Spinghar University- Kabul

Spinghar Journal of Biomedical Sciences (SJBS)

Vol. 1., No.1, October 2025, pp. 50-59

Parasitological Contamination of Fenced and Unfenced Primary School Playgrounds in K-Vom, Plateau State, Nigeria: Prevalence and Risk Assessment

*Onah Isegbe Emmanuel [1], Ipenyi Joseph Lucius [2]

1. *Department of General Studies, Federal College of Veterinary and Medical Laboratory Technology, NVRI, Vom, Nigeria*
2. *Department of Applied Parasitology and Entomology, Nasarawa state University, Keffi, Nigeria*

ARTICLE INFO

Type: Original Article
Received: 11/07/2025
Accepted: 15/09/2025

*Corresponding Author:
Onah Isegbe Emmanuel

E-mail address:
isegbeonah@gmail.com

DOI:
https://doi.org/10.64444/sjbs.15

ABSTRACT

Background: Parasitological contamination of soil in school environments poses a public health risk to school-aged children, particularly in settings with inadequate sanitation. We assessed the parasitological contamination of playground soils in fenced and unfenced primary schools in K-Vom, Plateau State, Nigeria, with emphasis on soil-transmitted helminths (STHs).

Methods: Soil samples (n = 80) were examined for STH eggs and larvae, and questionnaires were administered to 120 pupils to assess the demographics, hygiene practices, and behavioral risk factors. Data were analyzed using chi-square tests and odds ratio analysis at 5% significance.

Results: Ten of 80 soil samples (12.5%) were positive for parasites. Hookworm larvae predominated (6/80, 7.5%), followed by *Ascaris lumbricoides*, *Strongyloides stercoralis*, mites, and *Taenia* species (each 1/80, 1.3%). Soil contamination was higher in fenced schools (17.5%) than unfenced schools (7.5%) ($\chi^2 = 32.73$, $P < 0.001$). Pupils with untrimmed nails had higher risk of STH (OR = 0.318, 95% CI: 0.098–1.033, $P = 0.0088$), and those using teeth to trim nails also showed increased risk (OR = 2.249, 95% CI: 0.966–5.232, $P = 0.0284$). Sand playground surfaces and daily playground use were significantly associated with higher STH exposure ($P < 0.01$). Awareness of STH was low (31.7%).

Conclusion: Soil contamination with STHs is prevalent in primary school playgrounds, influenced by environmental and behavioral factors. Improvements in sanitation, personal hygiene, and health education are critical to reduce infection risk.

Keywords: Parasitological contamination; Soil-transmitted helminths; Playground contamination; Primary school children; Sanitation; Nigeria

Introduction

Soil serves as a crucial medium for the transmission of a wide range of parasites of public health and veterinary importance. Soils can serve as reservoir for infective stages of soil-transmitted helminths (STH) as well as other parasitic organisms, including protozoa, arthro-

pods, and cestodes, particularly in settings with poor sanitation and unrestricted human or animal access. Environmental factors such as soil type, pH level, moisture contents, temperature, and organic matter influence the viability or survival and persistence of these parasitic stages in the soil [1].

STHs encompass a group of parasitic worms with complex life cycles that involve stages of development in soil and within the human host. The most common species include hookworms (*Necator americanus* and *Ancylostoma duodenale*), *Ascaris lumbricoides* (roundworm), and *Trichuris trichiura* (whipworm). They shed their eggs or larvae into the environment through the feces of infected individuals, initiating the environmental phase of their life cycle [2].

Although STHs constitute the primary focus of most school-based parasitological studies due to their well-established disease burden, the presence of other parasites in soil environments serves as an important indicator of broader environmental contamination and potential zoonotic exposure. Helminth eggs and larvae can persist in soil for extended periods, particularly under favorable environmental conditions. The presence of organic matter and adequate moisture levels promotes the survival and development of parasite stages outside the human host [3].

The environmental persistence of helminth stages in soil contributes to the endemicity and transmission of STH infections in communities. STHs represent a significant global health issue, particularly in regions with poor sanitation and hygiene practices. These parasitic worms infect over 1.5 billion individuals worldwide, with the highest burden observed in tropical and subtropical areas [4]. STH infections are associated with a range of adverse health outcomes, including malnutrition, anemia, impaired cognitive development, and reduced school attendance, predominantly affecting children living in resource-limited settings [5].

Primary school playgrounds serve as important environments where children engage in outdoor activities and social interactions. However, these spaces may also serve as potential hotspots for STH transmission due to the presence of soil contaminated with parasite eggs and larvae. Children's behaviors, such as playing barefoot and engaging in soil-related activities, increase their risk of exposure to STHs, highlighting the importance of investigating the prevalence of these parasites in playgrounds [4]. These parasitic worms pose a substantial burden on affected populations, leading to malnutrition, anemia, impaired cognitive development, and decreased school attendance, especially among children in resource-limited settings. Despite the recognized significance of primary school playgrounds as potential hotspots for STH transmission due to children's frequent outdoor activities and soil contact, there is need to update knowledge on regarding the prevalence of these parasites in such settings [6].

This study was justified by the significant public health impact of STH infections, particularly on children's health and educational performance. It emphasized the need for targeted intervention to protect children's well-being, improve school attendance and academic performance, raise community awareness about sanitation and hygiene, as well as implement preventive measures to control STH transmission among school-aged children.

Despite known STH prevalence in Nigerian communities, limited data exist on environmental contamination of school playgrounds and the contribution of behavioral risk factors. We aimed to assess the level of parasitological contamination of playground soils in fenced and unfenced primary schools in K-Vom, Jos South Local Government Area, Plateau State, Nigeria, and to examine selected environmental and behavioral factors associated with potential exposure among pupils.

Methods

Study area

The study was carried out in two primary schools (one with fence and one without fence) in K-Vom Jos South Local Government Area of Plateau State, Nigeria. Jos south LGA is situated in Nigeria's middle belt region and is the administrative capital of Plateau state. It is located at $9^0$56, N$8^0$53 E high on the Jos Plateau. The major ethnic group in K-Vom is Berom. Vom has average elevation, annual temperature, rainfall and humidity of 4015 ft (1223m) above sea level, 20 ^{0}C 1450mm and 60% respectively.

Sampling Techniques

A purposive sampling technique was employed to select schools for soil sample collection [6]. This approach was adopted to ensure the inclusion of schools with distinct environmental characteristics relevant to the study objective, specifically fenced and unfenced school premises, known to influence children's exposure to soil-transmitted helminths. Schools were deliberately selected based on their fencing status to allow for a comparative assessment of contamination risk between restricted and unrestricted playground environments. Within each selected school, soil sampling points were also purposively determined following on-site assessment during pupils' break periods. Areas frequently used by pupils for playing and other outdoor activities, such as playgrounds and open spaces around classrooms, were identified and prioritized for soil collection. This ensured that soil samples were obtained from locations with the highest likelihood of contact with children, thereby enhancing the epidemiological relevance of the findings.

Soil Sample Collection

Total of 80 playground soil samples were collected from five spots in the two selected primary school in K-Vom. Sampling points were evenly distributed to ensure representative sampling. In each school, locations where pupils frequents either to play or carry out other activities were considered. It was ensured that all-through the period of collection, 100 – 200 g of samples were obtained on same spots within a 5 m radius at 2 – 3 cm depth and preserved at room temperature until needed for parasitological investigation. This process was conducted twice in a week for four weeks across the two selected schools [5]. All soil samples were collected into clean polythene bags and transported to the parasitology laboratory of Federal College of Veterinary and Medical Laboratory Technology, Vom for analysis.

Parasitological Examination of Soil Samples

Flotation method (sucrose solution) was used to obtain eggs and larvae. Soil samples were mixed with distilled water, and sieved into centrifuge tubes to remove large particulates before they were concentrated by centrifugation and decanted. Thereafter, tubes were refilled with sucrose solution and cover slips were placed on the surface. Floated eggs/ larvae adhered to the surface of the cover slips and these slips were placed on slides and examined under the microscope [7,8]. Recovered parasites were identified using appropriate keys [9,10].

Questionnaire Administration

A structured questionnaire was used for collecting data to access the pupil's knowledge and practices regarding risk factors associated with STH exposure, including playground use, handwashing practices, nail hygiene, footwear usage, deworming history, and awareness of STH infections.

Permission/Ethical Issues

For the purpose of confidentiality, the names of the schools are not mentioned in the study. Permission was obtained from the head teachers of the schools before the commencement of the study. Letters seeking for parental consent were

sent to the parents of the pupils before the pupils filled the questionnaires.

Data Analysis

Data from questionnaires and soil sample examinations were analyzed using Microsoft Excel and exported to SPSS version 23.0 (IBM Corp., Armonk, NY, USA) for statistical analysis. Descriptive statistics summarized participant demographics, soil parasite prevalence, and categorical risk factors. The associations between school type and categorical risk factors were assessed using the Chi-square test. Odds ratios (OR) with 95% confidence intervals (CI) estimated the likelihood of a pupil in a fenced school exhibiting a given risk behavior compared to a pupil in an unfenced school. Associations were considered statistically significant when the 95% CI did not include 1.0, with $P < 0.05$.

Results

A total of 120 pupils were enrolled from the selected primary schools in K-Vom, Jos South LGA, Plateau State. The demographic characteristics of the pupils showed that equal numbers of males and females were sampled (50.0% each). Pupils were aged 9–12 years were highest in number (46.7%), followed by 5–8 years (36.7%). The dominant tribe was Berom (40.8%), while the least was Igbo (3.3%) and Christianity was the most common religion (85.0%) (Table 1).

Table 1: Demographic Characteristics of Pupils in the Primary Schools Sampled

Demographic Characteristics	***Variables***	***Fenced Primary School (%)***	***Unfenced Primary School (%)***	***Total (%)***
Gender	Female	30 (50.0)	30 (50.0)	60 (50.0)
	Male	30 (50.0)	30 (50.0)	60 (50.0)
Age group (yr)	5-8	20 (33.3)	24 (40.0)	44 (36.7)
	9-12	27 (45.0)	29 (48.3)	56 (46.7)
	13-16	13 (21.7)	7 (11.7)	20(16.7)
	Above 16	0 (0.0)	0 (0.0)	0 (0.0)
Tribe	Berom	17 (28.3)	32 (53.3)	49 (40.8)
	Angas	9 (15.0)	7 (11.7)	16 (13.3)
	Igbo	2 (3.3)	3 (5.0)	5 (4.2)
	Yoruba	3 (5.0)	3 (5.0)	6 (5.0)
	Taroh	3 (5.0)	0 (0.0)	3 (2.5)
	Magavol	8 (13.3)	0 (0.0)	8 (6.7)
	Others	18 (30.0)	15 (25.0)	33 (27.5)
Religion	Christian	52 (86.7)	50 (83.3)	102 (85.0)
	Islam	5 (8.3)	5 (8.3)	10 (8.3)
	ATR	0 (0.0)	2(3.3)	2 (1.7)
	Others	3 (5.0)	3 (5.0)	6 (5.0)

A total of 80 soil samples were collected from playgrounds within the schools. Five parasite species were recovered. Hookworm larvae had the highest occurrence at 7.5%, followed by *A. lumbricoides* (1.3%), *S. stercoralis* larvae (1.3%), Mites (1.3%), and *Taenia* spp. (1.3%). Overall, the prevalence of contamination in school playgrounds was 12.5%. Fenced schools recorded a higher contamination (17.5%) than unfenced schools (7.5%) (Table 2).

Table 2: Prevalence of Parasites recovered from Selected Primary School Playgrounds

Parasite detected	***Description of School sampled***		***Total (%) (N = 80)***
	Fenced (n= 40)	Unfenced (n=40)	
Hookworm larvae	3(7.5)	3(7.5)	6(7.5)
Ascaris lumbricoides	1(2.5)	0(0.0)	1(1.3)
Strongyloides stercoralis larvae	1(2.5)	0(0.0)	1(1.3)
Mite	1(2.5)	0(0.0)	1(1.3)
Taenia spp.	1(2.5)	0(0.0)	1(1.3)
Total	7(17.5)	3(7.5)	10(12.5)

Analysis of the risk factors associated with STH among pupils showed varying levels of exposure (Table 3). There was a statistically significant association between the type of playground surface and STH risk ($\chi^2 = 32.730$; $P < 0.001$). Pupils in unfenced schools were more exposed to grassy surfaces (58.3%). Significant associations were also observed for nail trimming habits ($\chi^2 = 6.857$; $P = 0.0088$), nail-biting behavior ($\chi^2 = 4.800$; $P = 0.0284$), and frequency of playground use ($\chi^2 = 11.660$; $P = 0.0086$). Other factors assessed showed no statistically significant association.

Odds ratio analysis (Table 4) revealed that pupils who used their teeth to trim nails were more than twice as likely to be at risk of STH infection compared to those who did not. Pupils who did not trim fingernails properly were less likely to be recorded in fenced schools compared to unfenced schools. Although both estimates suggested potential protective and risk effects respectively, the 95% confidence intervals included unity, indicating that these associations were not statistically conclusive at the 5% significance level. Other hygiene-related behaviors, including washing vegetables before eating and regular footwear use, showed no meaningful differences between school types.

Table 3: Risk Factors Associated with STH Among Primary School Pupils In K-Vom

Risk Factors	***Variables***	***Type of School/ Location (%)***		***Total (%)***	χ^2	***P-value***	***D.f***
		Fenced School	Unfenced School				
Type of surface on school playground	Grass	7 (11.7)	35 (58.3)	42 (35.0)	32.730	<0.001	2
	Sand	50 (83.3)	25 (41.7)	75 (62.5)			
	Concrete	3 (5.0)	0 (0.0)	3 (2.5)			
Heard of STH	Yes	19 (31.7)	19 (31.7)	38 (31.7)	5.385	0.0677	2
	No	32 (53.3)	23 (38.3)	55 (45.8)			
	Not sure	9 (15.0)	18 (30.0)	27 (22.5)			
If yes, Source of information on STH	Radio	7 (11.7)	10 (16.7)	17 (14.2)	11.233	0.0465	5
	Television	6 (10.0)	5 (8.3)	11 (9.2)			
	Motorpark	0 (0.0)	1 (1.7)	1 (0.8)			
	Hospital	4 (6.7)	10 (16.7)	14 (11.7)			
	School	4 (6.7)	8 (13.3)	12 (10.0)			
	Indifferent	39 (65.0)	26 (43.3)	65 (54.7)			
Frequency of playground cleaning	Daily	39 (65.0)	31 (51.7)	70 (58.3)	3.664	0.1601	2
	Weekly	14 (23.3)	18 (30.0)	32 (26.7)			
	Monthly	7 (11.7)	11 (18.3)	18 (15.0)			
Finger nail trimmed	Yes	56 (93.3)	49 (81.7)	105(87.5)	6.857	0.0088	1

	No	4 (6.7)	11 (18.3)	15 (12.5)			
Trimming nails with teeth	Yes	17 (28.3)	9 (15.0)	26 (21.7)	4.800	0.0284	1
	No	43 (71.7)	51 (85.0)	94 (78.3)			
Washing vegetables before eating	Yes	53 (88.3)	54 (90.0)	107(89.7)	0.091	0.7629	1
	No	7 (11.7)	6 (10.0)	13 (10.8)			
Habit of always wearing shoes/footwear	Yes	51 (85.0)	50 (83.3)	101(84.7)	0.111	0.7388	1
	No	9 (15.0)	10 (16.7)	19 (15.8)			
How often playground is used	Everyday	32 (53.3.)	43 (71.7)	75 (62.5)	11.660	0.0086	3
	Several times a week	10 (16.7)	12 (20.0)	22 (18.3)			
	Once a week	12 (20.0)	5 (8.3)	17 (14.7)			
	Others	6 (10.0)	0 (0.0)	6 (5.0)			
How often hands are washed after playing	Always	16 (26.7)	24 (40.0)	40 (33.3)	4.609	0.2028	3
	Sometimes	38 (63.3)	28 (46.7)	86 (71.7)			
	Rarely	6 (10.0)	6 (10.0)	12 (10.0)			
	Never	0 (0.0)	2 (3.3)	2 (1.7)			
Measures/strategies to keep the playground clean	Yes	42 (70.0)	36 (60.0)	78 (65.0)	3.518	0.1723	2
	No	4 (6.7)	10 (16.7)	14 (11.7)			
	Not sure	14 (23.3)	14 (23.3)	28 (23.3)			
Time since last deworming	1- 6 months	34 (56.7)	31 (51.7)	65 (54.2)	4.885	0.0869	2
	1- 12 month	13 (21.7)	8 (13.3)	21 (17.5)			
	> 1 year	13 (21.7)	21 (35.0)	34 (28.3)			

Table 4: Odds Ratio Analysis of STH Risk Behaviors Between Fenced and Unfenced Primary School Pupils

Risk Factor (Outcome)	***Fenced School (Risky/Safe)***		***Unfenced School (Risky/Safe)***		χ^2	***Odds Ratio (OR)***	***95% Confidence Interval (CI)***
	Yes	No	Yes	No			
Finger nail trimmed (No)	56	4	49	11	0.0088	0.318	0.098 – 1.033
Use teeth to trim nails? (Yes)	17	43	9	51	0.0284	2.249	0.966 – 5.232
Wash vegetables before eating? (No)	53	7	54	6	0.7629	1.180	0.354 – 3.931
Always wear foot ware? (No)	51	9	50	10	0.7388	0.882	0.329 – 2.368

CI: Confidence Interval; OR: Odds Ratio.

Discussion

We investigated the level of parasitological contamination of primary school playground soils as well as environmental and behavioral risk factors associated with potential exposure among school-aged children in K-Vom, Plateau State, Nigeria. The findings demonstrate that soil contamination with soil-transmitted helminths persists in school environments and appears to be influenced by a combination of playground characteristics and pupil-related hygiene practices rather than by fencing status alone. The presence of the larvae and eggs of parasites in soil are common in the developing countries [11]. Faecal-oral route is the major transmission mode for most STH infections, and soil has been reported to be the most direct indicator of risk [12].

Findings are in line with earlier observation reported in Primary schools in Zaria [13] and in Edo state [14] where soil samples collected and examined in school premises were contaminated with STH eggs/larvae. The result is also similar to previous reports from Ibadan and Oyo states of Nigeria where hookworm larvae were the most most frequently detected parasites found in soil samples [15,16]**.** Schools that lack functional toilets and those where the functional ones remained under lock and key, often have pupils who defecate around refuse dump sites located close to the toilets [15].

Efforts by the WHO to eliminate the transmission of helminths has been on mass drug administration. This approach alone is not possible to achieve the elimination goal without deploying environmental measures to interrupt acquisition of new infections [17,18]. Identification and estimating soil parasites burden could help in achieving this goal. The identification of parasites in any locality could be useful in planning an effective integrated and sustainable preventive and control programme.

Ten out of the 80 samples examined in this study were positive (12.5%) for at least one parasite. Improper disposal of animal and human faeces is a widely reported practice because majority of the school's surrounding community lack functional toilet facilities, secured perimeter fence, proper drainage and waste disposal systems. For school lacking perimeter fence, when it rains, the playgrounds could receive faecal-contaminated water from the surrounding environment [19]. This might be the reason why larva of hookworm was found in the soils of the playgrounds of the schools. Lack or partial perimeter fencing has been attributed as a source of contamination, whereby animals could freely move into and out of the school premises and defecate. Egestion of human faeces by dogs increases the possibility of transporting STH eggs into the playground as sticky-coated *A. lumbricoides* egg might adhere to the dog's coat for relatively longer period [20,21].

The predominant parasites in these areas were *A. lumbricoides, S. stercoralis,* hookworm and *Taenia spp*. While the study primarily examined soil-transmitted helminths, the detection of non-helminth parasites such as mites and *Taenia* species reflects broader environmental contamination of playground soils and potential exposure to zoonotic and mechanically transmitted parasites. We therefore believe that one of the sources of soil contamination with STHs in these playgrounds may have been through open defecation from pupils and inhabitants of respective host communities living close to the school premises. The higher prevalence recorded in fenced schools (17.5%) as against 7.5% for the unfenced school indicates that factors beyond the mere presence or absence of a perimeter fence influenced soil contamination in the study area. Although fencing is commonly assumed to limit animal intrusion and external contamination, it does not directly modify soil characteristics, sanitation practices, or playground management.

In this study, fenced school playgrounds were predominantly sand-based, a surface known to retain moisture and support prolonged survival of helminth eggs and larvae. In addition, higher intensity and frequency of playground use, limited soil turnover, and potential internal contamination from pupils' hygiene practices may have contributed to parasite accumulation within the enclosed environment. These findings suggest that fencing alone might be insufficient to reduce soil contamination unless accompanied by complementary environmental controls such as appropriate playground surface selection, regular cleaning, and effective sanitation measures. Therefore, the association between fencing and soil-transmitted helminth risk appears to be context-dependent, mediated by environmental management and human behavior rather than by structural barriers alone.

In low-resource school settings, interventions that directly modify environmental contamination and pupil exposure should be prioritized over fencing alone. Interventions such as regular playground cleaning, improved sanitation facilities, replacement of sand surfaces with grass or concrete, supervised handwashing, and sustained hygiene education. Therefore, resource allocation should emphasize cost-effective measures with demonstrated impact on exposure pathways rather than fencing as a sole preventive strategy.

Poor infrastructural facility, socioeconomic status and sanitation have been reported as the primary factors responsible for the presence *S. stercoralis* in soils [22-24]. Detection of *S. stercoralis* larvae in the playground suggests a substantial health risk to children exposure to the soil of their school. Egestion of soil is widespread among school children and this habit has been associated with STH infections [24-25]. The study demonstrates various risk factors associated with STH. Fenced school had a higher prevalence of sand playground surfaces (83.3%) compared to unfenced school (41.7%), which mainly has grass surfaces (58.3%). Studies have demonstrated that sand surfaces harbor more helminth eggs, increasing the risk of infection [26]. The daily cleaning of playgrounds is more prevalent in fenced school, indicating a better effort to maintain hygiene, which is crucial in reducing helminth transmission [3].

Regarding personal hygiene, nail trimming is essential for preventing parasites [2]. However, awareness of STH and prevention methods is low in both schools, with only 31.7% of pupils having heard about STH, highlighting a gap in health education. This contrasts with a study that emphasize the importance of awareness and health education in reducing STH prevalence [27]. Despite frequent playground use, many pupils only sometimes wash their hands after playing, posing a significant risk for STH transmission [28]. A widely recognized important behavioral factor in the transmission of soil-transmitted helminths is fingernail hygiene. Infective eggs may accumulate beneath fingernails and through hand-to-mouth contact they can be transferred to the mouth. In the present study, pupils who trimmed their fingernails showed a trend toward reduced STH risk, while those who used their teeth to trim nails showed increased odds of exposure. However, the confidence intervals for both estimates crossed unity, indicating that these associations were not statistically definitive.

When compared to similar studies which reported lower frequencies of regular deworming and footwear usage [4,29], this study demonstrates higher percentages of students consistently wearing footwear (84.7%) and undergoing regular deworming within the last six months. This difference suggests that health interventions in these schools are having a positive impact. However, continuous education and infrastructure improvements are necessary to further reduce the risk of STH infections. The higher rates of deworming and footwear usage in this study might be attributed to recent public health initiatives or school programs aimed at improving child health [30,31].

Despite the insights provided, this study is not without limitations. The restricted sample size of two schools and 80 soil samples limits the generalizability of the findings to larger urban or different ecological settings in Nigeria. Furthermore, the absence of fecal examinations of the pupils means the direct link between environmental contamination and clinical infection remains inferential. Future research should employ longitudinal designs and molecular diagnostic tools to better characterize the transmission dynamics in these settings.

Conclusion

Primary school playgrounds in K-Vom are contaminated with a diversity of parasites, reflecting ongoing environmental exposure risks for schoolchildren. Playground characteristics and

pupil-related hygiene practices were identified as important contributors to contamination and potential transmission. The detection of parasites in both fenced and unfenced schools highlight the need for improved environmental sanitation, effective school hygiene practices, and sustained health education. Strengthening infrastructure and preventive measures is essential to reduce parasite exposure and protect child health. The findings of this study are context-specific and should be generalized with caution, as the investigation was limited to two primary schools within a single rural community. Environmental, cultural, and socioeconomic factors such as climate, soil type, sanitation infrastructure, and hygiene practices vary across regions and may influence parasite transmission. Therefore, these results are most applicable to similar low-resource settings, and broader policy application requires further studies in diverse contexts.

Improved sanitation infrastructure, regular playground maintenance, and sustained hygiene education should be prioritized in primary schools to reduce environmental parasite contamination. School-based health education and supervision of personal hygiene practices among pupils are essential preventive measures. Future studies should incorporate molecular diagnostic techniques to enhance parasite identification and better distinguish human from zoonotic sources.

Acknowledgments

This study was not funded. The researchers conducted it as an independent study.

Conflict of interest

The authors declare no conflict of interests.

References

1. Maizels RM, McSorley HJ, Smyth DJ. Helminths in the hygiene hypothesis: sooner or later? Clin Exp Immunol. 2014; 177(1):38–46.
2. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas, A, Diemert D, Hotez PJ. Soil-transmitted helminth infections: Ascariasis, trichuriasis, and hookworm. Lancet. 2006; 367(9521), 1521-1532.
3. Strunz EC, Addiss DG, Stocks ME, Ogden S, Utzinger J, Freeman MC. Water, sanitation, hygiene, and soil-transmitted helminth infection: a systematic review and meta-analysis. PLoS Med. 2014; 11(3): e1001620.
4. Brooker S, Clements AC, Bundy DA. Global epidemiology, ecology and control of soil-transmitted helminth infections. Advances in Parasitology. 2006; 62, 221-261. https://doi.org/10.1016/S0065-308X(05)62007-6
5. Mitrea IL Parazitologie si boli parazitare. Ed. Ceres, Bucuresti. 2011.
6. Traversa D, Di Regalbono AF, Di Cesare A, La Torre F, Drake J, Pietrobeli M. Environmental contamination by canine geohelminths. Parasites and Vectors. 2014; 7: 67.
7. Kish L. Survey Sampling. John Wiley & Sons. 1965, ISBN: 978-0471078331
8. Foreyt WJ. Veterinary Parasitology Reference Manual. 5th ed. Ames, Iowa. Blackwell Publishing Professional. 2001; pp 45 –222.
9. Horiuchi S, Paller VG, Uga S. Soil contamination by parasite egg in rural village in the Phillipines. Trop. Biomed. 2013; 30(3):495 – 503.
10. Marques JP, Guimarães CR, Boas AV, Carnaúba PU. Contamination of public parks and squares from Guarulhos (São Paulo State, Brazil) by *Toxocara spp*. and *Ancylostoma* spp. Rev Inst Med Trop Sao Paulo. 2012; 54(5): 267–271.
11. Ojurongbe O, Adedokun SA, Odetoyinbo OS, Odukoya AO. Soil-transmitted helminthiasis among school-aged children in rural communities in Osun State, Nigeria. World Journal of Environmental Biosciences, 2013; 2(3): 16-20.
12. Uga S, Nagnaen W. Chongsuvivatwong V. Contamination of soil with parasite eggs and oocysts in southern Thailand. Southeast Asian J Trop Med Publ Heal. 1997; 28(3):14–17.
13. Nock IH, Duniya D, Galadima M. Geohelminth eggs in the soil and stool of pupils of some primary schools in Samaru, Zaria, Nigeria. Nigerian Journal of Parasitology. 2007; 24:115–122.
14. Isaac C, Turay PN, Inegbenosun CU, Ezekiel SA, Adamu HO, Ohiolei IA. Prevalence of soil-transmitted helminths in primary school play-

grounds in Edo State, southern Nigeria, Helminthologia. 2019; 56, 4: 282 – 295.

15. Hassan AA, Oyebamiji DA. Intensity of soil transmitted helminths in relation to soil profile in selected public schools in Ibadan metropolis. Biom Biostat Int J. 2018; 7(5):413–417. DOI: 10.15406/bbij.2018.07.00239
16. Oniya MO. Soil Contamination as an indicator of geohelminthiasis in primary schools in Ibarapa East Local Government Area of Oyo State. Glob J Med Res: K Interdisciplinary. 2019; Online ISSN: 2249-4618 & Print ISSN: 0975-5888.
17. Truscott JE, Hollingsworth TD, Brooker SJ, Anderson RM. Can chemotherapy alone eliminate the transmission of soil transmitted helminths? Parasit Vectors. 2014; 7: 266. DOI:10.1186/1756-3305-7-266.
18. Anderson R, Truscott J, Hollingsworth TD. The coverage and frequency of mass drug administration required to eliminate persistent transmission of soil-transmitted helminths. Philos Trans R Soc Lond B Biol Sci. 2014; 369. (1645): 20130435. DOI:10.1098/rstb.2013.0435
19. Echazu A, Bonanno D, Juarez M, Cajal SP, Heredia V, Caropresi S, Cimino RO, Caro N, Vargas PA, Paredes G. Effect of poor access to water and sanitation as risk factors for soil-transmitted helminth infection: selectiveness by the infective route. PLos Negl Trop Dis. 2015; 9: e0004111. DOI: 10.1371/journal.pntd.0004111
20. Nonaka N, Nakamura S, Inoue T, Oku Y, Kata kura K, Mat sumoto J, Chembesofu M, Phiri IG. Coprological survey of alimentary tract in dogs from Zambia and evaluation of a coproantigen assay for canine echinococcosis. Ann Trop Med Parasitol. 2011; 105: 521–531. DOI: 10.1179/2047773211Y.0000000001
21. Traub RJ, Robertson ID, Irwin P, Mencke N, Thompson RC. The role of dogs in transmission of gastrointestinal parasites in a remote tea-growing community in northeastern India. Am J Trop Med Hyg. 2002; 67: 539 – 545. DOI: 0.2105/AJPH.92.11.1841
22. Beknazarova M, Whilley H, Ross K. Strongyloidiasis: a disease of socioeconomic disadvantage. Int J Environ Res Public Health. 2016; 13: 517. DOI: 10.3390/ijerph13050517
23. Wong MS, Bundy DA. Quantitative assessment of contamination of soil by the eggs of *Ascaris lumbricoides* and *Trichuris trichiura*. Trans R Soc Trop Hyg 1990; 84(4): 567 – 70. DOI:10.1016/0035-9203(90)90043-E
24. Geissler WR, Taylor PG, Mwaniki DL. Geophagy among school children in rural Kenya: The relationship between soil ingestion and STH infections. Trans R Soc Trop Med Hyg. 1998; 92(3): 260-264. https://doi.org/10.1016/S0035-9203(98)90906-5
25. Nchito M, Geissler PW, Mubila L, Friis H, Olsen A. Effects of iron and Mult micronutrient supplementation on geophagy: a two-by-two factorial study among Zambian schoolchildren in Lusaka. Trans R Soc Trop Med Hyg. 2004; 98: 218 – 227. DOI:10.1016/s0035-9203(03)00045-2
26. Hotez PJ, Fenwick A, Savioli L. Rescuing the bottom billion through control of neglected tropical diseases. The Lancet. 2008; 373(9674), 1570-1575.
27. Parker M, Allen T, Hastings J, Pionetti C. Addressing the challenge of soil-transmitted helminths in the context of the Sustainable Development Goals. Lancet Infect Dis. 2020; 20(2): e81-e85.
28. Freeman MC, Chard AN, Nikolay B, Garn JV, Okoyo C, Kihara J, Brooker SJ. Associations between school-based water, sanitation, and hygiene interventions and soil-transmitted helminth infections in Kenyan schoolchildren: a cluster-randomized trial. Lancet Global Health. 2014; 2(9): e716-e724.
29. Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. Parasites & Vectors. 2014; 7, 37.
30. Ziegelbauer K, Speich B, Mäusezahl D, Bos R, Keiser J, Utzinger J. Effect of sanitation on soil-transmitted helminth infection: systematic review and meta-analysis. PLoS Med. 2012; 9(1): e1001162.
31. Mwinzi PNM, Montgomery SP, Owaga CO, Mwanje MT, Muok EMO, Ayisi JG, Secor WE. Integrated community-directed intervention for urinary schistosomiasis and soil-transmitted helminth control in Western Kenya–a pilot study. Parasites & Vectors. 2012; 5(1): 198.