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Research Article

Comparative Evaluation of Intestinal Parasitic Burden among Some Pupils in Public and Private School in Nkpolu-Oroworukwo Community, Port Harcourt, Rivers State

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Abstract

Intestinal parasitic infections (IPIs) are among the neglected tropical diseases highly prevalent in developing countries, probably due to the low level of enlightenment, personal hygiene, low standard of living and overall economic status of the subjects. Thus, the aim of the study was to study the prevalence of intestinal parasites among pupils of selected public and private primary schools in Nkpolu-Oroworukwo, Port Harcourt, and Rivers State. A total of 112 Samples were collected at random using convenient sample collection research design. The analysis of the samples was explored using standard parasitological procedures. Results from the study revealed that *Ascaris lumbricoides* recorded the highest prevalence (33.3%) while Hookworm, *Strongyloides stercoralis* and *Entamoeba sp.* had 11.1% of the positive cases each. Furthermore, *Trichuris trichiura, Ascaris lumbricoides,* Hookworm and *Strongyloides stercoralis* were all implicated in mixed infections that stood at 33.3% positive cases. IPIs were more prevalent in the public school (22.2%) than in the private school (10.3%); however, the difference was not statistically significant ($p > 0.05$). Pupils within the age group of 10 and 13 years recorded a higher prevalence of infection (25%) than pupils within the age group of 6 and 9 years (7.1%). There was no statistically significant difference in the prevalence of IPIs between the male and the female pupils ($p > 0.05$). Nonetheless, there were more pupils with unemployed parents in the public school (77.8%) than in the private school (46.6%). However, pupils with unemployed parents in the overall population had more infections (21.2%) than those with employed parents (4.7%). Lack of frequent worming was also a problem as a large percentage of the pupils had not wormed for over 3 months before sample collection, and a reasonably high percentage of them had IPIs (17.9%). Besides, 16.1% of the entire population was infected. It is therefore strongly recommended that frequent worming of school children, health education campaigns, improved sanitary conditions and personal hygiene would help to control and reduce the incidence of IPIs in the study area.

Keywords: *Neglected Tropical Disease; Intestinal Parasites; Infants; Anaemia; Stunted Growth; School Pupils*

Introduction

Humans and intestinal parasites compete for trophic supremacy when the parasites get into the human body. The parasites may overcome the humans (host) and cause disease, while the humans may overcome the parasites and remain healthy [1]. Nevertheless, not less than 26% of the world's population (over 2 billion people) has soil-transmitted helminth (STH) infections globally. The major soil-transmitted helminths affecting humans are *Ascaris lumbricoides*, *Trichuris trichiura* and Hookworms (*Necator americanus* and *Ancylostoma* *duodenale*), and the highest prevalence occurs in areas with poor sanitation and unsafe water supplies [2,3]. Tropical and subtropical regions have a wide distribution of infections, with Sub-Saharan Africa, the Americas, China and East Asia having the greatest numbers [4]. A large percentage of these parasites undergo a direct lifecycle in which they are transmitted via contaminated soil containing an infective egg or larvae from human or animal faeces [5].

Protozoa-incriminated intestinal parasitic infections are also a major Public Health problem globally. In developing countries, they rank among the most widespread human infections, and children are the most susceptible population [6]. The major causes of diarrhoea in children are intestinal protozoans such as *Cryptosporidium spp.* and *Giardia duodenalis* (also known as *Giardia intestinalis* or *Giardia lamblia*) [7]. According to the recent data from the Global Enteric Multicenter Study (GEMS) on the burden and aetiology of childhood diarrhoea in developing countries, the apicomplexan protists, *Cryptosporidium spp*., are recently one of the leading causes of moderate to severe diarrhoea in children under the age of 2 years [8, 9]. Whereas, approximately 200 million individuals are infected with *Giardia duodenalis* globally and is peculiar to daycare centres and among school children [10]. These protozoans are transmitted via the faecal-oral route, following direct or indirect contact with their infectious stages. Furthermore, other means of transmission include human-to-human, zoonotic, waterborne, and foodborne transmissions outcome [7].

Intestinal parasitic diseases burden on the health and quality of life of infected individuals are mainly attributed to the chronic and insidious impact rather than to the mortality caused by the disease. Impaired physical growth and cognitive development ensue in heavy intensity infections, which also cause micronutrient deficiencies including critical iron deficiency anaemia. It also presents with such symptoms as intestinal manifestations (e.g. diarrhoea and abdominal pain), malnutrition, general malaise and weakness. These can in turn, result in poor school performance and absenteeism in children, as well as reduced work productivity in adults, and huge adverse impact outcomes among pregnant mothers [4,11,12].

As a way of reducing the disease morbidity by reducing the parasite burden, the World Health Organization (WHO) recommends periodic worming of all at-risk individuals living in endemic areas without prior individual diagnosis. The WHO also encourages health and hygiene education to reduce transmission and reinfection [4].

However, several unhygienic practices are associated with pre-school and school-age children which predispose them to intestinal parasitic infections (IPIs), thereby making them a susceptible population, although pregnant women are at the greatest risk of IPIs-related morbidity [13,14]. The children who are mostly affected include disadvantaged children, especially those who live in densely populated and under-serviced urban informal settlements, as well as those in some rural areas [15,16]. Although IPIs scarcely cause death directly, they are still associated with poor growth in children, deficiencies in vitamins, iron-deficiency anaemia, and poor educational performances. Recent studies have shown that poly-parasitized children experience worse cognitive outcomes than children with one parasite; poly-parasitism has been associated with higher mortality rates, as well as increasing the susceptibility of patients to other infections [13,17].

Nonetheless, there are billions of people affected by intestinal parasitic diseases worldwide; the high risk population which includes the children and pregnant women outnumbers the other adults in developing countries. Intestinal parasitic diseases are among the neglected tropical diseases in which the World Health Organization has shown massive rekindled interest to tackle the menace globally, so as to prevent or reduce it's Public Health consequences among venerable subjects especially in developing Communities [13,14].

Nevertheless, the study was aimed at comparing the prevalence of intestinal parasitic infections between children attending public primary school and those in private primary school in the study area, even as the pupils from these different schools have relatively exhibited different lifestyle, status and myriad of behavioral outcome in their daily engagement for survival. It is therefore, strongly believed that data generated from this study would provide much needed impetus towards improving innovative management and control strategy of reducing the Public Health impact of the parasites in the region, even as it would help to direct the attention of Government and her relevant agencies to focus critically on the policies that would lead to the control and prevention of the parasitic burden among children in the region.

Materials and Methods

Study area

The study area (Nkpolu-Oroworukwo) is located in Port Harcourt local government area (PHALGA) of Rivers State, South-South geopolitical zone of Nigeria. Furthermore, Port Harcourt lies along the Bonny River (an eastern distributary of the Niger River), 66km upstream from the Gulf of Guinea. The area covers a landmass of 360 square kilometres at latitude 4° 46' 38.71" N and longitude 7° 00' 48.24" E, with an estimated population of about 2,000,000 people as of 2009. The overall climate of Port Harcourt is tropical; rainfall is significant in most months of the year (with an annual rainfall of 1950.7 mm) while the dry season is short [18-20]. The inhabitants of this area are actively involved in trading and subsistent farming. The school-aged children, after school, often go to the market to assist their parents in selling. Two primary schools in Nkpolu-Oroworukwo, one public (State Primary School, Nkpolu), and one private (Adventist Nursery/Basic Education Centre, Mile 3) were the focus of this study.

Figure 1: *Map of Rivers State Showing the Study Area (Mile III) [21].*

Inclusion and exclusion criteria

Only the pupils in basic 1 - 5 (for the private primary school) and basic 1 - 6 (for the public primary school) were sampled. Nursery pupils were not sampled due to claims by the management of the schools that they were too young to participate in the study. Although a total of 7 schools were initially contacted to participate in the study, only 2 schools responded.

A total of 97 parents from the private school and 99 from the public school gave their consent. However, only 58 pupils from the private school and 54 pupils from the public school complied with sample submission, giving a total of 112 samples.

Sample collection and ethical consideration

Before the commencement of this study, ethical approval was obtained from the Department (Medical Laboratory Science), and the ethical committee of the institution (Rivers State University, Port Harcourt). Informed consent was also obtained from the management of the primary schools and consent forms were issued to the parents of the pupils. Each participant was provided with a structured questionnaire (to obtain demographic data), and a sterile screw-capped universal container, with detailed instructions on how to obtain the stool sample. It was emphasized that only fresh stool, not mixed with urine, and passed early in the morning of submission would be acceptable [22]. A total of 112 samples were collected from the pupils and transported to the Microbiology laboratory of the Department of Medical Laboratory Science, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, for examination.

Faecal analysis

Macroscopy

The stool samples were examined macroscopically for the colour, consistency, abnormal features and the presence or absence of worms and worm segments [22].

Direct wet preparation

An applicator stick was used to emulsify a small amount of stool (1g) on a drop of fresh normal saline on one end of a clean glass slide, and the same quantity of the stool was emulsified on a drop of iodine solution on the opposite end of the slide. Each preparation was covered with a coverslip (avoiding air-bubbles) and examined systematically under the x10 and x40 objectives of the microscope accordingly [23].

Formol-ethyl acetate concentration technique

With the aid of an applicator stick, 1g (pea-size) of the stool specimen was emulsified in 4ml of 10% formol saline in a screw-cap tube, and an additional 4 ml of formol saline was added to the mixture and mixed by shaking. The mixture was sieved through medical gauze into a beaker, and the filtrate was transferred to a conical centrifuge tube, to which 4ml of ethyl acetate was added thereafter. The tube was stoppered, mixed for 1 minute and centrifuged at 3000 r.p.m. for 1 minute. After centrifugation, a fresh applicator stick was used to unplug the layer of faecal debris from the side of the tube and the supernatant fluid was decanted, leaving behind the concentrate at the bottom of the tube. The tube was then tapped on the bottom to resuspend the concentrate and a drop was emulsified on a drop of normal saline on one end of a clean grease-free glass slide. Another drop of the concentrate was also emulsified on a drop of iodine solution on the other end of the slide and both preparations were covered with coverslips (avoiding air-bubbles) and examined under the x10 and x40 objectives of the microscope accordingly [23].

Structured questionnaire: In this study, a well-structured questionnaire was used to collect the demographic data of the school pupils and possible potential risk factors among the subjects. This was achieved with the help of the co-operation of the parents who accepted to participate in the study after an oral consent was granted on behalf of the minors to answer the questions.

Statistical analysis

The statistical analysis was carried out using GraphPad Prism version 8. The differences in prevalence between the schools, age groups and gender were tested using Chi-squared test at a confidence interval of 95%. Also, the differences between the means of the parasites in the population were tested using one-way analysis of variance (ANOVA). P-values greater than 0.05 were considered as not significant.

Results

It was observed from table 1 that 16.1% out of the 112 pupils examined in the study showed the presence of intestinal parasites. The public primary School showed a greater prevalence of infection (22.2%) while a prevalence of 10.3% was observed in the private primary school. However, the difference observed from the Chi-squared comparison between the two primary schools was not statistically significant ($p > 0.05$). The parasite species implicated in the infections include *Ascaris lumbricoides*, *Trichuris trichiura,* Hookworm, *Strongyloides stercoralis* and *Entamoeba sp*. *A. lumbricoides* recorded the highest number of positive cases 6 (33.3%), whereas Hookworm, *S. stercoralis* and *Entamoeba sp.* had 2 (11.1%) of positive cases each. It was also observed that 6 (33.3%) of cases were mixed infections involving all the four helminths mentioned above. However, the analysis of variance (ANOVA) of the prevalence of the parasites showed that there was no statistically significant difference between their prevalence.

School	Sample Size	No. infected (%)	Parasites						
			A. lumb. No. (%)	Hookw. No. (%)	*S. Sterc.* No. (%)	*Ent. spp.* No. (%)	Mixed infections		
							T. Trich. and *S. Sterc.* No. (%)	Hookw. and *S. sterc.* No. (%)	*A. lumb.* and Hookw. No. (%)
Private school	58	6 (10.3)	0 (0)	2 (33.3)	0 (0)	2 (33.3)	0 (0)	0 (0)	2 (33.3)
Public school	54	12 (22.2)	6 (50)	0(0)	2 (16.7)	0 (0)	2 (16.7)	2 (16.7)	0 (0)
Total	112	18 (16.1)	6 (33.3)	2 (11.1)	2 (11.1)	2 (11.1)	6 (33.3)		

Table 1: *Parasite prevalence in the overall population.*

With respect to the two age groups involved in the study, it was observed that in the private school, pupils aged between 6 and 9 years showed a parasite prevalence of 7.1%, while a prevalence of 13.3% was observed in those aged between 10 and 13. Also, in the public school, a prevalence of 7.1% was observed in the pupils aged between 6 and 9, whereas, the pupils aged between 10 and 13 showed a prevalence of 38.5%. In the overall population, the prevalence of the infection in pupils aged between 6 and 9 was 7.1% while that of the pupils aged between 10 and 13 was 25%. However, the private school had 33.3% of the total infections while the public school has 66.7%, but these differences observed were not statistically significant ($p > 0.05$) (Table 2).

School	Age Group	Sample Size	No. of infections (%)	Total (% of the overall infection)
Private	6 - 9	28	2 (7.1)	6 (33.3)
	10 - 13	30	4 (13.3)	
	Total	58	6 (10.3)	
Public	6 - 9	28	2 (7.1)	12 (66.7)
	10 - 13	26	10 (38.5)	
	Total	54	12 (22.2)	
Both	6 - 9	56	4 (7.1)	18 (100)
	10 - 13	56	14 (25)	
	Total	112	18 (16.1)	

Table 2: *Age related prevalence in the studied population.*

Furthermore, with respect to gender, the private school male pupils showed a greater prevalence of infection (13.3%) than the females who showed a prevalence of 7.1%. In the public school, the male pupils also showed a greater prevalence (25.9%) than the female pupils who showed a prevalence of 18.5%. The result also revealed that in the overall population, the male pupils had a greater number of infections (with a prevalence of 19.3%) than their female counterparts who showed a prevalence of 12.7%. However, these differences were not statistically significant ($p > 0.05$).

School	Sex	Sample Size	No. of infections (%)
Private	Male	30	4 (13.3)
	Female	28	2 (7.1)
	Total	58	6 (10.4)
Public	Male	27	7 (25.9)
	Female	27	5 (18.5)
	Total	54	12 (22.2)

Table 3: *Sex-related prevalence of intestinal parasitic infections in both schools.*

Nonetheless, the evaluation of the possible risk factors showed that 46.6% of the pupils tested in the private school had unemployed parents and 12.9% of this population were infected; whereas, 53.5% of the private-school pupils had employed parents and only 6.6% of them were infected. However, in the public school, 77.8% of the tested pupils had unemployed parents and 28.6% of this population were infected; whereas, 22.2% of them had employed parents and nobody in this group was infected. Also, all the tested pupils in the private school always wore footwears when playing and 10.3% of them were infected. Whereas, in the public school, 87% of the tested pupils wore footwears when playing and had an infection rate of 25.5%, while 13% of them play without footwears but none of them was infected. Finally, in the private school, 63.8% of the pupils had been wormed within 3 months before sample collection and 10.8% of them were infected; whereas, 36.2% of the pupils had not been wormed for over 3 months before sample collection, and 9.5% of them were infected. However, in the public school, only 14.8% of the tested pupils had been wormed within the previous 3 months and 25% of them were infected; whereas, 85.2% of the pupils had not been wormed for over 3 months and 21.7% of them were infected (Table 4). But none of these differences observed was statistically significant ($p > 0.05$).

School	Parents' employment status				Mode of playing				Last wormed			
	Emp. (%)	Inf. (%)	Unemp. (%)	Inf. (%)	With footwear (%)	Inf. (%)	Without footwear (%)	Inf. (%)	Within 3 months (%)	Inf. (%)	Over 3 months (%)	Inf. (%)
Private (58 pupils)	31 (53.5)	2 (6.5)	27 (46.6)	4 (12.9)	58 (100)	6 (10.3)	0 (0)	0 (0)	37 (63.8)	4 (10.8)	21 (36.2)	2 (9.5)
Public (54 pupils)	12 (22.2)	0 (0)	42 (77.8)	12 (28.6)	47 (87)	12 (25.5)	7 (13)	0 (0)	8 (14.8)	2 (25)	46 (85.2)	10 (21.7)
Overall (112 pupils)	43 (38.4)	2 (4.7)	69 (61.6)	16 (21.2)	105 (93.8)	18 (17.1)	7 (6.3)	0 (0)	45 (40.2)	6 (13.3)	67 (59.8)	12 (17.9)

Table 4: *Impact of risk factors on parasite prevalence.*

Abbreviations: Emp. = Employed; Unemp. = Unemployed; Inf. = Number Infected.

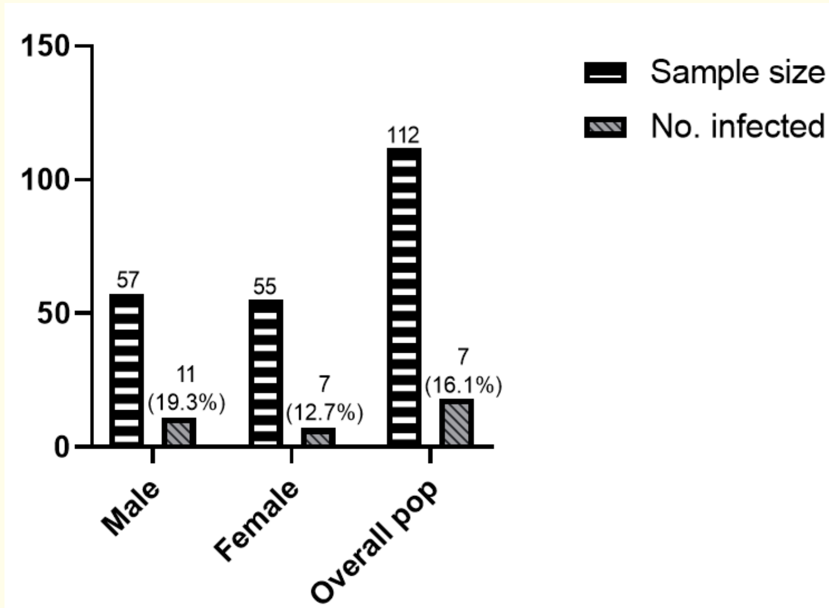

Figure 2: *Bar chart showing the sex-related prevalence of intestinal parasitic infections in the overall population. The bar chart reveals that the infection showed a greater prevalence in the males (19.3%) than the females (12.7%), while a prevalence of 16.1% was observed in the overall population.*

Discussion

A 16.1% prevalence rate of intestinal parasitic infections was obtained in this study. This is comparable to the prevalence rate of 16.9% obtained in South-Eastern Nigeria [24], 19.2% obtained in Sapele, Delta State [3], 19.2% obtained in Port Harcourt, Rivers State [25] and 13.9% obtained in Southern Thailand [26]. However, it was significantly lower than the prevalence rate of 61.9% obtained in Gojjam, Ethiopia [27] among food handlers. These variations may probably reflect the differences in sanitary standards, local endemicity, timing, seasonal differences and personal hygiene in the two different location studied [3]. The parasites identified in this study include *Ascaris lumbricoides*, *Strongyloides stercoralis*, Hookworm, *Trichuris trichiura*, and *Entamoeba sp*. (all of which are of Public Health importance), and most of which have previously been reported in Nigeria [28-30]. The presence of these parasites in the body has been implicated in several pathophysiologies in humans, ranging from mild to severe. For instance, the larvae of *S. stercoralis* have been known to cause type-1 hypersensitivity reaction, whereas the adult worm affects the intestinal mucosa where it causes localized inflammation [31]. Rarely, patients with chronic strongyloidiasis may develop chronic malabsorption, duodenal obstruction, nephrotic syndrome and cardiac arrhythmias [32]. Hookworms may also cause type-1 hypersensitivity when they migrate to the lungs and severe extravasation of blood when they migrate to the intestine [31,33]. It is also known to be one of the leading causes of anaemia in pregnant women and children globally [34]. *A. lumbricoides*, on the other hand, may cause partial or complete bowel obstruction when in large numbers; it can also cause pancreatitis, hepatobiliary pathologies and impaired growth in children [35, 36, 37]. *T. trichiura* also causes colonic mucosal inflammation, while *Entamoeba sp.* may cause amoebic colitis or invasive intestinal amoebiasis in severe cases [38].

The higher prevalence of *A. lumbricoides* in the population can be attributed to the ability of its infective form (the ova) to withstand environmental extremes due to its mucopolysaccharide coat that protects it from desiccation [3]. The relative higher prevalence of *S. ster-*

coralis and Hookworm could be attributed to poor environmental and personal hygiene, as well as indiscriminate human waste disposal [23]. However, the relatively high prevalence of hookworm in this study may indicate a risk to the public due to the zoonotic abilities of its larvae [39]. The low level of *T. trichiura* could as well be attributed to its minimal dispersion since the female worm releases a relatively lower number of eggs, and the eggs cannot withstand high temperature over time [40]. Whereas, the low level of *Entamoeba sp.* could be probably be attributed to the fact that the study was conducted in an urban settlement where there is the availability of potable water for cooking and drinking unlike in the remote communities that lacks the provision of potable water.

The public school recorded a higher prevalence of infection (22.2%) than the private school (10.3%) and the former recorded 66.7% of the overall infections while the latter accounted for the remaining 33.3%. These may be attributed to the higher quality of life, occupation and level of education and enlightenment of the parents of the pupils in the private school when compared to their public-school counterparts. It is further strongly believed that the high societal status of the parents of the pupils in private school has an overwhelming massive impact on their quality of life, food and strong practice of personal hygiene and environmental sanitation uptake which must definitely rub-off on the children over time. Also, pupils aged between 6 and 9 years had a lower prevalence of infection when compared to those aged between 10 and 13 years for both schools. In the overall population, pupils aged between 6 and 9 years also had a lower prevalence of infection (7.1%) when compared to the pupils aged between 10 - 13 years (25%). This observed variation, being consistent both in the within-school comparisons and in the overall population, could be attributed to the fact that children within the age group of 10 - 13 years, unlike those between 6 - 9 years, are more exposed to the environmental risk factors in the course of their daily activities such as street hawking and selling in markets, playing in the soil, farming, as well as other soil-related activities. They are mostly engaged in supporting the family, even as they have longer time of exposure in the environment as their passion to play in the soil and dirty broken drainages waters cannot be over emphasized.

The male subjects also showed a greater prevalence of the infection than the female subjects in both the within-school comparisons and the overall population. This observed difference in prevalence is comparable to the 54.5% male infection and 48.3% female infection obtained in Northern Nigeria [41] and the 18.4% male infection and 20% female infection obtained in Southern Nigeria [3]. The above study results, including the result obtained from this study; show that there is usually no significant difference between male and female intestinal infections outcome. Besides, the reason for none significant association is not known per se, but however, this could probably be linked to sample size, methods of assay and the location of the study area of this present study.

The public school had a reasonably higher percentage of pupils whose parents were unemployed when compared to the private school. This could be attributed to the fact that employed parents usually have a higher quality of life and tend to send their children to good private schools since they can afford the fees; however, this is not usually the case for unemployed parents who oftentimes, struggle to feed, and hence, may not afford the fees involved in the private schools. Also, in both the within-school comparisons and the overall population, pupils with unemployed parents had a greater prevalence of infection than those with employed parents. Such factors as high standard of living, good quality of life, as well as the relatively high level of education and enlightenment associated with employed parents helps reduce the risks of infection on their children, as it makes room for healthier living environments and parental care. However, unemployed parents, with relatively lower quality of life, as well as little or no education and enlightenment, may not provide the same for their children, thereby predisposing them to intestinal parasitic infections given the reign of lack of health education that remains a strong veritable tool for infection control and prevention in Public Health promotion.

Worming was also a problem as 85.2% of the pupils from the public school and 36.2% of pupils from the private school had not wormed for over 3 months prior to sample collection. The alarming high percentage of unwormed pupils in the public school could be attributed to the various parental factors mentioned earlier. However, in the public school, a higher number of infections came from the unwormed population; whereas, in the private school, the higher number of infections came from the wormed population. This contradicting difference can be attributed to the differences in hygienic practices, immune systems, level of exposure to risk factors and parental care associated with each pupil. It could also be due to poor worming or the presence of drug-resistant parasites in the population [39]. Finally, 100% of the pupils from the private school and 87% of those from the public school always put on footwear when playing in the soil. Hence, transmission via penetration of larvae through the skin may not be the case in this study as none of the pupils from both schools who played without footwear were infected. However, This may have played an important role in the overall low prevalence of the infection as wearing footwears during soil-related activities reduces the chances of infection with parasites whose larvae are capable of penetrating the intact skin such as the filariform (L3) larvae of *Hookworms* and *S. stercoralis*, which are barely visible to the unaided eyes [33,42].

Conclusion

This study revealed that the public primary school had a greater prevalence of intestinal parasitic infections than the private primary school. This difference could be attributed to the low quality of life and relatively poor hygiene peculiar to the parents of the public-school pupils. The study also revealed that though there were a high number of pupils who were not wormed for over 3 months prior to sample collection, a larger proportion of them came from the public school, and this can be attributed to the economic status and level of enlightenment of their parents. However, poor worming, as well as the presence of drug-resistant parasites, may have contributed to the prevalence of the parasites in the population. Hence, there is need for regular worming of school-aged children, as well as the conducting of health education and enlightenment campaigns to inform the public about infections and the need for improved sanitary conditions and personal hygiene. In addition, the high rate of unemployment may have played a role in the prevalence of the infection. Hence, reducing unemployment will improve the quality of life of many families and reduce the predisposing factors of infection.

Conflict of Interest

None to the best of my knowledge among authors.

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Bibliography

1. El-Tonsy MM. "Introduction to medical parasitology". In Kotchetkov V. [Edition.], Encyclopaedia of Life Support System (2012): 53.
2. World Health Organization. "Soil-Transmitted Helminthiasis: Eliminating Soil-Transmitted Helminthiasis as a Public Health Problem in Children: Progress Report 2001-2010 and Strategic Plan 2011-2020, World Health Organization, Geneva, Switzerland (2012).
3. Wokem GN and Onosakpondme EO. "Soil transmitted helminthiasis in Sapele Local Government, Delta State". *Nigerian Journal of Parasitology* 35.1-2 (2014): 143-148.
4. World Health Organization. "Soil-transmitted helminth infections" (2020).
5. Bethony J., *et al.* "Soil-transmitted helminth infections: Ascariasis, trichuriasis, and hookworm". *The Lancet* 367.9521 (2006): 1521-1532.
6. Harhay MO., *et al.* "Epidemiology and control of human gastrointestinal parasites in children". *Expert Review of Anti-infective Therapy* 8 (2010): 219-234.

7. Caccio SM., *et al.* "Unravelling *Cryptosporidium* and *Giardia* epidemiology". *Trends in Parasitology* 21 (2005): 430-437.
8. Striepen B. "Parasitic infections: Time to tackle cryptosporidiosis". *Nature* 503 (2013): 189-191.
9. Kotloff KL., *et al.* "Burden and aetiology of diarrhoeal disease in infants and young children in developing countries [the Global Enteric Multicenter Study, GEMS]: a prospective, case-control study". *Lancet* 382 (2013): 209-222.
10. Heresi GP., *et al.* "Giardiasis". *Seminars in Pediatric Infectious Diseases* 11 (2000): 189-195.
11. Hall A., *et al.* "A review and meta-analysis of the impact of intestinal worms on child growth and nutrition". *Maternal and Child Nutrition* 4 .1 (2008): 118-236.
12. Maikai BV., *et al.* "Molecular characterizations of *Cryptosporidium, Giardia*, and *Enterocytozoon* in humans in Kaduna State, Nigeria". *Experimental Parasitology* 131 (2012): 452-456.
13. Supali T., *et al.* "Polyparasitism and its impact on immune system". *International Journal for Parasitology* 40.10 (2010): 1171-1176.
14. World Health Organization (2019).
15. Nyarango RM., *et al.* "The risk of pathogenic intestinal parasite infections in Kisii municipality, Kenya". *Bio Med Central Public Health* 8.1 (2008): 237.
16. Uttah EC., *et al.* "Pattern of infection by six intestinal parasite species among inmates of new Bakasi resettlement camp in Ekpiri-Ikang, Nigeria". *Advance Tropical Medicine and Public Health International* 2.3 (2012): 88-99.
17. Ngui R., *et al.* "Association between anemia, iron deficiency anemia, neglected parasitic infections and socioeconomic factors in rural children of west Malaysia". *Public Library of Science/Neglected Tropical Diseases* 6.3 (2012): e1550.
18. Custom Weather. Climate and weather averages in Port Harcourt, Nigeria (2015).
19. Britannica. Port Harcourt (2019).
20. Latitude. Main cities in Nigeria: Administrative regions in Nigeria (2019).
21. Nigeria Galleria. Nigeria: States of Nigeria - Rivers State (2017).
22. Nyenke CU. "Basics of specimen collection and analysis for health workers". Nigeria: Jaenoc Int'l. Co (2013).
23. Cheesbrough M. "District laboratory practice in tropical countries part 1". New York: Cambridge University Press (2010).
24. Chigozie JU., *et al.* "Soil transmitted helminth infection in school children in South Eastern Nigeria; the public health implication". *The International Journal of Third World Medicine* 4.1 (2007): 41-65.
25. Wokem GN and Wokem VC. "Epidemiology of intestinal helminthiasis among school children attending public and private primary school in Port Harcourt, Rivers State". *Nigerian Journal of Parasitology* 35.1-2 (2014): 41-55.
26. Punsawad C., *et al.* "Prevalence of intestinal parasitic infection and associated risk factors among village health volunteers in rural communities of southern Thailand". *Bio Med Central Public Health* 17.1 (2017): 564.
27. Asires A., *et al.* "Prevalence and associated factors of intestinal parasitic infections among food handlers at prison, east and west Gojjam, Ethiopia". *Advances in Medicine* (2019): 2101089.
28. Adekeye TA., *et al.* "Environmental contamination and public health risk of soil parasites in Ibadan South East Local Government Area, Nigeria". *Zoology and Ecology* 26.2 (2016): 150-157.

29. Hassan AA., *et al.* "Spatial patterns of soil transmitted helminths in soil environment around Ibadan, an endemic area in southwest Nigeria". *Nigerian Journal of Parasitology* 38.2 (2017): 179-184.

30. Nwoke EU., *et al.* "Examination of soil samples for the incidence of geohelminth parasites in Ebonyi, north-central area of Ebonyi State, south-east of Nigeria". *Archives of Applied Science Research* 5.6 (2013): 41-48.

31. Jourdan PM., *et al.* "Soil-transmitted helminth infections". *The Lancet* 391.10117 (2017): 252-265.

32. Centers for Disease Control and Prevention". DPDx - Laboratory Identification of Parasites of Public Health Concern (2019).

33. Haburchak DR. Hookworm Disease (2018).

34. Brooker S., *et al.* "Hookworm-related anaemia among pregnant women: a systematic review". *PLoS Neglected Tropical Diseases* 2 (2008): e291.

35. Centers for Disease Control and Prevention. Parasites - Ascariasis (2018).

36. Lal C., *et al.* "Parasitic diseases of the pleura". *American Journal of Medical Sciences* 345 (2013): 385-389.

37. Das AK. "Hepatic and biliary ascariasis". *Journal of Global Infectious Diseases* 6 (2014): 65-72.

38. Centers for Disease Control and Prevention. DPDx - Laboratory Identification of Parasites of Public Health Concern (2019).

39. Olufotebi I., *et al.* "Prevalence of soil-transmitted helminths' ova in soil in Ibadan, Oyo State, Nigeria". *Nigerian Journal of Parasitology* 40.2 (2019): 186-192.

40. Nkouayep VR., *et al.* "Profile of geohelminth eggs, cysts and oocysts of protozoans contaminating the soils of ten primary schools in Dschang, West Cameroon". *Journal of Parasitology Research* 2017 (2007): 1534675.

41. Tyoalumun K., *et al.* "Prevalence of intestinal parasitic infections and their association with nutritional status of rural and urban pre-school children in Benue State, Nigeria". *International Journal of MCH and AIDS* 5.2 (2016): 146-152.

42. Centres for Disease Control and Prevention. Parasites strongyloides (2019).

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