JOBIMB, 2024, Vol 12, No 1, 27-33
https://doi.org/10.54987/jobimb.v12i1.958

HIBISCUS PUBLISHER

JOURNAL OF BIOCHEMISTRY, MICROBIOLOGY AND BIOTECHNOLOGY

Website: http://journal.hibiscuspublisher.com/index.php/JOBIMB/index

JOBIMB VOL 12 NO 1 2024
Histoarchitecture of albino rat's liver

Risk Factors Association of Soil-transmitted Helminth Infections Among Primary School Children in Kano, northern Nigeria

Adamu Rabiu[1,2]*, Nor Azwady Bin Abd Aziz[1], Muskhazli Mustafa[1] and Shamarina Shohaimi[1]

[1]Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
[2]Department of Biology, School of Secondary Education (Sciences), Federal College of Education (Technical) Bichi, Kano, 703101 Kano State, Nigeria.

*Corresponding author:
Rabiu Adamu,
Department of Biology,
School of Secondary Education (Sciences),
Federal College of Education (Technical) Bichi,
Kano, 703101 Kano State,
Nigeria.
Email: rabiuadamu15@gmail.com/ gs60901@student.upm.edu.my

HISTORY

Received: 4th April 2024
Received in revised form: 21st June 2024
Accepted: 30th July 2024

KEYWORDS

Soil-transmitted Helminth
Prevalence
Risk factors
School-aged Children
Nigeria

ABSTRACT

Soil-transmitted helminths (STHs) are nematode species transmitted through soil contamination, primarily by eggs found in human faeces. This study investigates STH infection prevalence and associated risk factors among children attending early child centres (ECC) and primary schools in Tamburawa, Dawakin Kudu local government area, Kano State, Nigeria. A total of 560 primary school children (PSC), aged between five and sixteen, were recruited from seven selected primary schools (PS) for faecal sample collection and subsequent analysis. The formol-ether sedimentation technique used to detect the presence of STH eggs or larvae, and IBM SPSS Statistics version 26 used to analyze the results. Among the screened PSC, 357 (63.8%) were male, and 203 (36.2%) were female, while 60.4% (338 individuals) tested positive for STH infection, with 9.8% (52 individuals) exhibiting mixed infections. Notably, hookworm (35.2%), *Ascaris lumbricoides* (19.5%), and *Trichuris trichiura* (5.7%) emerged as the predominant STH species (5.7%). Gender-specific prevalence indicated a higher rate among females (32.3%) than males (28.1%). Analysis of potential risk factors revealed significant associations. Children residing in households with four or more members had a higher risk of STH infection (OR = 2.938, 95% CI: 0.195–0.578), Children who used pit latrines had a twofold increased risk of contracting STH (OR = 2.059, 95% CI: 1.682–34.712, p = 0.001). The findings of this study underscore the importance of targeted public health interventions, routine deworming initiatives, provision of potable water, and promotion of personal hygiene practices, particularly among school-aged children.

INTRODUCTION

The term 'soil-transmitted helminths' refers to several species of parasitic worms, the most common of which are roundworms such as *Ascaris lumbricoides*, whipworms like *Trichuris trichiura*, and hookworms including *Ancylostoma duodenale* and *Necator americanus* [1,2]. Soil-transmitted helminthiases (STH) is a term referring to a group of parasitic diseases caused by nematode worms transmitted through soil contaminated with faecal matter [3]. These diseases are often discussed collectively due to the common occurrence of multiple worm infections in individuals, particularly children in less developed countries [4]. Such children usually suffer from malnutrition, stunted growth, and various cognitive impairments, including intellectual retardation and educational deficits. Numerous baseline surveys have been conducted in Nigeria to assess the prevalence of soil-transmitted infections [5–7]. This study aims to contribute to the expanding database of crucial baseline information on Nigeria's prevalence and intensity of soil-transmitted helminth infections. These infections are closely linked to low standards of sanitation and poverty, affecting an estimated 480-500 million children globally, with mortality rates ranging from 40,000 to 130,000 individuals annually [8].

Various factors, such as the consumption of raw vegetables, animal husbandry practices, water supply systems, and prior use of medication, have been significantly associated with intestinal parasitic infections [9,10]. Furthermore, different species of soil-transmitted helminths exhibit distinct primary routes of infection [11]. Cross-sectional studies conducted in urban and rural settings have reported associations between living in households with earthen floors and an increased risk of parasitic infections, particularly hookworm [12].

https://doi.org/10.54987/jobimb.v12i1.958

Univariate analysis has revealed statistically significant associations between soil-transmitted helminth infections and behaviours such as regular trimming fingernails, geophagy, and the availability of restrooms at home [13]. Certain cultural practices, such as using water for post-defecation cleaning and communal feeding from shared bowls in open spaces, contribute to the high prevalence of soil-transmitted helminths [14,15]. Additionally, meals exposed to environmental elements, insects, and domestic animals during communal dining events may contaminate helminth ova while awaiting consumption [16]. The warm and moist climate prevalent throughout much of Nigeria provides an optimal environment for parasite development year-round [17–19]. This research focuses on the prevalence and risk factors associated with helminthiasis among children.

Materials and Methodology

Study area and population

Tamburawa, located 15 kilometres from Kano town along the Zaria Road, is a significant town within the Dawakin Kudu Local Government Area of Kano State. Its population predominantly comprises Hausa farmers, with both seasonal and irrigation farming widely practised. According to the 2006 population census, Tamburawa was recorded to have 11,453 inhabitants. Geographically, Tamburawa is positioned at 11º 50' 4" N and 8º 35' 53" E (**Fig. 1**). The area experiences a mean temperature ranging from 18ºC to 20ºC during the rainy season and 26ºC to 30°C during the dry season. Rainfall patterns exhibit a bimodal distribution, with short rains between October and December and heavier rainfall observed from March to May. The mean annual rainfall ranges from 700 mm to 1000 mm.

Within the Dawakin Kudu district, the population stood at 416,113 during the 2006 census (427,223 as of 2022), with males constituting 48.6% of the total population. The district has 24 health facilities, including one teaching hospital (Northwest University Teaching Hospital), one general hospital, three comprehensive health centres, fifteen primary health centres, and four basic health centers.

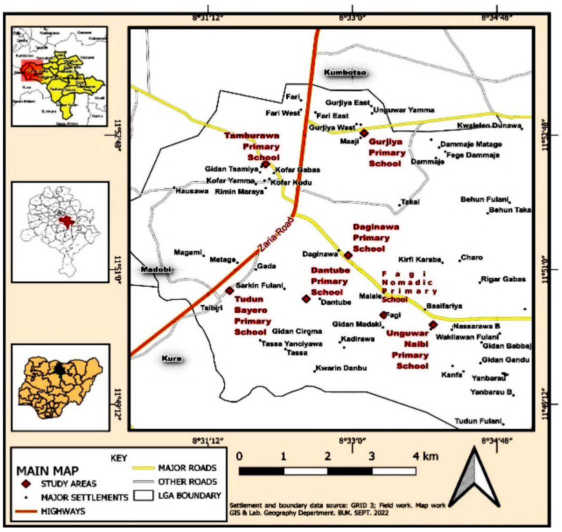

Figure 1. Dawakin Kudu local government area showing the study areas. Source: Adopted and Modified from Dawakin Kudu Local Government Area Map 2022.

A random sampling method was used to select seven primary schools for inclusion in the study: Tamburawa, Gurjiya, Tudun Bayero, Fagi Nomadic, Daginawa, Dantube, and Unguwan-Na'ibi. Within each selected school, all children enrolled in primary one and Early Child Center (ECC) classes were randomly chosen for participation in the study.

Study design and sampling methods

The study was conducted from June 2022 to January 2023, during which 560 children were examined with the permission of the Primary Health Care Department (PHCD), the Local Education Authority of Dawakin-Kudu Local Government (DKLEA), and the Kano State Ministry of Health (KSMoH). Fresh morning stool samples were collected in wide-mouth plastic containers containing 10 ml of 10% formaldehyde. Each container was carefully labelled and promptly transported to the Tetfund Research Laboratory (TRLab) at Sa'adatu Rimi University of Education, Kano, for analysis. Study identification numbers were used instead of children's names to maintain confidentiality, and all collected information was treated with utmost confidentiality.

Ethical considerations

Before the commencement of the study, meetings were convened with the Education Secretary (ES), community leaders, and head teachers from all selected villages to explain the study's objectives. Village leaders organised community meetings to raise awareness and sensitize residents about the survey. The study's objectives, sample collection protocols, potential benefits, and associated risks were explained during these meetings. Informed consent for children's participation in the survey was sought from parents and legal guardians subsequent to providing clear and thorough information about the study. Children were also informed of their right to refuse to participate in the study or withdraw at any time without compromising their rights.

Ethical approval

Ethical clearance was obtained from multiple authorities to ensure the ethical conduct of the study. Approval was granted by the Primary Health Care Department (PHCD) of Dawakin Kudu Local Government, with reference number DKD/PHC/HIM/VII; 29/08/2021. Additionally, clearance was obtained from the Dawakin Kudu Local Government Education Authority (DKLGEA) of the State Universal Education Board, Kano, with reference number DKD/LEA/EP/2021/09; 04/10/2021 and the Research Ethics Committee of the Kano State Ministry of Health (KSMoH), with reference number NHREC/17/03/2018; 14/10/2021. These clearances were duly communicated to the Headmasters and Headmistresses of the selected schools to ensure adherence to ethical guidelines throughout the study.

Ethical Supervisory Committee

The local government council established a 10-member Ethical Supervisory Committee (DKD/PHC/DSN/001; 06/07/2022), comprising experts from the Disease, Surveillance and Notification Unit (DSNU), Essential Drugs Unit (EDU), Health Education Unit (HEU) and Health Information Unit (HIU). The committee's mandate was to oversee, monitor and ensure adherence to all ethical principles and regulations during sample collection. In addition, individuals diagnosed with soil-transmitted helminth infections received treatment per standard protocol. Albendazole, administered as a 400 mg single dose, was provided to infected individuals, except those diagnosed with trichuriasis, who received 400 mg of albendazole for three consecutive days. The local government supplied the drugs to the committee for distribution and administration to affected individuals.

Collection and examination of stool samples

Faecal samples were collected from 560 school-age children between 6 and 15 years old, with eighty (80) children participating from each school. The samples were placed in a screw-cap plastic container, and each plastic container was labelled with the child's identification number. The samples were immediately transported to be processed in the laboratory. The samples were examined for gastrointestinal parasites using the formal-ether sedimentation technique. The test procedures were carried out in accordance with standard protocols as described by Bhumbla for stool examination [20] and [21] for the procedure manual mount. Quality control measures were implemented, wherein 10% of randomly selected samples underwent repeated examination by the same technologists, who were unaware of their initial results. This process ensured the reliability and accuracy of the test results [22,23].

Statistical Analysis

A structured questionnaire was administered to each selected pupil to obtain information on various factors, including handwashing practices after toilet use, washing of fruits and vegetables before consumption, source of drinking water, engagement in water-related activities, parents' occupations, communal eating habits and methods of waste disposal. The collected data were presented in tabular format, with interpretations provided in percentages. Statistical analysis assessed associations between prevalence and variables such as age, sex and identified risk factors. Odds ratio and chi-square tests were used to test for association between prevalence and the variables contained in the questionnaire.

RESULTS

The overall prevalence of soil-transmitted helminth infections among 560 samples collected and examined was 338 (60.4%). The specific prevalence rates for each parasite encountered in the study were as follows: hookworm 197 (35.2%), *Ascaris lumbricoides* 109 (19.5%), and *Trichuris trichiura* 32 (5.7%) (**Table 1**).

Table 1. The overall prevalence of soil-transmitted helminth infections.

Parasites Identified	Number of Children Infected	Percentage
Hookworm	197	35.2
Ascaris lumbricoides	109	19.5
Trichuris trichiura	32	5.7
Total	338	60.4

Prevalence of soil-transmitted helminth infections per school

The prevalence of soil-transmitted helminth infection varied among the seven primary schools in the study. Gurjiya Primary School exhibited the lowest prevalence, with 19 cases (3.4%), while Faqi Nomadic Primary School recorded the highest prevalence at 57 cases (10.%), and Dantube Primary School followed closely with 52 (9.3%). Notably, the majority of examined children, 286 (51.1%), presented with a single infection, while only 52 (9.3%) were diagnosed with mixed infections (**Table 2**).

Table 2. Prevalence of soil-transmitted helminth infections based on school.

School	Examined (n)	Infected n (%)	Mixed Infection (n) (%)
Tamburawa Primary School	80	27 (4.8)	1 (0.2)
Gurjiya Primary School	80	19 (3.4)	2 (0.4)
Tudun Bayero Primary School	80	41 (7.3)	11 (1.9)
Fagi Nomadic Primary School	80	57 (10.2)	4 (0.7)
Daginawa Primary School	80	44 (7.9)	10 (1.8)
Dantube Primary School	80	52 (9.3)	14 (2.5)
Unguwar Na'ibi Primary School	80	46 (8.2)	10 (1.8)
Total	560	286 (51.1)	52 (9.3)
$\chi 2$		46.400	22.514
p-value		< 0.001*	0.001*

* The Chi-square statistic is significant at the 0.05 level.

Prevalence and gender-specific soil-transmitted helminth infections

The prevalence of soil-transmitted helminth infections varied between genders, with females exhibiting a slightly higher rate (181 cases, 32.3%) than males (157 cases, 28.1%). However, there was no statistically significant difference in the prevalence of infection between genders (p=0.684) (**Table 3**). The highest prevalence in both males (91 cases, 16.3%) and females (106 cases, 18.8%) was recorded in hookworm infection. In contrast, *Trichuris trichiura* infection demonstrated the lowest gender-specific prevalence, with 17 cases (3.0%) males and 15 cases (2.7%) females.

Table 3. Gender-specific prevalence of soil-transmitted helminth infections.

Parasites Identified	Male (N=357) n (%)	Female (N=203) n (%)	Total Infected (N=560) n (%)	$\chi 2$	p-value
Hookworm	91 (16.3)	106 (18.9)	197 (35.2)	0.724	0.003
Ascaris lumbricoides	49 (8.8)	60 (10.7)	109 (19.5)	0.171	0.019
Trichuris trichiura	17 (3.0)	15 (2.7)	32 (5.7)	0.645	0.622
Total	157 (28.1)	181 (32.3)	338 (60.4)	0.273	0.684

Age-specific prevalence of soil-transmitted helminth infections

The prevalence of soil-transmitted helminth infections varied across different age groups. Children aged between 8 and 10 years had the highest prevalence (18.9%), while those aged between 14 and 16 had the lowest prevalence (7.9%). Regardless of age group, hookworm infection consistently displayed the highest prevalence at 35.2%, while *Trichuris trichiura* infection consistently showed the lowest prevalence (5.7%) among the children examined in the sample schools (**Table 4**).

Table 4. Age-specific prevalence of soil-transmitted helminth infections

Parasite Identified	Number of Children Infected				
	5-7 Years (n=90) n (%)	8-10 Years (n=106) n (%)	11-13 Years (n=98) n (%)	14-16 Years (n=44) n (%)	Total
Hookworm	43 (7.7)	62 (11.1)	67 (11.9)	25 (4.5)	197 (35.2)
A. lumbricoides	39 (7.0)	33 (5.9)	21 (3.8)	16 (2.9)	109 (19.5)
Trichuris trichiura	8 (1.4)	11 (1.9)	10 (1.8)	3 (0.5)	32 (5.7)
Total	90 (16.1)	106 (18.9)	98 (17.5)	44 (7.9)	338 (60.4)

https://doi.org/10.54987/jobimb.v12i1.958

Effects of social factors on the prevalence of soil-transmitted helminthiases

The effect of various social factors on the prevalence of soil-transmitted helminthiases was assessed based on responses obtained from the students through questionnaires, as summarized in **Table 5**. Statistical analysis was conducted to show associations between different factors and disease prevalence, using odd ratios (OR) greater than one to signify varying degrees of relationship strength. Children with soil-transmitted helminth infections were likelier to hail from households with 4-5 members, as indicated by an odds ratio of 2.937 (95% CI: 0.194 – 0.575). This finding suggests a potential association between household size and disease prevalence, warranting further investigation into socio-environmental determinants of infection transmission. The influence of certain risk factors on the prevalence of soil-transmitted helminthiases was examined, and it was found that children of farmers were approximately five times more likely to be infected with soil-transmitted helminths compared to children whose parents were civil servants or traders (OR = 4.950, 95% CI: 0.212 – 8.403) (p=0.004). Similarly, children of parents with basic or secondary education were more susceptible to infection compared to those with tertiary-educated parents (OR = 6.494, 95% CI: 7.856 – 89.354; OR = 4.158, 95% CI: 1.251 -13.811) (p< 0.001).

Effects of several risk factors on the prevalence of soil-transmitted helminthiases

Some practices and environmental factors were significantly associated with soil-transmitted helminth infections. Failure to wash fruits or vegetables before consumption increased the likelihood of infection by two-fold (OR = 2.678, 95% CI: 0.295 – 0.575) (p=0.001), while children who did not trim their fingers regularly were linked to approximately three times higher risk of infection (OR= 3.950, 95% CI: 0.102 – 0.951) (p=0.001). Children using pit latrines were twice as likely to be infected (OR = 2.059, 95% CI: 1.682 – 34.712) (p=0.001), and those with limited access to functional toilet facilities at school were at a significantly higher risk of infection (OR = 3.251, 95% CI: 5.802 – 12.323) (p=0.005) (**Table 6**). These findings suggest the importance of addressing behavioural and environmental factors in preventing and controlling soil-transmitted helminthiases among school-aged children.

Table 5. Prevalence of soil-transmitted helminthiases by social factors.

Variables	Examined n (%)	Negative n (%)	Positive n (%)	OR (95% CI)	P-value
Number of Household Members					
1 - 3	352 (62.9)	207 (58.8)	145 (41.2)	1	
4 - 5	208 (37.1)	16 (7.7)	192 (92.3)	2.937 (0.194 – 0.575)	<0.001
Occupation of Household					
Civil Servant	21 (14.6)	13 (61.9)	8 (38.1)	1	
Farming	478 (85.4)	177 (37.0)	301 (63.0)	4.950 (0.212 – 8.403)	0.004
Trading	61 (14.4)	32 (52.5)	29 (47.5)	1	
Level of Education of Households					
Basic	224 (40.0)	27 (12.1)	197 (87.9)	6.494 (7.856 – 89.354)	<0.001
Secondary	312 (55.7)	176 (56.4)	136 (43.6)	4.158 (1.251 – 13.811)	<0.001
Tertiary	24 (4.3)	19 (79.2)	5 (20.8)	1	
Knowledge of STH *Infection*					
Yes	52 (9.3)	40 (76.9)	12 (23.1)	1	
No	508 (90.7)	182 (35.8)	326 (64.2)	7.508 (1.105 – 53.743)	<0.001
Visit to Hospital/Clinic					
Often	78 (13.9)	75 (96.2)	3 (3.8)	1	
Sometime	363 (64.8)	126 (34.7)	237 (65.3)	4.428 (1.872 –14.523)	<0.001
Never	119 (21.3)	21 (17.6)	98 (82.4)	5.379 (7.857 – 89.355)	<0.001

Table 6. Prevalence and risk factors associated with soil-transmitted helminthiases.

Variables	Examined n (%)	Negative n (%)	Positive n (%)	OR (95% CI)	P value
Wash fruits and vegetables?					
Yes	97 (17.3)	78 (80.4)	19 (19.6)	1	
No	463 (82.7)	144 (31.1)	319 (68.3)	2.678 (0.295 – 0.575)	0.002
Trimming fingernails regularly?					
Yes	114 (20.4)	13 (61.9)	8 (38.1)	1	
No	446 (79.6)	177 (37.0)	314 (63.0)	3.950 (0.102 – 0.951)	0.001
Methods of refuse disposal					
Around the House	224 (40.0)	27 (12.1)	197 (87.9)	6.954 (1.857 – 89.355)	<0.001
Farm	312 (55.7)	176 (56.4)	136 (43.6)	4.308 (0.562 – 19.216)	0.014
Waste Bin	24 (4.3)	19 (79.2)	5 (20.8)	1	
Toilet facility					
Flush toilet	43 (7.7)	37 (86.0)	6 (14.0)	1	
Pit latrine	382 (68.2)	164 (42.9)	218 (84.4)	2.059 (1.682 – 34.712)	0.001
Open defecation	135 (24.1)	21 (15.6)	114 (82.4)	5.428 (2.635 – 89.355)	0.000
Number of Toilets					
1-3	438 (34.9)	124 (28.3)	314 (71.7)	3.251 (5.802 – 12.323)	0.005
4-6	109 (34.4)	87 (79.8)	22 (20.2)	1	
7 and above	13 (30.7)	11 (84.6)	2 (15.4)	1	

Table 7. Effects of common cultural practice on prevalence of soil-transmitted Helminthiases.

Variables	Examined n (%)	Negative n (%)	Positive n(%)	OR (95% CI)	P value
Do you eat together in a single bowl?					
Yes	498 (88.9)	171 (34.3)	327 (65.7)	4.108 (0.212 – 57.575)	<0.001
No	62 (11.1)	51 (82.3)	11 (17.7)	1	
Do you eat with your hand?					
Yes	512 (91.4)	181 (35.4)	331 (64.6)	5.250 (0.225 – 64.840)	<0.001
No	48 (8.6)	41 (85.4)	7 (14.6)	1	

Effects of cultural practice on the prevalence of soil-transmitted helminthiases

The common tradition of eating together, often from a single bowl, was significantly associated with soil-transmitted helminth infections. Children who engaged in communal eating were approximately four times more likely to contract soil-transmitted helminth infection (OR= 4.108, 95% CI: 0.212 – 57.575) (p<0.001). Similarly, the likelihood of infection with soil-transmitted helminths was also higher in children who eat with their hands. School children who ate food with their hands were five times more susceptible to soil-transmitted helminth infections (OR = 5.250, 95% CI: 0.225 – 64.840) (p<0.001) (**Table 7**).

DISCUSSION

The results of this investigation revealed a 60.4% prevalence of STH eggs within the study environment, encompassing eggs of *Ascaris lumbricoides*, hookworm and *Trichuris trichiura*. Given that the adult stages of these worms reside in the intestine, the presence of their eggs in stool samples indicates faecal contamination [24]. This assertion is supported by the fact that Fagi Nomadic Primary School, which had the highest prevalence of STH infections (10.2%), lacked adequate toilet facilities. This forces the pupils to defecate in the nearby bushes surrounding the school. Consequently, during rainfall, the eggs from these stools are washed into the school compound, contributing to the highly contaminated environment with parasite eggs.

The observation of the age-specific prevalence of helminth parasites aligns with previous research findings (18 that reported a decrease in the worm burden of all three parasites as children progressed to higher classes. Similarly, [25] conducted a related study in Owo town, Ondo State, examining 978 pupils with soil-transmitted helminth (STH) infections. The study revealed a general prevalence of 92.74%, with 907 children testing positive for one or more helminth infections. Among the infected stool samples, *A. lumbricoides* infection was the most prevalent parasite among the pupils.

The overall prevalence of helminth infections among males and females (28.1% and 32.3%, respectively) was very close and showed no significant difference, indicating a comparable risk of infection among school-age children exposed to a similar risk of infection by these helminths. Similar results have been reported by [17] in Enugu, Nigeria, and [26] in the Philippines. However, the prevalence of *T. trichiura* (3.0%) was higher in males than females. [27], in a study conducted in the Ngorongoro Conservation Area, Tanzania reported a significantly higher prevalence in males than females but suggested more investigations to determine if helminth infection is gender dependent. In contrast, [2] Ethiopia reported a higher prevalence of A. lumbricoides and hookworm among females than males and attributed this to different patterns of soil contact between genders.

This study identified various factors associated with soil-transmitted helminth infections in regions where soil-transmitted helminthiases are prevalent. Socioeconomic indicators of households, including household size, number in the house, occupation, level of education, and knowledge of STH infection. Children with soil-transmitted helminth infections were more likely to be from households with 4-5 members (OR = 2.937, 95% CI: 0.194 – 0.575). Children of farmers had approximately five times more increased risk of being infected with soil-transmitted helminths compared to children of civil servants or traders (OR = 4.950, 95% CI: 0.212 – 8.403). The findings suggest that knowledge, attitudes, and practices were determinants of soil-transmitted helminth infection in the study area. In Nigeria, helminthic infections continue to be associated with poverty, with a strong correlation between parental socioeconomic status and intestinal parasitosis in children [28,29] also observed a higher prevalence of helminthic infections among secondary school students whose parents were either unemployed or petty traders compared to students from professional or middle-class backgrounds.

Compared with children whose parents had attended tertiary education, those whose parents had completed basic or secondary schooling had a higher likelihood of soil-transmitted helminth infection (OR = 6.494, 95% CI: 7.856 – 89.354; OR = 4.158, 95% CI: 1.251 -13.811) (p<0.001). These findings align with the [8] report in 2020, which identified a low level of parental education as a reliable indirect indicator of soil-transmitted helminth infections However, [30] found no significant association between parental education level and the exposure of primary school children to soil-transmitted helminth infections in central Mozambique. Higher parental education levels have been linked to improved sanitation practices, thereby reducing the spread of STH infections [31,32].

The frequency of hospital visits was also significantly associated with soil-transmitted helminth infections. Children who occasionally visited hospitals were four times more likely to be at a higher risk of STH infections (OR= 4.428, 95% CI: 1.872 – 14.523) (p<0.001), while those who had never visited hospitals were five times more likely to be at a higher risk (OR= 5.379 95% CI: 7.857 – 89.355) (p<0.001). Preventive chemotherapy, available in hospitals, clinics and health centres, has reduced the endemicity of neglected tropical diseases (NTDs), including STH infections, by 62% in tropical and subtropical regions [33,34]. However, despite low infection intensities, the high prevalence of soil-transmitted helminth infections observed in this studyuggests that fewer school-age children may receive treatment, as treatment and control programmes typically rely on periodic deworming initiatives available at health facilities [35].

School-aged children who do not wash fruits or vegetables before consumption were found to be twice as likely (OR = 2.678, 95% CI: 0.295 – 0.575) (p=0.001) to be infected with soil-transmitted helminths. This finding is consistent with [36], who observed a significant association between consuming unwashed fruits, partially cooked vegetables, and untreated drinking water and increased odds of orally ingested soil-transmitted helminths. Children who did not trim their fingers regularly were approximately three times more likely to be infected with soil-transmitted helminths (OR= 3.950, 95% CI: 0.102 – 0.951) (p=0.001). A study [19] in Ijebu East, Ogun also identified fingernail trimming as a prominent risk factor for soil-transmitted helminth infections.

Improper disposal of refuse around the household and in farmland increased the likelihood of soil-transmitted helminth infections by sixfold and fourfold, respectively (OR = 6.954, 95% CI: 1.857 – 89.355; OR = 4.308, 95% CI: 0.562 -19.216) (p<0.001; 0.014) respectively. Similarly, compared to children who used flush toilets, those practising open defecation were more susceptible to soil-transmitted helminths (OR=5.428, 95% CI: 2.635 – 89.355) (p<0.001). This association is particularly pronounced for hookworm infection, as the infective stages of this parasite thrive in areas where people defecate, increasing the risk of transmission. The study also highlighted that primary school children in rural settings are more likely to engage in outdoor activities, potentially exposing them to contaminated soil and helminth infections. This finding aligns with previous reports from Nigeria [17,37,38], Ethiopia [39,40], and Tanzania [41]. Promoting improved sanitation practices and providing water closet systems can help eliminate open defecation [42].

A significant correlation was observed between methods of refuse disposal, toilet facilities and the number of toilets in households, and soil-transmitted helminth infections ($P<0.05$). Impoverished hygiene practices have been identified to impact helminth infection rates and school attendance, as infected children are likely to miss school [43,44]. This association was expected, given the substandard or non-existent toilet facilities observed in the schools visited within the study. Consequently, children resorted to indiscriminate defecation in the school surroundings, exposing themselves to soil-transmitted helminth infections. As shown in this study, children who defecated openly were found to have a higher likelihood of soil-transmitted helminth infections. Moreover, where toilet facilities were available, their poor condition significantly influenced the likelihood of school children being infected with soil-transmitted helminths.

The customary practice of communal feeding, often involving sharing meals from a single bowl in open street yards, prevalent in some rural regions, has shown a significant association with soil-transmitted helminth infections. Children who eat together from a single bowl were at approximately four times higher risk of contracting soil-transmitted helminths (OR= 4.108, 95% CI: 0.212 – 57.575) ($p<0.001$). This practice exposes meals to contaminants such as wind, insects, and domestic animals, potentially contaminating food with helminth ova while awaiting communal dining participants [45].

Moreover, consuming meals with bare hands elevated the risk of soil-transmitted helminth infections among school children [46,47]. Those who habitually eat with their hands are five times more likely to be infected with soil-transmitted helminths (OR = 5.250, 95% CI: 0.225 – 64.840) ($p<0.001$). This observation suggests that soil-transmitted helminth infections persist within the population despite ongoing deworming interventions. In 2021 [48] reported rapid re-emergence of soil-transmitted helminth infections following mass drug administration, particularly in endemic areas. This highlights that some traditional factors contribute to the reinfection of treated individuals with the disease within the study area, warranting comprehensive strategies to address medical and behavioral interventions in combating these infections.

CONCLUSION

The finding from this study reveals that STH infections are common in Tamburawa, Dawakin Kudu Local Government in Kano State, Nigeria, highlighting the poor hygiene conditions and the prevalence of asymptomatic carriers. This study contributes to baseline data on the occurrence of helminth infections among Nigerian schoolchildren. There is a pressing need for prospective studies to assess the impact of intestinal helminth infections on school children's academic performance, including measures of intelligence and absenteeism, as well as on their growth. Emphasizing education regarding geophagia prevention should be integrated into control programmes to reduce the worm burden, minimize environmental contamination by affected children, and enhance overall school performance. Given the importance of public health promotion in combating STH infections, schools serve as a strategic starting point for comprehensive intervention programs. Health control measures represent long-range strategies for combating STH infections in tropical regions. Merely curing infections is insufficient to eradicate the problem, as patients can easily become reinfected due to inadequate sanitation practices. The results of this study suggest that the parents are not adequately equipped with knowledge regarding the transmission modes and symptoms associated with STH infections. Healthcare providers must prioritize educating parents about STH infection transmission modes and symptoms. Additionally, government intervention is essential to enforce policies ensuring the availability and usability of latrines. These measures would significantly enhance the quality of life, particularly for children. A shift in focus towards community-tailored information dissemination would complement existing programs aimed at combating helminthiasis. This targeted approach holds promise for effectively addressing STH infections and promoting better public health outcomes.

REFERENCES

1. Djuardi Y, Lazarus G, Stefanie D, Fahmida U, Ariawan I, Supali T. Soil-transmitted helminth infection, anemia, and malnutrition among preschool-age children in Nangapanda subdistrict, Indonesia. PLoS Negl Trop Dis. 2021;15(6).
2. Fetene Y, Hailu T, Yimer M, Alemu M. Determinants of Helminthic Infections and Anemia among Schoolchildren in Bahir Dar Zuria District, Northwest Ethiopia. J Parasitol Res. 2021;2021.
3. Cho FN, Ngala HN, Bongazi RT, Kinsam RS, Tata BT, Aji D, et al. Effects of Soil-Transmitted Helminths and Intestinal Protozoan Infections on Haemoglobin Levels among School-Aged Children in Belo and Bui, North West Cameroon: A Cross-Sectional Study. J Parasitol Res. 2021;2021.
4. Mugel SG, Clasen TF, Bauza V. Global practices, geographic variation, and determinants of child feces disposal in 42 low- and middle-income countries: An analysis of standardized cross-sectional national surveys from 2016 – 2020. Int J Hyg Environ Health. 2022 Aug 1;245.
5. Bassey DB, Mogaji HO, Dedeke GA, Akeredolu-Ale BI, Abe EM, Oluwole AS, et al. The impact of worms and ladders, an innovative health educational board game on soil-transmitted helminthiasis control in Abeokuta, southwest Nigeria. PLoS Negl Trop Dis. 2020;14(9):1–17.
6. Eze P, Agu UJ, Aniebo CL, Agu SA, Lawani LO. Perception and attitudinal factors contributing to periodic deworming of preschool children in an urban slum, Nigeria. BMC Public Health. 2020;20(1).
7. Yaro CA, Kogi E, Luka SA, Nassan MA, Kabir J, Opara KN, et al. Edaphic and climatic factors influence on the distribution of soil transmitted helminths in Kogi East, Nigeria. Sci Rep. 2021;11(1).
8. Montresor A, Mupfasoni D, Mikhailov A, Mwinzi P, Lucianez A, Jamsheed M, et al. The global progress of soil-transmitted helminthiases control in 2020 and world health organization targets for 2030. PLoS Negl Trop Dis. 2020;14(8):1–17.
9. Camacho-Alvarez I, Goyens P, Luizaga-López JM, Jacobs F. Geographic differences in the distribution of parasitic infections in children of Bolivia. Parasite Epidemiol Control. 2021 Aug 1;14.
10. Palmeirim MS, Mrimi EC, Minja EG, Samson AJ, Keiser J. A cross-sectional survey on parasitic infections in schoolchildren in a rural Tanzanian community. Acta Trop. 2021 Jan 1;213.
11. Majid MF, Kang SJ, Hotez PJ. Resolving "worm wars": An extended comparison review of findings from key economics and epidemiological studies. PLoS Negl Trop Dis. 2019;13(3).
12. Loukouri A, Méité A, Kouadio OK, Djè NN, Trayé-Bi G, Koudou BG, et al. Prevalence, Intensity of Soil-Transmitted Helminths, and Factors Associated with Infection: Importance in Control Program with Ivermectin and Albendazole in Eastern Côte d'Ivoire. J Trop Med. 2019;2019.
13. Mekonnen Z, Getachew M, Bogers J, Vercruysse J, Levecke B. Assessment of seasonality in soil-transmitted helminth infections across 14 schools in Jimma town, Ethiopia. Pan Afr Med J. 2019;32.
14. Clements ACA, Addis Alene K. Global distribution of human hookworm species and differences in their morbidity effects: a systematic review. Lancet Microbe. 2022;3:e72–9.

https://doi.org/10.54987/jobimb.v12i1.958

15. Sripa B, Leonardo L, Hong SJ, Ito A, Brattig NW. Status and perspective of Asian neglected tropical diseases. Acta Tropica. 2022;225.
16. Enogiomwan Imalele E, Offiong Effanga E, Ukam Usang A. Environmental contamination by soil-transmitted helminths ova and subsequent infection in school-age children in Calabar, Nigeria. Sci Afr. 2023 Mar 1;19.
17. Aribodor DN, Bassey SA, Yoonuan T, Sam-Wobo SO, Aribodor OB, Ugwuanyi IK. Analysis of Schistosomiasis and soil-transmitted helminths mixed infections among pupils in Enugu State, Nigeria: Implications for control. Infect Dis Health. 2019;24(2):98–106.
18. Imam A, Farouk ZL, Hassan-Hanga F, Ihesiulor UG. A comparative cross-sectional study of prevalence and intensity of soil-transmitted helminthic infection between healthy and severe acutely malnourished pre-school aged children in Kano, Northern Nigeria. BMC Infect Dis. 2019 Feb 6;19(1).
19. Taiwo A, Adedamola M, C O. An investigation on the epidemiology and risk factors associated with soil-transmitted helminth infections in Ijebu East Local Government Area, Ogun State, Nigeria. Sci Afr. 2021 Jul;12:e00757.
20. Bhumbla U. Stool Examination. In: Workbook for Practical Microbiology. Jaypee Brothers Medical Publishers; 2018. p. 142–142.
21. Santosh KA. Microbiological Stool Examination: Overview [Internet]. 2012 May. Available from: https://www.researchgate.net/publication/236303794
22. Suwansaksri J, Nithiuthai S, Wiwanitkit V, Soogarun S, Palatho P. The formol-ether concentration technique for intestinal parasites: Comparing 0.1 N sodium hydroxide with normal saline preparations. 2002.
23. Methanitikorn R, Sukontason K, Sukontason KL, Piangjai S. Technical report evaluation of the formalin-tween concentration technique for parasitic detection. 2003.
24. Gilmour B, Alene KA, Clements ACA. The prevalence of soil transmitted helminth infections in minority indigenous populations of south-east Asia and the western Pacific region: A systematic review and meta-analysis. PLoS Negl Trop Dis. 2021;15(11).
25. Oluwafemi FS, Akharaiyi FC, Alo BE, Agunbiade BT. Prevalence of soil transmitted helminths infection among primary school age children in Owo Town, Ondo State, Nigeria. Int J Vet Sci. 2019;8(4):224–8.
26. Mationg MLS, Tallo VL, Williams GM, Gordon CA, Clements ACA, McManus DP, et al. The control of soil-transmitted helminthiases in the Philippines: the story continues. Infect Dis Poverty. 2021;10.
27. Eltantawy M, Orsel K, Schroeder A, Morona D, Mazigo HD, Kutz S, et al. Soil transmitted helminth infection in primary school children varies with ecozone in the Ngorongoro Conservation Area, Tanzania. Trop Med Health. 2021 Dec 1;49(1).
28. Edosomwan EU, Evbuomwan IO, Agbalalah C, Dahunsi SO, Abhulimhen-Iyoha BI. Malaria coinfection with Neglected Tropical Diseases (NTDs) in children at Internally Displaced Persons (IDP) camp in Benin City, Nigeria. Heliyon. 2020 Aug 1;6(8).
29. Samweli LG, Sesera AJ, Mushi V, Silvestri V, Palilo H, John W, et al. Intestinal schistosomiasis among secondary school students in Northern Tanzania: prevalence, infection intensity and associated risk factors. IJID Regions. 2023 Mar 1;6:125–34.
30. Muadica AS, Balasegaram S, Beebeejaun K, Köster PC, Bailo B, Hernández-de-Mingo M, et al. Risk associations for intestinal parasites in symptomatic and asymptomatic schoolchildren in central Mozambique. Clin Microbiol Infect. 2021 Apr 1;27(4):624–9.
31. Khan W, Khan J, Khan N, Iqbal R, Ullah A, Ghaffar R, et al. Soil-transmitted helminth infections in school children of three districts of Malakand region, Khyber Pakhtunkhwa, Pakistan. Pak J Pharm Sci. 2019;32(2):799–803.
32. Vlaminck J, Levecke B, Cools P, Albonico M, Ame S, Chanthapaseuth T, et al. Piloting a surveillance system to monitor the global patterns of drug efficacy and the emergence of anthelmintic resistance in soil-transmitted helminth control programs: A Starworms study protocol. Gates Open Res. 2020;4.
33. Macleod CK, Bright P, Steer AC, Kim J, Mabey D, Parks T. Neglecting the neglected: The objective evidence of underfunding in rheumatic heart disease. Trans R Soc Trop Med Hyg. 2019;113(5):287–90.
34. Mutombo PN, Man NWY, Nejsum P, Ricketson R, Gordon CA, Robertson G, et al. Diagnosis and drug resistance of human soil-transmitted helminth infections: A public health perspective. Adv Parasitol. 2019;104:247–326.
35. Sartorius B, Cano J, Tusting LS, Pullan RL, Marczak LB, Miller-Petrie MK, et al. Prevalence and intensity of soil-transmitted helminth infections of children in sub-Saharan Africa, 2000-18: a geospatial analysis [Internet]. 2020. Available from: https://espen.afro.who.int
36. Robertson LJ, Chitanga S, Mukaratirwa S. Food and waterborne parasites in Africa - threats and opportunities. Food Waterborne Parasitol. 2020 Sep 1;20.
37. Abe EM, Echeta OC, Ombugadu A, Ajah L, Aimankhu PO, Oluwole AS. Helminthiasis among school-age children and hygiene conditions of selected schools in Lafia, Nasarawa State, Nigeria. Trop Med Infect Dis. 2019 Jul 29;4(3).
38. Opara KN, Wilson EU, Yaro CA, Alkazmi L, Udoidung NI, Chikezie FM, et al. Prevalence, Risk Factors, and Coinfection of Urogenital Schistosomiasis and Soil-Transmitted Helminthiasis among Primary School Children in Biase, Southern Nigeria. J Parasitol Res. 2021;2021.
39. Boltena MT, El-Khatib Z, Kebede AS, Asamoah BO, Boltena AT, Yeshambaw M, et al. Comorbidity of geo-helminthes among malaria outpatients of the health facilities in Ethiopia: Systematic review and meta-analysis. Int J Environ Res Public Health. 2021;18:1–15.
40. Eyayu T, Wubie A, Kiros T, Tiruneh T, Damtie S, Sema M, et al. Prevalence of Intestinal Parasitosis and Its Associated Factors Among Children Aged 6 to 59 months Attending Mekane Eyesus Primary Hospital, Northcentral Ethiopia. Glob Pediatr Health. 2021;8.
41. Okello E, Kapiga S, Grosskurth H, Makata K, McHaro O, Kinungh'I S, et al. Factors perceived to facilitate or hinder handwashing among primary students: A qualitative assessment of the Mikono Safi intervention schools in NW Tanzania. BMJ Open. 2019;9(11).
42. Avokpaho EFGA, Houngbégnon P, Accrombessi M, Atindégla E, Yard E, Means AR, et al. Factors associated with soil-transmitted helminths infection in Benin: Findings from the deworm3 study. PLoS Negl Trop Dis. 2021 Aug 1;15(8).
43. Darlan DM, Winna M, Simorangkir HAH, Rozi MF, Arrasyid NK, Panggabean M. Soil-transmitted helminth and its associated risk factors among school-aged children. In: IOP Conference Series: Earth and Environmental Science. Institute of Physics Publishing; 2019.
44. Wijaya W, Pasaribu AP, Yanni GN, Suteno E, Husin N, Pasaribu S. Correlation between soil-transmitted helminths and anemia incidence in primary school children in Talawi, Batubara Regency. Open Access Maced J Med Sci. 2021 Jan 10;9(T3):325–9.
45. Ohiolei JA, Isaac C, Omorodion OA. A review of soil transmitted helminthiasis in Nigeria. Asian Pac J Trop Dis. 2017;7(8):841–8.
46. Kafinta HS, Shah MM, Sharif U. Prevalence of helminthic infection among primary school children in some selected primary schools in municipal local government area, Kano state, Nigeria. J Appl Adv Res. 2018 May 16;84–9.
47. Ihesiulor GU, Emokpae MA, Adeeke SI, Sumaila AB. Soil transmitted helminthiasis among apparently healthy children in Kano municipality. Afr J Clin Exp Microbiol. 2007;8(1):81–7.
48. Hailu GG, Ayele ET. Assessment of the prevalence of intestinal parasitic infections and associated habit and culture-related risk factors among primary schoolchildren in Debre Berhan town, Northeast Ethiopia. BMC Public Health. 2021 Dec 1;21(1).