategies for young children, such as bed nets, insecticide spraying, and early diagnosis and treatment.[3-9]

In Pupils within age 6–10 years: a significant proportion of pupils were infected with *A. lumbricoides* (59.4%), *S. mansoni* (74%), *E. histolytica* (45.5%), and *Plasmodium* (61.5%). Hookworm infection was observed in 30% of pupils, and *F. gigantica* infected 20% of them. No cases of *S. haematobium* infection were reported. *A. lumbricoides* is a roundworm that primarily infects the intestines. The high prevalence indicates a significant burden of this parasitic infection among children in this age group. Ascaris infections can lead to various health complications, including abdominal pain, malnutrition, stunted growth, and impaired cognitive development.[1,2,7-11] Efforts should focus on preventive measures such as improved sanitation, hygiene education, and deworming programs to reduce the prevalence and associated health risks. *S. mansoni* is a parasitic flatworm that causes schistosomiasis, a neglected tropical disease.[1,2,7-11] The high prevalence suggests a substantial burden of schistosomiasis in this age group. Schistosomiasis can lead to chronic inflammation, liver and spleen enlargement, anemia, and impaired growth and development.[1,2,7-11] Control measures should include regular treatment with antiphrastic drugs, improved sanitation, and awareness campaigns to prevent waterborne transmission. *E. histolytica* is a parasite that causes amoebiasis, primarily affecting the intestines.[7-11] The relatively high prevalence indicates a significant burden of amoebiasis among children in this age range. Amoebiasis can lead to diarrhea, abdominal pain, malnutrition, and in severe cases, liver abscesses. Improving sanitation, promoting personal hygiene practices, and access to safe drinking water are crucial in preventing and controlling amoebiasis. *Plasmodium* is the parasite responsible for malaria, a life-threatening mosquito-borne disease.[1,2,7] The high prevalence suggests a significant burden of malaria among children in this age group. Malaria can cause fever, anemia, organ damage, and, if untreated, can be fatal. Effective control measures include the use of insecticide-treated bed nets, indoor residual spraying, prompt diagnosis, and treatment with antimalarial drugs. *F. gigantica* is a liver fluke that can cause fascioliasis, a parasitic infection. The prevalence suggests a significant burden of fascioliasis in this age group. Fascioliasis can lead to liver damage, abdominal pain, and digestive disturbances. Preventive measures involve avoiding the consumption of contaminated water plants, implementing proper livestock management practices, and raising awareness about the disease.[1,2,7-11]

The findings reveal a considerable burden of various parasitic infections among pupils aged 6–10 years. These infections can lead to a range of health complications, including nutritional deficiencies, impaired growth, organ damage, and cognitive impairments. To address these implications, comprehensive interventions are needed, including deworming programs, improved sanitation and hygiene practices, access to clean water, and targeted control measures for specific parasites.[1,2,7-11]

Among pupils aged 11–15 years, a considerable proportion had *A. lumbricoides* (40.6%), *E. histolytica* (54.5%), and *F. gigantica* (60.0%) infections. *S. mansoni* was found in 28.6% of pupils, while Hookworm infected 70.0% of them. *Plasmodium* was detected in only 15.4% of pupils, and *S. haematobium* infected 100% of the reported cases. Higher prevalence of Hookworm, *E. histolytica*, and *F. gigantica* infections: This age group shows a relatively higher incidence of these parasitic infections. The causes of these infections can be attributed to factors such as engagement in agricultural activities, closer contact with contaminated soil or livestock, poor sanitation, and suboptimal personal hygiene practices.

These findings emphasize the need for targeted interventions to improve hygiene, sanitation, and preventive measures in this age group. Significant prevalence of *A. lumbricoides*, *S. mansoni*, *E. histolytica*, and *Plasmodium* infections:[3-9] This age group exhibited a notable proportion of pupils infected with these parasitic species. The high prevalence of these infections can be associated with factors such as poor sanitation, inadequate access to clean water, and exposure to contaminated environments. Efforts should focus on improving sanitation facilities, access to clean water, and health education to reduce the burden of these parasitic infections.[7-11]

In the oldest age group (16–20 years), no infections were reported for *A. lumbricoides*, *S. mansoni*, *E. histolytica*, Hookworm, *Plasmodium*, or *S. haematobium*. However, 20% of the pupils were found to be infected with *F. gigantica*. Minimal infections, except for *F. gigantica*: The oldest age group showed a low prevalence of most parasite species, indicating a potential decline in infection rates as individuals grow older.[7-11] However, 20% of pupils were found to be infected with *F. gigantica*, which suggests potential exposure to contaminated water sources or consumption of contaminated food. Strategies should be implemented to prevent and control *F. gigantica* infection in this age group.[7-11]

The findings underscore the importance of comprehensive public health interventions targeting specific age groups to combat parasitic infections effectively. This includes improving sanitation, promoting hygiene practices, providing access to clean water, implementing agricultural and livestock management practices, and implementing targeted control measures for specific parasites. By addressing these factors, the prevalence and burden of parasitic infections can be reduced, leading to improved health outcomes among school-age children.[7-11]

The distribution of the proportion of total number of pupils infected by parasite species based on age reveals important scientific and health implications. In the age group of 1–5 years, 2.42% of the total number of pupils was infected with parasitic species. This relatively low prevalence suggests that younger children in this age group may have a lower risk of exposure to parasites compared to older age groups. However, it is worth noting that 23.1% of the infected pupils in this age group had *Plasmodium* infection, indicating the presence of malaria in this population. Malaria is a significant health concern in many tropical regions, including Nigeria, and can have severe consequences if not properly treated.[7-11]

The age group of 6–10 years had the highest proportion of pupils infected with parasitic species, accounting for 54.84% of the total infections. This finding suggests that children in this age range are particularly vulnerable to parasitic infections. The high prevalence of *A. lumbricoides* (59.4%), *S. mansoni* (74%), *E. histolytica* (45.5%), and *Plasmodium* (61.5%) highlights the need for targeted interventions and preventive measures in this age group. These parasites can cause various health problems, including gastrointestinal issues, anemia, and impaired cognitive development.[7-11]

In the age group of 11–15 years, 41.94% of the total infections were observed. *A. lumbricoides* (40.6%), *E. histolytica* (54.5%), and *F. gigantica* (60.0%) were the most prevalent parasites in this age range. Additionally, 70.0% of the pupils in this age group were infected with Hookworm. These findings indicate that older children are still at significant risk of parasitic infections, emphasizing the importance of sustained preventive measures and health education targeting this population.[7-11]

Among pupils aged 16–20 years, the prevalence of parasitic infections was relatively low, with only 0.81% of the total infections. However, it is noteworthy that 20% of the pupils in this age group were infected with *F. gigantica*. Although the overall infection rate is low, this finding suggests that certain parasites, such as *F. gigantica*, may still pose a risk to older adolescents and young adults.[7-11]

In summary, the distribution of parasitic infections among pupils in Kwara State reveals the burden and prevalence of different parasites in the region. The study highlights the importance of addressing parasitic infections through targeted interventions, including improved sanitation infrastructure, access to clean water sources, hygiene education, regular deworming programs, and appropriate vector control measures for malaria prevention. The age-specific distribution provides insights into the varying risk factors and transmission dynamics among different age groups, facilitating the development of age-targeted interventions. The findings of this study can guide public health authorities and policymakers in implementing effective strategies to reduce the prevalence and associated health risks of parasitic infections among school-aged children in Kwara State, Nigeria. The results indicate a varying distribution of parasite species among different age groups. Younger children (1–5 years) showed no infections except for a relatively high percentage of *Plasmodium* cases, suggesting a higher susceptibility to malaria. In the 6–10 and 11–15 age ranges, there was a notable prevalence of several parasite species, including *A. lumbricoides*, *E. histolytica*, and Hookworm. The highest prevalence of *S. haematobium* was observed in the 11–15 years of age group. The oldest age group (16–20 years) had a lower infection rate overall, except for a small proportion infected with *F. gigantica*. These findings can help guide targeted interventions and public health strategies for the prevention and control of parasitic infections in school-age children. The distribution of parasite infections based on age highlights the varying vulnerability of different age groups to different parasitic species. It underscores the importance of age-specific interventions, including deworming programs, improved sanitation, hygiene practices, and malaria prevention strategies, to effectively address the burden of parasitic infections and promote the health and well-being of pupils in Kwara State, Nigeria.

Conclusion

In this study, the distribution of parasitic infections among pupils in Kwara State, Nigeria was investigated. The study

included primary school pupils from Kwara Central, Kwara South, and Kwara North. A total of 638 samples were collected from these areas and analyzed for the presence of parasites. The results revealed an overall prevalence of parasitic infections among pupils in Kwara State to be 19.4%. Out of the infected pupils, the most common parasite found was *A. lumbricoides* (55.6%), followed by *S. mansoni* (11.2%), *Plasmodium* (10.5%), *E. histolytica* (8.9%), Hookworm (8.1%), *F. gigantica* (4.0%), and *S. haematobium* (1.6%). The age distribution analysis showed variations in the prevalence of parasitic infections among different age groups. In pupils aged 1–5 years, *Plasmodium* infection had the highest proportion (23.1%), while in pupils aged 6–10 years, *A. lumbricoides* (59.4%), *S. mansoni* (74%), and *E. histolytica* (45.5%) were the most prevalent parasites. Among pupils aged 11–15 years, *A. lumbricoides* (40.6%), *S. mansoni* (28.6%), and Hookworm (70%) were the dominant parasites. No infections were observed in pupils aged 16–20 years.

The study highlights the presence of multiple parasitic infections among pupils in Kwara State, with varying prevalence rates across different age groups. These findings underscore the importance of implementing targeted interventions and public health measures to control and prevent parasitic infections in this population.

Contributions to knowledge

This study on the distribution of parasitic infections among pupils in Kwara State, Nigeria, makes several valuable contributions to existing knowledge in the field. The findings of this research provide important insights into the prevalence and age-specific distribution of parasitic infections, shedding light on the burden of these infections among school-age children in the region.

Overall prevalence

The study reveals an overall prevalence of parasitic infections among pupils in Kwara State to be 19.4%. This information contributes to our understanding of the epidemiology of parasitic infections in the region and serves as a baseline for future studies and interventions aimed at reducing the prevalence of these infections.

Parasite-specific distribution

The research findings highlight the proportions of different parasitic infections in the study population. The high prevalence of *A. lumbricoides* (55.6%) and *S. mansoni* (11.2%) infections indicates the importance of addressing these specific parasites in control and prevention efforts. Understanding the distribution of specific parasite species is crucial for tailoring interventions and implementing targeted treatment strategies.

Age-specific distribution

The study provides detailed information on the age-specific distribution of parasitic infections. This knowledge is significant for designing age-specific control programs and interventions. The findings indicate that younger pupils (1–5 years) are more susceptible to *Plasmodium* infection, while *A. lumbricoides* and *S. mansoni* infections are more prevalent among pupils aged 6–10 years. The higher prevalence of *S. haematobium* among pupils aged 11–15 years emphasizes the need for specific interventions targeting this age group.

Identification of risk factors

By identifying the age groups at higher risk for specific parasitic infections, this study contributes to the understanding of risk factors associated with these infections. Factors such as environmental exposure, water sources, hygiene practices, and behavioral patterns can be further investigated to determine their influence on the distribution of parasitic infections in the region.

Basis for intervention strategies

The findings of this research provide a foundation for the development and implementation of targeted intervention strategies. By identifying the specific parasites and age groups with higher prevalence, policymakers, and health-care professionals can design effective control and prevention programs. These may include deworming campaigns, health education programs, improved sanitation infrastructure, and access to clean water sources, all of which are crucial for reducing the burden of parasitic infections.

This study on the distribution of parasitic infections among pupils in Kwara State, Nigeria, significantly contributes to the existing knowledge base. The findings provide valuable information on the overall prevalence, parasite-specific distribution, and age-specific patterns of parasitic infections. This research serves as a basis for the development of evidence-based interventions and strategies to mitigate the burden of parasitic infections among school-age children in the region.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

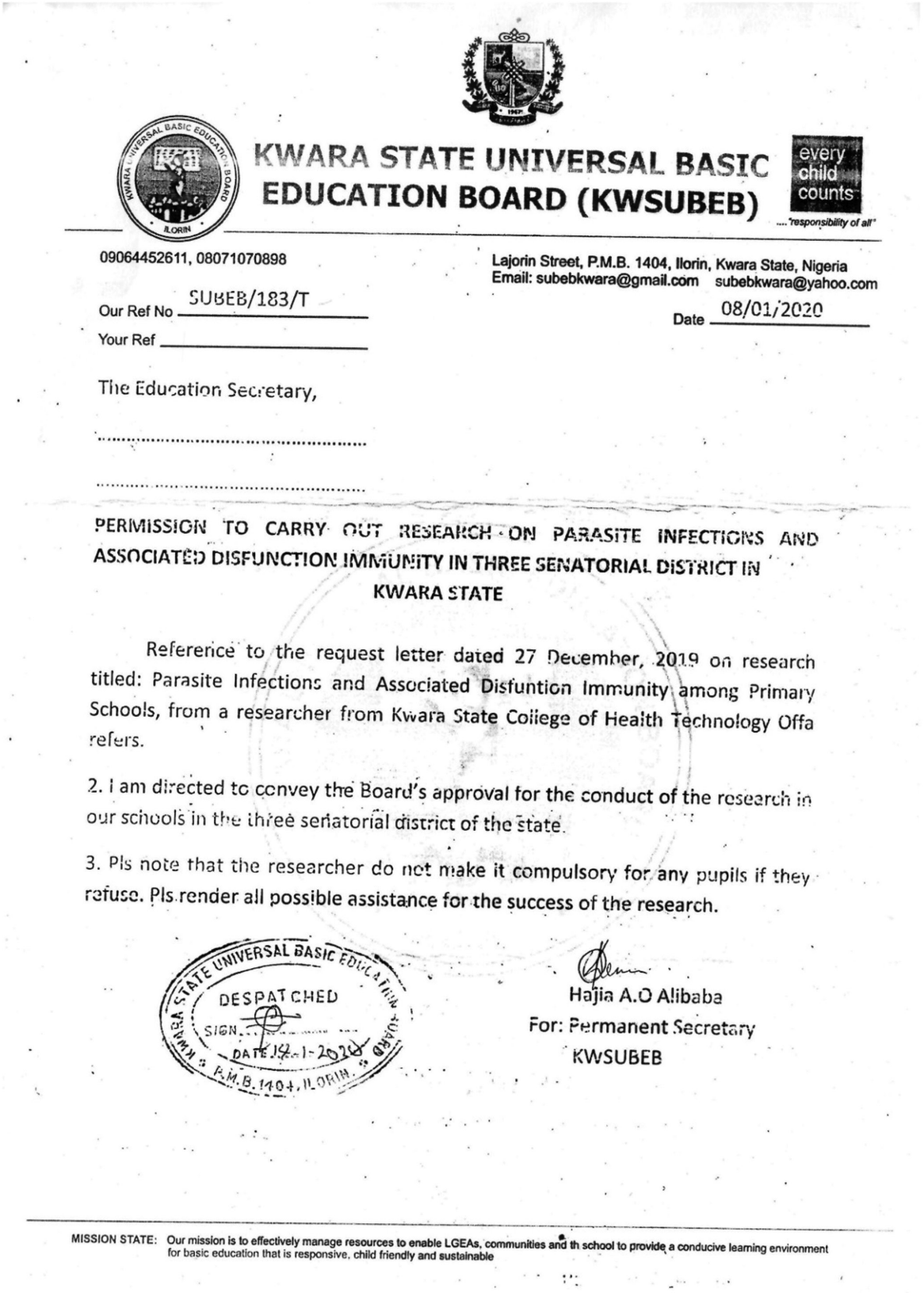
References

1. Cummings RD, van Die I, Varki A, Cummings RD, Esko JD, Stanley P, *et al*. Parasitic infections. In: Essentials of Glycobiology. 3rd ed., Ch. 43. Cold Spring Harbor (NY): Cold Spring Harbor Laboratory Press; 2015. p. 2017.
2. Shea-Donohue T, Qin B, Smith A. Parasites, nutrition, immune responses and biology of metabolic tissues. Parasite Immunol 2017;39:10.1111/pim.12422.
3. Shrestha J, Bhattachan B, Rai G, Park EY, Rai SK. Intestinal parasitic infections among public and private schoolchildren of Kathmandu, Nepal: Prevalence and associated risk factors. BMC Res Notes 2019;12:192.
4. Aliyu RA, Omosigho PO, Olaniyan MF. Parasitic infections among pupils in three Kwara senatorial districts, Nigeria. Biomed Biotechnol Res J 2022;6:489-93. Available from: https://www.bmbtrj.org/text . https://journals.lww.com/bbrj/fulltext/2022/06040/parasitic_infections_among_pupils_in_three_kwara.3.aspx [Last accessed on 2023 May 14].
5. Ola-Fadunsin SD, Adebanjo AO, Abdullah DA, Hussain K, Sanda IM, Rabiu M, *et al.* Epidemiology and public health implications of parasitic contamination of fruits, vegetables, and water in Kwara central, Nigeria. Ann Parasitol 2022;68:339-52.
6. Adedoja A, Tijani BD, Akanbi AA 2nd, Ojurongbe TA, Adeyeba OA,

Ojurongbe O. Co-endemicity of *Plasmodium falciparum* and intestinal helminths infection in school age children in rural communities of Kwara state Nigeria. PLoS Negl Trop Dis 2015;9:e0003940.
7. Cable J, Barber I, Boag B, Ellison AR, Morgan ER, Murray K, *et al.* Global change, parasite transmission and disease control: Lessons from ecology. Philos Trans R Soc Lond B Biol Sci 2017;372:20160088.
8. van Seventer JM, Hochberg NS. Principles of infectious diseases: Transmission, diagnosis, prevention, and control. In: International Encyclopedia of Public Health. Boston, MA, USA: Boston University School of Public Health; 2017. p. 22-39.
9. Opara KN, Udoidung NI, Opara DC, Okon OE, Edosomwan EU, Udoh AJ. The impact of intestinal parasitic infections on the nutritional status of rural and urban school-aged children in Nigeria. Int J MCH AIDS 2012;1:73-82.
10. Ola-Fadunsin SD, Uwabujo PI, Halleed IN, Richards B. Prevalence and financial loss estimation of parasitic diseases detected in slaughtered cattle in Kwara state, North-central Nigeria. J Parasit Dis 2020;44:1-9.
11. Krumrie S, Capewell P, Smith-Palmer A, Mellor D, Weir W, Alexander CL. A scoping review of risk factors and transmission routes associated with human giardiasis outbreaks in high-income settings. Curr Res Parasitol Vector Borne Dis 2022;2:100084.
12. Monica C. District Laboratory Practice in Tropical Countries Part 2. Cambridge, England: Cambridge University Press; 2006.

Appendixes

Appendix I



KWARA STATE UNIVERSAL BASIC EDUCATION BOARD (KWSUBEB)

every child counts
"responsibility of all"

09064452611, 08071070898

Lajorin Street, P.M.B. 1404, Ilorin, Kwara State, Nigeria
Email: subebkwara@gmail.com subebkwara@yahoo.com

Our Ref No SUBEB/183/T

Date 08/01/2020

Your Ref

The Education Secretary,

.....

.....

PERMISSION TO CARRY OUT RESEARCH ON PARASITE INFECTIONS AND ASSOCIATED DISFUNCTION IMMUNITY IN THREE SENATORIAL DISTRICT IN KWARA STATE

Reference to the request letter dated 27 December, 2019 on research titled: Parasite Infections and Associated Disfuntion Immunity among Primary Schools, from a researcher from Kwara State College of Health Technology Offa refers.

2. I am directed to convey the Board's approval for the conduct of the research in our schools in the three senatorial district of the state.

3. Pls note that the researcher do not make it compulsory for any pupils if they refuse. Pls render all possible assistance for the success of the research.

KWARA STATE UNIVERSAL BASIC EDUCATION BOARD
DESPATCHED
SIGN.....
DATE 17-1-2020
P.M.B. 1404, ILORIN.

Hajia A.O Alibaba
For: Permanent Secretary
KWSUBEB

MISSION STATE: Our mission is to effectively manage resources to enable LGEAs, communities and th school to provide a conducive learning environment for basic education that is responsive, child friendly and sustainable

Appendix II

MINISTRY OF HEALTH

P.M.B. 1386, FATE ROAD, ILORIN, KWARA STATE.
Tel: 08099901188, 08099903366.

Our Ref: MOH/KS/EU/777/354 *Your Ref:* _____ *Date:* 29th November, 2019.

ALIYU, **Abdul-Rauf Alabi**

Department of Medical Laboratory Science,
Medical Microbiology,
College of Natural and Applied Sciences,
Igbinedion University, Okada,
Edo State.

APPROVAL TO CARRY OUT A RESEARCH TITLED: **"Parasitic Infections and Associated Disfunction Immunity Among Primary School Pupils in Parts of Kwara State, Nigeria."**

Sequel to your request and the interest of the State Ministry of Health in Health related research activities to improve the health of the citizens. I am directed to forward to you the approval of the Ministry of Health to carry out the dissertation as itemized in your protocol. This approval dates from 29th November, 2019 to 29th November, 2020.

2. You are mandated to acknowledge the State Ministry of Health by your presentations/publications and deposition of the final copy of the research findings/publications.

3. Best wishes in your research project.

Mrs Sadiq T.R
For: Honourable Commissioner

CMD/Officer in charge.

.....

.....

Above for your information and necessary action, please.

Appendix III

Dear Respondent,

Kindly provable information as requested below.

This questionnaire is designed to collect supporting information on the Parasitic Infections And Associated Dysfunction Immunity Among Primary School Pupils In Parts Of Kwara State, Nigeria. The information will only be used for research to provide preventive information on parasitic infection among primary school pupils. It will be treated confidentially.

A. Demographic Information

Identification number.....

Town.....

Local Government Area .....

Sex.....

Age.....

Primary school Class.....

Weight.....

Height.....

Family status - Under single parent..... Polygamy .....

Monogamy ..... Others .....

Parents' educational status.....

Religion denomination.....

B. Hygienic Practices, Environmental hygiene, Poverty level, and nutritional practices

Instruction: Kindly thick (✓) against each question as applicable

SERIAL NUMBER	QUESTIONS	STRONGLY AGREED(4MKS)	AGREED (3MKS)	DISAGREED (2MKS)	STRONGLY DISAGREEL (1MKS)
1.	Pupils Swim/bath in open water source :				
2.	Indiscriminate or open defecation/urination is the practice in the community				
3.	Majority of the community people Fetch water from ponds/streams				
4.	No toilet in most of the houses				
5.	No public toilet				
6.	Pupils always absent from school because of school fees				
7.	Many pupils cannot afford more than one school uniform				
8.	Most pupils wear faded or toured uniform				
9.	Many parents cannot afford the school fees of private schools				
10.	Pupils source for their school fees themselves through hawking etc				
11.	Pupils do share domestic utensils				
12.	Families live closer to refuse dump site				
13.	Pupils Play around refuse dump site				
14.	The surrounding of the community is bushy				

15.	There is water scarcity in the community				
16.	Always bitten by mosquito and other flies.				
17.	Wash clothes & utensil in open water				
18.	Pupils wash their hands after visiting toilet				
19.	Pupils Wear shoes when outside				
20.	Pupils Drink untreated water				
21.	Community do Seek treatment from clinic for GIT and urinary tract symptoms				
22.	Pupils do smoke				
23.	Pupils drink Alcohol				
24.	Eat in not less than 3 times a day				
25.	Take a combination of protein, carbohydrate, mineral rich food regularly and daily				
26.	Do not always have food to eat				
27.	Eat anything that is available				
28.	Clinics and hospitals are far from the community				
29.	Can conveniently access health facilities				
30.	Have had health education on parasitic infection and nutrition				
31.	Practice good health/ hygienic habits				
32.	Clinics and hospitals are available but ill equipped with human and material resources				