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Soil-Transmitted Helminths and Their Impact on Nutritional and Anaemia Status Among School-Aged Children in Some Schools in Dutsin-Ma, Katsina State Nigeria

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Soil-transmitted helminthiases,
Thinness,
Underweight,
WASH.

ABSTRACT
Malnutrition and anaemia among school-aged children, particularly in developing nations, are serious public health issues linked to soil-transmitted helminths (STHs). This study aimed to investigate STHs and their impact on the nutritional and anaemia status among school-aged children in some schools in Dutsin-Ma, Katsina State, Nigeria. A cross- sectional study involving 400 randomly selected school-aged children was conducted. All stool samples collected were examined for the presence of STHs using the formal-ether concentration technique. Anthropometric measurements were taken according to World Health Organisation (WHO) standards and haematocrit packed cell volume (PCV), respectively were used to determine the nutritional and anaemia condition of the sampled children. Questionnaire was administered to gather information on socio-demographic factors. The overall prevalence of STHs was 49.0% (196) in which three types of STHs were identified, *Ascaris lumbricoides* most dominant (50.5%) than hookworm (26.5%) and *Trichuris trichiura* (5.1%). A statistically significant association was observed between age group (χ^2 = 9.409, p = 0.009). Residing close to dumpsite, walking barefoot, and playing with sand, were not significantly associated with SHTs(p>0.05). However, washing hands with soap after toilet use was significantly associated with STHs(OR = 0.607, p = 0.017) provides a protective effect against STHs. The BMI for age shown that 26.3% were underweight and 2.8% overweight. Infected children were more anaemic though not statistically significant. Soil-Transmitted Helminthiases remains a public health concern among children and negatively affect children's nutritional and anaemia status. Therefore, an integrated approach to STH management, nutrition, initiatives, iron supplementation and implementation of WASH are encouraged.

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INTRODUCTION

Soil-transmitted helminth (STH) infections are the most widespread among neglected tropical diseases (NTDs), affecting approximately 1.5 billion individuals globally and thus representing the most prevalent infection worldwide (PAHO, 2024). In 2020, the World Health Organization (WHO) set ambitious goals to mitigate the impact of STHs by aiming to eliminate it as a public health issue by 2030(WHO, 2020). While these infections can affect individuals of any age, pre-school-aged(not yet in primary school 0-4years) and school-aged children (in primary school and junior secondary school 5-14years) are particularly vulnerable (WHO, 2017). In Africa, 42 countries are endemic for STHs, with 284 million cases among both school-aged and preschool-aged children (Usang *et al*. 2025). Persistent STH infections can lead to growth retardation, weight loss, anaemia, increased school absenteeism, and diminished academic performance (Lebu.*et al*. 2023). In addition to their physical health impact, these infections can also impair cognitive development in children (Quiroz *et al*. 2020)

Among the most prevalent NTDs worldwide, which affect the poorest and most deprived communities, are those caused by STHs. The roundworm (*Ascaris lumbricoides*), hookworms *(Necator americanus* and *Ancylostoma duodenale*), and whipworms (*Trichuris trichura*) are the main that infect people (Adenusi *et al*. 2024). In areas where there is poor hygiene, STH transmission is by ingesting eggs present in human faeces, which invariably contaminate the soil, or through skin penetration (Ibrahim *et al*. 2022). School-aged children (SAC) of about one billion are at risk of being infected with at least one STH species (Pullan *et al*., 2014).

The world's poorest populations frequently suffer from intestinal helminth infections; which are frequently considered as the primary cause of prevalent chronic diseases (Anunobi *et al*., 2019). In developing nations, intestinal parasitism is a severe public health issue frequently disregarded (Elmonir *et al*., 2021). Communities with low environmental and personal cleanliness, inadequate nourishment, overcrowding, and favorable climatic conditions are more likely to have infections (Karshima, 2018). Children are said to have the highest risk of contracting intestinal helminths due to their unclean habits, including playing with dirt and/or handling infected objects, using unhygienic restroom practices and consuming contaminated food and water (Idowu *et al*., 2019 and Lawal *et al*.2022). Soil-transmitted helminths are common in tropical and subtropical countries worldwide, including China, Americas, sub-Saharan Africa, and East Asia where the standard of living is low and sanitary and environmental conditions are poor (Nwankwo *et al*., 2021). Infection with soil-transmitted helminth parasites, including giant roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) and hookworm (*Necartor americanus* and *Ancylostoma duodenale*) affect about one fourth of the world population (Ahmed and Sani, 2019). Infection with soil-transmitted helminths frequently results in well-known symptoms such as malnutrition, decreased cognitive function, anaemia, diarrhoea, and gastrointestinal complications (Adekola *et al*., 2018). Due to low social and economic conditions, inadequate sanitation, and poor hygiene practices, parasitic diseases are a significant public health issue in underdeveloped nations. They lead to numerous issues with physical and mental development in children, including intestinal blockage, growth retardation, and iron deficiency anaemia (Ahmed *et al.*, 2012).

In developing countries, malnutrition and STH infections frequently occur together, creating a combined health issue for children that impacts their overall wellbeing (Usang *et al*., 2025). Soil-transmitted helminth infections can lead to malnutrition by depleting the host's nutrients or impairing nutrient absorption (Bain *et al*., 2013).

Due to increased metabolic rate, persistent anaemia, and diarrhoea brought on by a high worm load, soil transmitted helminth infection significantly impacts nutritional and cognitive health, particularly in school aged children. For assessing the nutritional status of populations, especially children in underdeveloped nations, anthropometry has evolved into a helpful instrument. Similarly, children's nutritional state is the best gauge of their overall well-being (Ajayi *et al*., 2017).

Dutsin-Ma, a town in Katsina State, faces similar challenges, with widespread soil-transmitted helminth infections attributed to poor sanitation facilities and open defaecation practices (Speich *et al*., 2016; Manir *et al*., 2017; Ismail *et al*., 2024; Igweachi *et al*.,2025).

The mass deworming programmes have shown a lot of development but limited study has been made to ascertain the nutritional and anaemia-related consequences of STH infections. This study aims to bridge these gaps by examining the soil transmitted helminths infections and their impacts on the nutritional and anaemia status of school-aged children in Dutsin-Ma, Katsina State.

MATERIALS AND METHODS

Study Area and duration

The study was conducted in Dutsin-Ma Town, in Dutsin-Ma Local Government Area, Katsina State, Nigeria. Dutsin-Ma occupies a land mass of 527 square kilometres. It is located on latitude (12^0 27'6.012'E) and longitude (7^0 29'52.98'N). The inhabitants are mostly Hausa and Fulani speaking people constitute a population of 169, 671 according to census 2006; The area is characterized by mean temperature ranges between 35^0C to 39^0C annually. The vegetation is dominated by trees, shrubs and grasses. Majority of the indigenes are farmers, fishermen civil servants, teachers and businessmen (NPC, 2006).

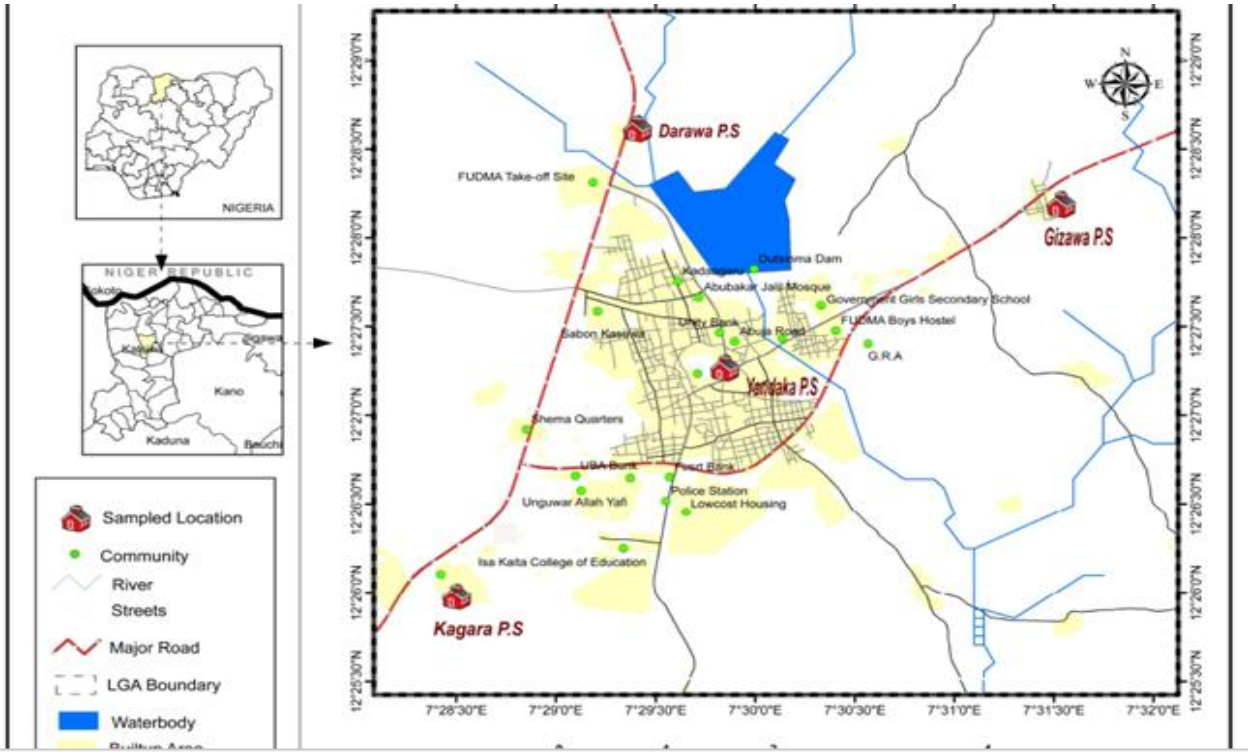

Figure 1: Map of the study Area

Ethical Consideration

Approval was obtained from the Katsina State Health Research Ethics Review Committee (MOH/ADM/SUB/1152/1/1116). Futhermore, approval came from the State Universal Basic Education Authority and school headteachers. Parental consent and verbal child assent were obtained.

Study Population and Design

The cross sectional study population consists of 400 school-aged children (5–14 years old) who were randomly selected among children attending the four primary schools selected for the study and 100 children were selected from each school. The schools include ,Gizawa Primary School, Darawa Primary School, Yandaka Primary School, Na-Alhaji Primary and Yandaka Primary School were randomly selected. This age group is targeted because they are at high risk of STH infections due to frequent exposure to contaminated environments and poor hygiene practices.

Sample Size Determination

The prevalence of gastrointestinal helminth infection (59.1%) in primary school children of Batagarawa Local Government Area, Katsina State, Nigeria (Lawal *et al*., 2022) was considered. The sample size was estimated using the formula below (Edogiawerie *et al*., 2016):

$n = (Z^2 \times PxQ)/d2$

where:

n = sample size

Z = Z-score corresponding to the desired level of confidence (1.96 for 95% confidence)

P = prevalence previously reported from related work

Q = 1-P

d = allowable error (0.05)

$(1.96)^2 \times 0.591(1-0.591)/(0.05)^2$

$3.8416 \times 0.591 \times 0.409/0.0025$

$=0.9285877104/0.0025$

$=371.43508416$

$n \approx 371$

However, 400 children were selected to take care of dropouts and the possibility of non-participation by some subjects.

Collection of Samples and Administration of Questionnaires

A total of 400 stool and blood samples were collected from the pupils after obtaining parental consent and also explaining the procedure to the participant. The students were given a structured questionnaire to obtain socio-demographic information, which they filled with the kind assistance of the school teachers and research assistant. Each student who signed up was given an identity number that matched to the questionnaire and sample bottle. Each student was instructed on how to collect stool sample to prevent contamination. Stool samples were collected in sterile screw cap container. Each student had two (2) ml of blood collected by experienced health

personnel, and then placed into an EDTA bottle labelled and kept in a thermo box by medical workers. Each child's weight was measured using an analog weighing scale with a preset weight of 0.1kilogram (kg). The age of each sampled student was recorded in accordance with height, which was subsequently measured using a height pole put on the wall (Manir *et al*., 2017; Ihejirika *et al*. 2019; Lawal *et al*., 2022). All samples were taken to biology laboratory and clinic of Federal University Dutsin-ma respectively for further investigations

Laboratory Analysis

Stool samples were examined for soil transmitted helminth using the Formal-ether Sedimentation Technique described by Cheesbrough (2006). Two grams (2g) each feacal sample was placed in a container, and preserved in 10% formalin immediately after collection to prevent degeneration of helminth eggs prior to laboratory analysis. Emulsified with 10ml of normal saline solution, which was then strained and mixed with ether into a centrifuge tube and centrifuged at 1500 rpm for five minutes. The supernatant was discarded, and the residue was placed on a slide, covered with a cover slip, and examined under a microscope at a magnification of 10x. Lugol's iodine was used to help identify the helminth eggs/ova as outlined in Cheesbrough (2006),(WHO, 2019) and (CDC, 2024) guidelines. Safety measures were maintained before, during and after the procedure such as soap was given to each participant to wash his/her hand, personal protective equipment (PPE) were also used. Meanwhile after the procedure all wastes were packed and disposed appropriately.

Determination of Packed Cell Volume

Blood samples from the EDTA bottle were placed in capillary tubes after being labelled. The capillary tips were cleaned with cotton wool, sealed, and placed inside the haematocrit centrifuge. Then, it was centrifuged 1200 revolutions per minute. Hematocrit reader was used to determine the parked cell volume (Cheesbrough, 2006; Lawal *et al*.,2022).

Anthropometry Assessment

The nutritional status of each child was determined using measurements of their height, weight, age and sex. The children's nutritional status was determined based on the Z score data. Using body mass index (BMI) for age, the nutritional indicators were classified as thinness, severe klthinness normal growth, overweight and obesity, according to the WHO Child Growth Standards for School-aged Children and Adolescents (WHO, 2007).

Data Analysis

Data collected for this study were coded and entered into SPSS (Statistical Package for Social Sciences) software version 20.0 for statistical analysis. Descriptive statistics was used to summarize the prevalence of STH. Prevalence of STH infections, nutritional status, and anemia were presented as frequencies and percentages. Means and standard deviations was used for continuous variables such as hemoglobin levels and BMI.

Chi-square statistics was used to determine the association between the prevalence of STHs and possible risk factors. Nutritional status was determined using 2007 WHO Child Growth Standards for School-aged Children and Adolescents. Chi-square test to compare significant difference among variables at 95% confidence level,with a p-value of less than 0.05 considered statistically significant.

RESULTS AND DISCUSSION

In total, 400 primary school children of Dutsin-Ma participated voluntarily in this study, among the four selected primary schools out of which majority being females 229 (57.25%) and 171 (42.75%) are males. Among age groups, 37 (9.25%) within 5–8 years, 228 (57%) within 9–11 years and 135 (33.75%) within 12 and above.

All 400 children who enrolled in this study provided stool sample (100%). As presented in Table 1, out of the 400 stool samples examined for the presence soil transmitted helminths ova and cysts, 196 stool samsples tested positive, giving a prevalence of 49.0%. Although variations were observed among the schools, the difference was not statistically significant ($\chi^2 = 3.922$, $p = 0.270$). This implies that school location did not significantly influence infection status among the pupils (Table 1). Though female students had slighty higher prevalence compared to their male counterparts, recording 49.3 %, a little above 48.5 % found in the male students. Statistical analysis showed no significant association between gender and infection status ($\chi^2 = 0.026$, $p = 0.873$).

Prevalence of STHs infection among the age groups of the subjects indicated among the school-age children, children of age group 9-11 years 122 (62.2%) which is the highest and lower prevalence among the 5-8 years with 22 (11.2%) is the least value recorded.

A statistically significant association was observed between age group and infection status ($\chi^2 = 9.409$, $p = 0.009$). This indicates that age plays an important role in determining the likelihood of infection. (Table 2). *Ascaris lumbricoides* was found to be present in roughly more than half (50.5%) of the infected children, hookworm was found to be present in 26.5% of the children, and *T. trichiura* was found in 5.1% of the children. The prevalence of mixed infections with hookworm plus *A. lumbricoides* was (14.3%) and *T. trichuira* with *A. lumbricoides* was 3.6% (Figure 2.)

The prevalence rates of normal growth, thinness, severe thinness, overweight and obesity were 70.8% (283/400), 14.8% (59/400),11.5% (46/400), 2.8% (11/400) and 0.3%

(1/400) respectively (Table 3). The study recorded overall anaemia prevalence of 30.5% among the study population. Additionally, the findings reported that children infected with STH were more anaemic 68/196 (34.7%) than the uninfected ones 54/204 (26.47%) (Table 4). But the association between SHT infection and anemia was not statistically significant.

Among the risk factors assessed, handwashing with soap after using toilet emerged as a significant protective factor against soil transmitted helminths infection. Other factors, such as playing with sand, living close to refuse dump sites and walking barefoot,were not significantly associated with infection (Table 5).

Table 1: Prevalence of Soil Transmitted Helminth Infection in the Selected Schools

Name of School	Number Examined	Number Infected	Prevelence %	P-Value	χ^2
Gizawa Primary School	100	52	52.0	0.270	3.922
Darawa Primary School	100	42	42.0		
Na-Alhaji Primary School	100	47	47.0		
Yandaka Primary School	100	55	55.0		
Total	400	196	49.0%		

Table 2: Prevalence of Soil Transmitted Helminth Infection In Relation to Demography

	No. Examined	No. Infected	Percentage (%)	P-value	DF	X^2
Gender						
Male	171	83	48.5	0.873	1	0.026
Female	229	113	49.5			
Total	400	196	100%			
Age Group						
5-8yrs	37	22	11.2	0.009	2	9.409
9-11yrs	228	122	62.2			
12>yrs	135	52	26.5			
Total	400	196	100%			

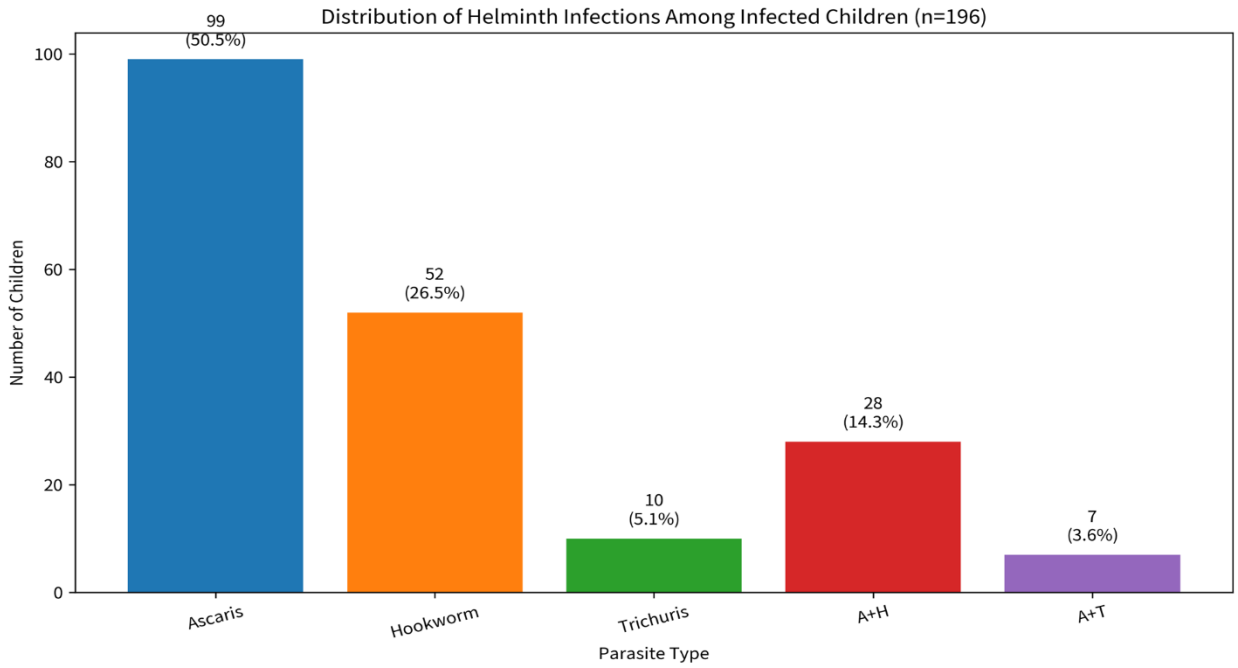

Figure 2: Parasite Distribution among School-Aged Children in Dustin-Ma

Table 3: Nutritional Status of School Aged Children in Dutsin-Ma

Nutritional Status	Count	Percentage (%)	P-value
Normal	283	70.8	0.756
Obesity	1	0.3	
Overweight	11	2.8	
Severe thinness	46	11.5	
Thinness	59	14.8	
Total	400	100%	

Table 4: Anaemia prevalence among infected and uninfected children in the study area (n=400)

Infection status	No. examined	Anemia status	
		No. anemic	No. non-anemic
Infected	196	68 (34.7%)	128 (65.3%)
Uninfected	204	54 (26.47%)	150 (73.5%)
Total	400	122 (30.5%)	278 (69.5%)

Table 5: Risk Factors Associated with Soil Transmitted Helminths Infections among School Children in the Study Area

Variables		STH	Odd ratio	X^2	P-value	95% CI
Close to refuse dump site	Yes	33	0.919	0.097	0.755	0.540-1.563
	No	163				
Washing hand after using toilet	Yes	96	0.821	0.950	0.330	0.555-1.219
	No	100				
Washing hand before eating	Yes	121	1.161	0.517	0.472	0.773-1.745
	No	75				
Washing hand with soap after toilet	Yes	82	0.607	5.683	0.017	0.402-0.916
	No	114				
Eating vegetable without washing	Yes	83	1.906	0.208	0.648	0.738-1.628
	No	113				
Walking barefoot	Yes	14	0.958	0.012	0.913	0.444-2.065
	No	182				
Playing with sand	Yes	55	1.068	0.089	0.765	0.693-1.648
	No	141				
Toilet type	Pit latrine	178		1.643	0.440	
	Flush toilet	16				
	Open defecation	2				
Do you use school toilet?	Yes	155	1.234	0.688	0.407	0.750-2.031
	No	41				

Discussion

Soil-transmitted helminth (STH) infections remain a major public health issue in developing countries, especially impacting children, who are more susceptible to these infections (WHO, 2024)

Findings from this study revealed an overall STH prevalence of 49.0% of soil transmitted helminths (STH) infections among school-aged children. These findings is comparable to the prevalence reported by Rhoda *et al*, (2024) in Rivers State and is also consistent with the 49.6% prevalence reporeted among school children in Enugu State. The data indicate that STH infections persist as a significant public health concern in the study area, a trend similar to that reported by Imalele *et al*. (2023) and Usang *et al*. (2025).The prevalence obtained is higher than many findings made previously among school-aged children such as the works of Usang *et al*.(2025)) who discovered a prevalence of 28.8% in Calabar, Nigeria; Ismail *et al*.,(2024) found a prevalence rate of 33.6%, in katsina State, Nigeria; Nwankwo *et al*. (2021) who discovered a prevalence of 44.2% in Anambra State, Nigeria.

The observed prevalence in this study is considerably lower than those reported by Lawal *et al*. (2022) prevalence rate of 59.1% in Batagarawa Katsina State, Nigeria. It is however, less than the prevalence rates discovered in a number of other studies, including 63.49% reported by Manir *et al*. (2017) among school-aged children in Dutsinma Area, Katsina State, Nigeria, 69.9% reported by Idowu *et al*. (2022) in Ogun State.

Variations were observed across schools, with Yandaka Primary School recording the highest prevalence (55.0%)

and Darawa Primary School the lowest (42.4%). But was not statistical significant. These differences may be attributed to variations in environmental sanitation, proximity to refuse dump sites, and access to improved water and sanitation facilities among the schools. In agreement with another study done by (Ibrahim *et al*., 2022). Additionally with respect to gender, females had a slightly higher prevalence (49.3%) compared to males (48.5%), although the difference was not statistically significant. This observation confirms equal exposure to infection risks in the setting, likely due to similar play habits and hygiene behaviors among the study population. (Manir *et al*., 2017 and Imalele *et al*., 2023).

Though this study reported highest prevalence of STH among children who do not wash hands at all after using the toilet, Akinsanya *et al*. (2021) reported highest prevalence among those who wash hands after using the toilet. This study is similar to the findings of Abdullahi *et al*. (2022), who reported highest prevalence among those who do not wash their hands after using the toilet, but differ from each other as this study could establish significant association between prevalence of STH and habit of washing hands with soap after the use of toilet (the association was protective). which was established by Abdullahi *et al*. (2022).The use of soap in handwashing after toilet interrupts transmission because it physically dislodges residual fecal material which may contain STHs eggs.According to Strunz *et al*. (2014) reported that soap use has significantly association with lower odds infection in any SHT.

The types of helminth parasites namely; *A. lumbriocoides*, Hookworm and *T. trichiura* documented in this study are comparable to those reported in studies of the same kind conducted in Nigerian (Ahemed and Sani, 2019; Omotola and Ofoezie, 2019; Idowu*et al*., 2019; Idowu *et al*., 2022; Lawal *et al*., 2022) and other sub-Saharan African nations, including Ethopia (Yarinbab and Darcha 2019), Kenya (Masaku *et al*., 2014), and Cameroon (Cho *et al*., 2021).

The most common dominate species was A. lumbricoides (50.5%). The relatively elevated prevalence of *A. lumbricoides* noted in this study could be attributed to the resilience of it eggs. The findings was consistent with Karshima *et al*., 2018; Awotokun *et al*. (2024) and Ismail *et al*. (2024). The development and transmission of these soil transmitted helminths indicate that soil, food, and water might be contaminated with infective stages. Some of the school environments do not have better water conditions, however, the prevalent sanitary condition of the study area favours the development and transmission of the parasites. Poor hygiene practices of not washing hands with soap after defecation and attitudes such as picking food from the ground, playing on contaminated soil, and more importantly, not wearing sandals might have predisposed these pupils to the risk of contaminating their hands with infective ova of A. lumbricoides and also active penetration of infective hookworm larvae on soil as the case may be. Lack of clean water, poor standards of public and personal hygiene, and inadequate health education promote the spread of such parasites. (Brooker *et al*,2008; Rhoda *et al*., 2024)

The prevalence obtained is higher than many findings made previously among school-aged children such as the works of Usang *et al*. (2025) who discovered a prevalence of 28.8% in Calabar, Nigeria; Isma'il *et al*. (2024) – Katsina state (33.6%) Nwankwo *et al*. (2021) - Anambra State 44.2%. This could be due to environmental and sanitation deficits; Eberemu *et al*. (2023) reported that 88.9% of vegetables (lettuce, cabbage, spinach, etc.) were contaminated with helminth eggs and larvae, highlighting significant environmental (soil) contamination as a major transmission driver. The high prevalence obtain may be due to poor sanitation, poor hand hygiene and environmental contamination Awotokun *et al*. (2024).

The observed rate of underweight (26.3%) in this study. This findings is closely similar to Usang *et al*.,2025 with the underweight of 25.2% among children and adolescent. It is also lower then Lawal *et al*.,2022 who reported 76.4% among STH infected children. The long established synergism with helminthiasis may also contribute to the high prevalence of malnutrition among these subjects (Zerdo *et al*.,2017). Malnutrition and STH infections are in a vicious circle in which one predisposes to the other. Poor nutrient intake increases susceptibility to parasitic diseases and together they negatively affect the childhood growth and development (Olveda, *et al*. (2014)

Moreso, the findings of this study indicated that 30.5% of all the subjects examined were anaemic. the study recorded overall anaemia prevalence of 30.5%. Among STH positive children anaemia prevalence 34.69% but the association between SHT infection and anaemia was not statistically significant. This findings is closely comparable to the 29.5% prevalence reported by Adewale *et al*. (2024) with Lawal *et al*. (2022). Helminths parasites infection is recognized as the major contributor to malnutrition which could influence the weight of infected subject (Dahal *et al*. *2020*). Although a higher proportion of anaemia was observed among infected. This suggests that while STH may contribute to anaemia in this population, other factors such as malaria, dietary deficiencies, or hemoglobinopathies may play more dominant roles.

Though this study reported highest prevalence of STH among children who do not wash hands at all after using the toilet, Akinsanya *et al*. (2021) reported highest prevalence among those who wash hands after using the toilet. This study is similar to the findings of Abdullahi *et al*. (2022), who reported highest prevalence among those who do not wash their hands after using the toilet, but differ from each other as this study could establish significant association between prevalence of STH and habit of

washing hands with soap after the use of toilet with lower odds, which was established by Abdullahi *et al.* (2022).
Lack of clean water, poor standards of public and personal hygiene, and inadequate health education promote the spread of such parasites. Some of the parasites have a high fecundity rate which may last long. In many places where sanitation and safe refuse disposal are non-existence, the environment, becomes thoroughly contaminated and infection is difficult to avoid.

CONCLUSION

This study has determined the prevalence of soil-transmitted helminth infections among school aged children in which showed STH prevalence of 49.0%, anaemia prevalence of 30.5% and 26.3% underweight. Therefore, Dutsin-Ma is moderately endemic to soil transmitted helminths and anaemia according to WHO risk classification and is of public health concern. These findings emphasize these actions should prioritize hand-washing with soap, providing clean drinking water, disposing of human waste and sewage properly, and educating people about public health. The importance of environmental hygiene and sanitation is a very important indicator in the control of helminth infection. The finding also calls for continuous reinforcement and sustainability of mass deworming programs.

RECOMMENDATIONS

There is an urgent need for strengthened school-based deworming programs with improved coverage, coupled with health education on hygiene practices, particularly handwashing with soap. Integration Water, Sanitation, and Hygiene (WASH) interventions, nutritional and iron supplementation recommended to achieve sustainable reduction in STH transmission. Further survey, using molecular diagnostic techniques should be embarked upon for genomic identification of the parasites to species level. Nonetheless, there is a need for more research into the health impact of STH-polyparasitism and other infections that can predispose SAC to malnutrition and anemia.
The school Board Management should provide hand washing facilities in the schools. The ministry of health should conduct health education on environmental sanitation and personal hygiene practices among primary school students.

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