

Common Risk Factors Associated with Transmission of Soil Helminths Infection and Body Mass Index of School Children in Jalingo, Wukari, And Zing Local Government Areas of Taraba State, Nigeria

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ABSTRACT

Soil-transmitted helminths (STHs) are a major public health problem in the Tropical and Sub-tropical developing countries with poor socio-economic status. STH is endemic in Nigeria. Children are the most vulnerable group infected by STHs, and their effects on these children include cognitive impairment, malnutrition, anaemia, and weight loss. The study determined the prevalence of Soil-transmitted helminthic diseases in Jalingo, Wukari, and Zing Local Government Areas of Taraba State. A total of 450 stool samples were collected from school children in three randomly selected Local Government Areas. The samples were examined using the Formol-ether concentration technique and the direct smear method. A questionnaire was used to collect information from the participants. The data collected were analysed using Chi chi-square (χ^2) test. The overall prevalence was 26(5.8%). *Ascaris lumbricoides* 20(4.4%), took the lead followed by Hookworm 5(1.1%), the least was *Strongyloides stecoralis* 1(0.2%). Zing Local Government had the highest percentage of infection 12(8.0%); Jalingo and Wukari Local Governments had a prevalence rate of 7(4.7%) each. Male children had the highest prevalence, 17(7.2%) and Female children had the least

prevalence 9(4.2%) ($\chi^2=1.791$; $P=1.2$). Children who fell under 6-10years had the highest prevalence 15(6.0%), the least prevalence were 1-5years and 11-15years with 2(5.6%) and 9(5.6) respectively, ($\chi^2=0.321$; $P=0.984$). Prevalence of STHs was highest in children who were underweight 23(6.5%), and least in children with normal weight 3(4.2%) based on Body Mass Index (BMI) ($\chi^2=0.483$; $P=0.87$). The highest rate of infection was recorded among children who walked barefoot 26(5.9%) ($\chi^2=0.627$; $P=0.428$), while those who washed their hands before and after eating had the least 9(2.9%), (OR=1.489; $\chi^2=12.324$; $P=0.301$). Those who used stream as their source of drinking water had the highest prevalence 5(35.7%) and the least were those who used Borehole 2(3.1), ($\chi^2=27.495$, $P=0.521$). Overall, there was a statistically significant difference observed in the study, except for BMI, which showed no significant difference. The prevalence of STHs infection in this study, though not high, could be used as a basis for continuous effective de-worming intervention programs by government agencies concerned.

Key Words: Soil Transmission Helminths, Risk Factors, Body Mass Index, Children, Infection

1. INTRODUCTION

Soil-transmitted helminthiasis (STH), also known as intestinal worm infections are caused by a group of intestinal parasites comprising *Ascaris lumbricoides* (roundworms), *Trichuris trichiura* (whipworms), *Necator americanus* and *Ancylostoma duodenale* (hookworms), *Enterobius vermicularis* and *Strongyloides stecoralis*. STH are transmitted by faecal contamination of soil; they adversely affect nutritional status and impair cognitive processes in children. More than 1.5 billion people, or 24% of the world's population, are infected with soil-transmitted helminths worldwide. Infections are widely distributed in tropical and subtropical areas, with the highest numbers occurring in sub-Saharan Africa, the Americas, China, and East Asia. Soil-transmitted helminthiasis is among the most common infections worldwide and affects the poorest and most deprived communities and is transmitted by microscopic eggs that are passed in the faces of infected people. Adult worms live in the intestine, where they produce thousands of eggs each day. In areas where sanitation is inadequate, the eggs excreted in human faces contaminate the soil (WHO, 2017). Soil-transmitted helminths are known to cause morbidity. The most obvious effects are the direct damage to tissues resulting from the blockage of internal organs or from the immense pressure exerted by the growing parasites. The most common target organs of infections are those of the alimentary tract and sometimes the circulatory system (Muller, 2002). These parasites can be transmitted through the ingestion of contaminated vegetables, fruits, water, and walking barefoot (Brooker et al., 2006a). STH infections are included in the list of the world's neglected tropical diseases (NTDs) and are the most common infections among the poorest and most deprived communities (WHO, 2016). Intestinal helminthiasis has been found to have a great effect on nutritional and cognitive status, especially among preschool and school-aged children, due to increased metabolic rate, anorexia,

chronic anemia, and diarrhea associated with heavy workload (Ezeamama, 2006).

These helminths cause decreased intake or a functional increase in the body's nutrient requirement by their interference with absorptive surfaces, physical obstruction of the intestinal lumen, production of proteolytic substances, and consumption of nutrients intended for the body. These processes ultimately lead to loss of macro- and micronutrients, fluid, and electrolytes as well as direct depletion of red blood cells and growth failure (Hotez, 2004).

Ascariasis is the most prevalent soil-transmitted disease, with an estimated one billion infections. *Trichuris trichiura* and Hookworm (*Ancylostoma duodenale* and *Necator americanus*) each infect approximately 600-300 million people (Bethony et al., 2006).

In Africa, Nigeria is estimated to have the highest number of people infected with helminthiasis, especially in mixed infections with schistosomiasis (WHO, 2015). Helminth infections are particularly common amongst poor populations. The burden of helminthiasis is high in settings with inadequate sanitation, overcrowding, and low socio-economic status. The infections, though rarely fatal, cause considerable morbidity. Conditions associated with intestinal helminths include intestinal obstruction, vomiting, weakness, and abdominal pain (John et al., 2006). At highest risk of morbidity are pre-school age pupils and pregnant women (Bethony et al., 2006). Negative effects of helminth infections include gastrointestinal impairment, iron deficiency, anemia, and low birth weight (Crompton, 2000), in children: growth retardation, delayed intellectual development, and cognition (Drake et al., 2000; Horton, 2003).

Intestinal helminths are amongst the most common infections of humans in the world. Kabatereine and Takahebwa (2004) and Harpham (2009) showed that intestinal helminth infections are highly prevalent, causing serious health challenges in the tropics. School-aged children carry the

heaviest burden of morbidity, Appleton et al. (2009) also showed that intestinal helminth infections are a major problem in rural settlements in Nigeria. This is as a result of poor socio-economic status and lack of basic amenities such as pipe-borne water and other sanitary facilities, illiteracy, and careless behaviors. These parasites cause a variety of acute, chronic, and even debilitating intestinal infections, some of which lead to the death of the host (Monto et al., 1991; Kabatereine and Tu-hebwa, 2005). They reduce school attendance among school children and impair their ability to pay attention in the classroom as reported by the Pan American Health Organisation (PAHO, 2010). The illnesses caused by these intestinal parasites slow the mental and physical growth of children, complicates pregnancies and birth outcomes, it also has a long-term effect on educational achievement and economic productivity.

In children, heavy helminthic infections can impair growth and cognitive development, and malnutrition can lead to deficiencies and anaemia. Nutritional deficiencies and diseases can negatively impact the health status of children and adolescents. Intestinal helminth infections can damage a child's intestinal mucosa, leading to improper digestion and poor absorption of nutrients. Deficiencies in both macro and micronutrient intake during childhood can impair both physical and cognitive growth as well as increase the risk of mortality. Moreover, inadequate intake of selected micronutrients can cause immune deficiency and increase susceptibility to infection. Children aged 5-14years suffer the highest burden of infectious diseases as a result of their increased risk behavior, frequent outdoor exposure, and poor personal hygiene. These are the major considerations in choosing the topic.

Periodic anthelmintic treatment reduces and maintains low intensity of infection, but, in

the longer term, provision of adequate sanitation is fundamental to break the cycle of infection and reinfection and sustainably controlling these infections. Health and hygiene education can also help in reducing transmission and reinfection (WHO, 2017b).

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in Jalingo, Wukari and Zing LGAs of Taraba State, Nigeria. Jalingo Local Government Area is the capital city of Taraba State in Northeastern Nigeria and has been estimated to have a population of 118,000. It lies roughly between latitude 8°53'37.2" N and longitude 11°21'34.6" E. Wukari is a Local Government Area in Taraba State; its area is 4,308 km². The city's population is 241,546. It lies between latitude 7°52'17.00" N and 9°46'40.30" E. Wukari is home to the Jukun people. Zing is a Local Government Area in Taraba State, Nigeria. Its headquarters is in the town of Zing with coordinates 8.9952° N and 11.7467° E. It has an area of 1,030 km² and a population of 127,363 at the 2006 census. 98% of people in Zing are predominantly Mumuye with twelve clans.

2.2 Study Design

A cross-sectional study design was used to determine the prevalence and risk factors of soil transmitted helminths parasite infections amongst primary school children. A random sampling was used to select three Local Government Areas and three schools in each Local Government Headquarter. Stool samples were collected from the selected pupils and examined for soil transmitted helminthes. A questionnaire was used to collect information from each participant on age, sex and risk factors. Measurement of body weight and height were taken for determination of body mass index (BMI).

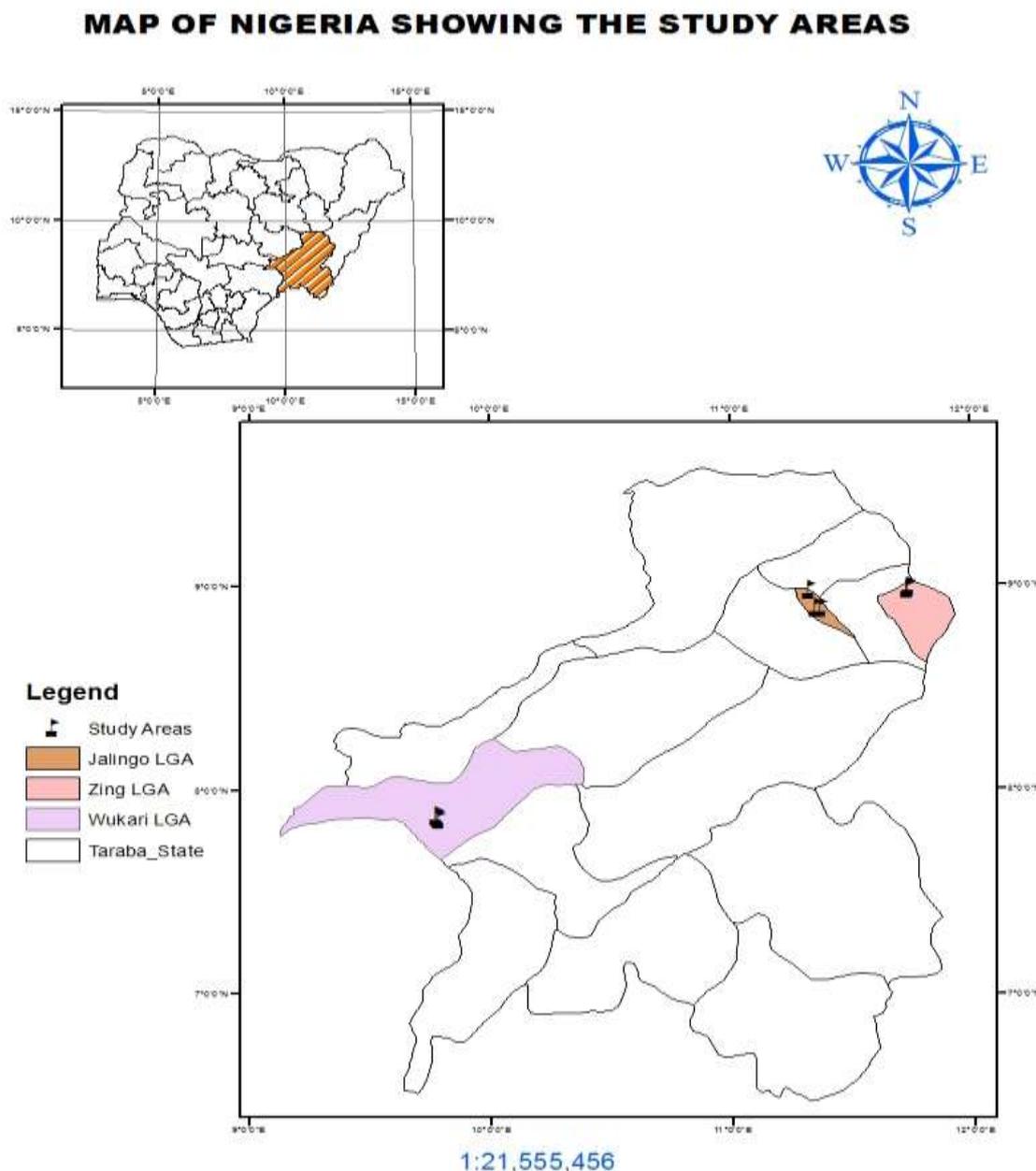


Figure 1.1: Map of Taraba State showing Wukari, Jalingo and Zing Local Government Areas.

2.3 Study Population and Sample Size

About 450 stool samples were obtained from Wukari, Jalingo and Zing LGAs, with 150 samples from each Local Government Area. The study population included school children from age 4- 15years whose parents or guardians gave permission to participate in the study. The samples size was obtained using the Fischer formula.

$$n = \frac{Z^2 Pq}{d^2}$$

Where

n = sample size,

Z = Z statistic for a level of confidence,

P = expected prevalence or proportion (0.5),

and

d = precision (0.05).

$q = 1 - p$

This calculation was conducted by using 95% confidence interval for Z statistics which is 1.96 and 5% precision.

$$\text{Therefore, } = (1.96)^2 \times 0.5(1-0.5) / (0.05)^2$$

$$= 3.8416 \times 0.5 \times 0.5 /$$

0.0025

The minimum sample size was $384.16 \approx 384$

2.4 Fecal Sample Collection

All the participating children were given relevant information at the beginning of sample collection about the aim and significance of the study. In addition, a verbal description and specific instruction for handling and avoidance of contamination of the stool specimen was also passed across to them. Children were given transparent sterile universal specimen containers containing 10% formalin and were instructed on how to use them to collect stool specimen. All stool specimens collected were labeled appropriately with identification code. The stool samples were taken to the laboratory for macro and microscopic examination.

2.5 Laboratory Techniques

Two laboratory methods were used.

2.5.1 Direct wet smear method

A clean, grease free microscopic slide was used, a drop of normal saline was placed on one half and a drop of Lugol's iodine on the other half of the slide respectively. An applicator stick was used to pick a small portion of the stool sample and mix with the drop of normal saline and Lugol's iodine respectively. Each mixture was covered with a separate cover slip and examined under the microscope. (Cheesbrough, 2006)

2.5.2 Formol-ether concentration technique

Formol- ether concentration technique as described by Cheesbrough (2006) was employed in the study. Using an applicator stick, 2g of stool was transferred into a centrifuge tube containing 4ml of 10% normal saline and centrifuged at 3000 rpm for 3minutes. The supernatant was decanted; 4ml of normal saline was again added to the sediment and centrifuged at 3000rpm for 3 minutes, and the supernatant was decanted. 2ml of Formol-ether was added to the supernatant and centrifuged for 3minutes at 3000rpm. After centrifugation, four layers were observed: the top layer of ether, a plug layer of fecal debris, a formalin layer and

sediments at the bottom. An applicator stick was used in a spiral movement to loosen the layer of fecal debris, and the other top layers were carefully poured out. Normal saline was added to the tube and mixed. Using a disposable pipette, a drop of the suspension was placed on a clean grease free microscope slide and covered with a cover slip and observed using x10 and x40 objective lens.

2.6 Determination of Body Mass Index (BMI)

Anthropometric measurements of height and weight were collected using standard procedures. Weight and height were measured using a portable digital scale to the nearest 0.1 kg and 0.1m, respectively, and parallax error was avoided. BMI was calculated using the 2007 World Health Organization Growth Reference thus: weight in kilograms divided by the Square of the Person's height in meters. (Holland, 2011).

$$BMI = W/h^2 \text{ ----- (2)}$$

Where W= weight of a person in kilograms;
H= height of a person in meters.

BMI of 25-30= overweight, 18.5-24.9= Normal, and BMI of <18.5= underweight.

2.7 STATISTICAL ANALYSIS

Statistical techniques such as percentages, frequency counts, tables were used to analyse the primary data collected. Data from questionnaires were coded, ranked and analysed using SPSS. Chi-square (χ^2) test and logistic regression were used to determine whether infection status was dependent on age, sex, hygiene behaviors, and to determine if there is a relationship between infection with STHs and BMI. Significance level was determined at $P \leq 0.05$ (95% confidence level) for all tests.

3. RESULTS

3.1 Prevalence of STHs in Relation to the Body Mass Index

Based on the Body Mass Index (BMI), no child was found to be overweight 0(0.0). Most of the children were underweight and the others at normal weight. The prevalence of STHs was highest in children who are

underweight with 23(6.5%) and 3(4.2%) ($\chi^2=0.483$, $P=0.487$) for children with normal weight as shown on Table 1. This shows

there was no significant difference in infection rate in respect to BMI.

Table 1.1: Prevalence of STHs in relation to the Body Mass Index of children studied

BMI	No. Examined	No. Infected (%)	χ^2	P-value
Underweight	353	23(6.5)	0.483	0.487
Normal	71	3(4.2)		
Overweight	26	0(0.0)		
Total	450	26(5.8)		

(BMI of 25-30 = Overweight, 18.5-24.9 = Normal and BMI of <18.5 = Underweight)

3.2 Personal Hygiene Practices Amongst Children in Relation to STHs Infection

The hygiene practices amongst school children showed that those who walked bare footed had a prevalence of 26(5.9%) with odd ratio of 1.570 ($\chi^2=0.627$, $p=0.428$), showing a significant difference in rate of infection between pupils in relation to walking bare footed. Those who do not wash hands before eating had a high prevalence of 17(11.9%) while those who wash hands

before eating had low prevalence 9(2.9%) with odd ratio of 1.489 ($\chi^2=12.324$, $p=0.301$), this shows a significant difference. Those who do not wash hands after using the toilet had a higher prevalence of 14(10.5%) compared to those who wash their hands after using the toilet 12(3.8%) with odd ratio 2.637 ($\chi^2=7.644$, $p=0.627$), this shows there was a significant difference in the infection rate amongst the pupils in relation to washing hands after using the toilet.

Table 1.2: Personal hygiene practices amongst children in respect to STHs infection

Risk factors	Responses	No. Examined	No. Infected (%)	OR	χ^2	P-value
Walk barefooted	Yes	440	26(5.9)	1.570	0.627	0.428
	No	10	0(0.0)			
Wash hands After using the toilet	Yes	316	12(3.8)	2.637	7.644	0.627
	No	134	14(10.5)			
Wash hands Before and after eating	Yes	307	9(2.9)	1.489	12.324	0.301
	No	143	17(11.9)			
Wash fruits Before eating	Yes	237	11(4.6)	1.863	1.183	0.157
	No	213	15(7.0)			

3.3 Prevalence of Soil-Transmitted Helminthes in Relation to Toilet Facilities and Sources of Drinking Water

The types of toilet facility and source of drinking water available to the children in relation to infection with STHs showed that those who practiced open defecation 1(16.7%) recorded the highest rate of infection compared to those who use Pit

latrine 25(5.7%), ($\chi^2=1.679$, $P=0.442$) showing a significant difference. As for the source of drinking water, those who drank water from the stream had the highest rate of infection 5(35.7%) compared to those who use Well 19(6.1%) and Borehole 2(3.1%), ($\chi^2= 27.405$, $p= 0.521$), which shows a significant difference in infection rate amongst pupils.

Table 1.3: Prevalence of Soil-Transmitted Helminthes in relation to Toilet facilities and Sources of drinking water

Facilities	Types	No. Examined	No. Infected (%)	χ^2	P-value
Toilets Facilities	Pit Latrine	438	25(5.7)	1.679	0.442
	Water cistern	6	0(0.0)		
	Open defecation	6	1(16.7)		

Source of drinking water	Well	313	19(6.1)	27.405	0.521
	Borehole	65	2(3.1)		
	Stream	14	5(35.7)		
	Tap	58	0(0.0)		

3.4 STHs Infection in Relation to Basic Knowledge and Health Seeking Practices

The basic knowledge of STHs and health seeking practices of the children in Jalingo, Wukari and Zing LGAs showed that those who knew intestinal worms had a low prevalence of infection 25(5.7%) compared to the high prevalence among those who do not know intestinal worms 1(7.7%), with OR=0.697, ($\chi^2=0.90$, P=0.764), showing a

significant difference in the infection rate amongst pupils. Those who do not know how intestinal worms are transmitted had a prevalence of 26(5.8%) with an odd ratio, OR=1.223 ($\chi^2=0.37$ P=0.848). For health-seeking practices, those who prefer herbal medicine had the highest prevalence 2(14.3%), those who went to the hospital had the least, 22(5.4%) ($\chi^2=2.164$, P=0.539). This shows a significant difference.

Table 1.4: Prevalence of STH in relation to deworming and time of deworming

Variables	Responses	No. Examined	No. Infected (%)	χ^2	P-value
Have you taken dewormer?	Yes	429	11(2.6)	3.829	0.430
	No	21	15(71.1)		
If Yes, when?	1-3months	38	0(0.0)		
	4-6months	36	0(0.0)		
	7-9months	215	4(1.9)		
	Forgotten	140	7(5.0)		
If No, why?	Don't know it	4	1(25.0)	3.629	0.270
	Can't afford it	7	5(71.4)		
	Prefer herbs	10	9(90.0)		
Where did you get dewormer	MDA	391	10(2.6)	3.556	0.314
	Drug vendors	34	1(2.9)		
	Pharmacy	4	0(0.0)		

MDA=Mass Drug Administration.

4. DISCUSSION

Intestinal helminths are distributed worldwide; among them Soil transmitted helminths pose a serious threat to the physical wellbeing of humans, especially school children. Poverty, illiteracy, ignorance and culture play an important role in the prevalence rate of helminthiasis. The overall prevalence of STHs in the three LGAs was found to be 26(5.8%).

The three different soil transmitted helminths identified in this study were *Ascaris lumbricoides* 20(4.4%), Hookworms 5(1.1%) which can either be *Necator americanus* or *Ancylostoma duodenale* and *Strongyloides stecoralis* 1(0.2%); *Ascaris lumbricoides* had the highest rate of infection and *Strongyloides stecoralis* had the least prevalence. The findings in this study agrees with the reports of Crompton and Neishein (2002); Hotez and Pritchard (1995), who

indicated that some common species of gastrointestinal helminths (GIHs) that infects humans are *Ascaris lumbricoides*, Hookworms, *Trichuris trichuria*, *Strongyloides stecoralis* and *Enterobius vermicularis*.

The prevalence in this study, 5.8% is lower than the 30.3% observed by Kelechi et al., (2015) in Amaruru community of Imo State and 34.2% observed by Anunobi et al. (2019) in Kogi State, Nigeria. Differences in prevalence obtained in various parts of the country relative to the present study may be attributable to environmental, ecological and anthropogenic factors that prevailed in each area.

Ascaris lumbricoides had the highest prevalence in the three LGAs; this is linked to the mode of transmission being feaco-oral. Children being the most vulnerable to infection are predisposed to risk factors

through poor hygiene and habits such as putting dirty hands in the mouth, eating without washing hands, eating unwashed fruits and vegetables, not washing hands after using the toilets and playing with soil and most importantly the source of drinking water. This study agrees with Ziegelbauer et al. (2012) who reviewed that child who played with soil had a high chance of being infected with intestinal helminths.

Hookworm infection is associated with outdoor activities such as farming, playing on moist soil especially when not putting on shoes; this exposes one to infective eggs and larvae in the soil since its transmission is majorly through penetration of the skin. In this study, the prevalence of hookworm at 5(1.1%) was recorded and children who did not wear shoes were the most infected. Soil moisture and relative humidity also influence the survival of ova and larvae of hookworm; the prevalence of hookworm in this study though not high could be as a result of humidity and soil moisture. This agrees with Hotez (2004) who said that high humidity is associated with faster development of hookworm.

Male children had a higher prevalence (7.2%) than Female (4.2%), this could be because males usually accompany their fathers to the farm and are also known to be more adventurous. This is in agreement with the report of Obiukwu et al. (2008).

The age groups of 6-10 years recorded higher prevalence rates of 6.0%. Children in these age groups engage in play activities in contaminated environments that could facilitate transmission of intestinal helminths. The children also tend to be less cautious of their personal hygiene because they are not old enough to understand the need for general cleanliness. Those who were under 6 years and above 10 years both had a prevalence (5.6%). Infection rate in the age group of 11–15 years may be due to the psychosocial development of adolescence, as they are more self-conscious of their personal hygiene and outward appearance to attract the opposite sex as shown by Ukpai and Ugwu (2003) and Adefioye et al. (2011).

Children who do not wash their hands after using the toilet 14(10.5%) had low prevalence compared to those who do not wash their hand before and after eating, 17(11.9%); this agrees with Addo et al. (2014), who stated that though auto-infection from freshly passed stool is not possible since period of incubation in the soil is required by STH, washing of hands after using the toilet is an indication of personal hygiene. More so, children who use regular open defecation sites are more likely to soil their hands with previously contaminated soil. Therefore, hand washing protects against STH.

Children who practiced open defecation had the highest prevalence rate at 16.7% this could be due to their predisposition to infective ova and larvae in the soil, as most of them walk barefoot. This agrees with Ojurongbe et al. (2015) who stated that improper sewage disposal is a major factor for STH infection.

Children who used stream as their source of drinking water had a high prevalence rate of 5(35.7%) compared to those who used Borehole 2(3.1%) and tap at 0(0.0%). This could be attributed because riverbanks are common sites for open defecation and the temperature and soil moisture aids the parasites to thrive therefore as children go to fetch water, play or swim along the riverbanks, they come in contact with infective ova or larvae. More so, the ova and larvae could be washed into the river which is used for drinking. This agrees with Abossie and Seid (2014) who stated that piped water source had a protective effect on children against intestinal parasitic infection as compared to stream water.

Children who seek medication from hospitals 5.4% had a low prevalence compared to 14.3% of those who preferred herbal medicine, this is expected because of the risk behaviors of children that exposes them to infection and high worm burden, this agrees with the WHO recommendation that treatment should be given once a year when the prevalence of soil-transmitted helminth infections in the community is over 20%, and

twice a year when the prevalence of soil-transmitted helminth infections in the community is over 50%. This intervention reduces morbidity by reducing the worm burden (NCDC, 2017).

5. CONCLUSION

This study reports a very low prevalence of STH infection in the study population, indicating significant progress in the adoption of WHO-recommended community-level strategies, including prevalence-based targeted distribution of albendazole and mebendazole among school-aged children, preschoolers, women of childbearing age, and adults. The findings also suggest improved hygiene practices, toilet facilities, and drinking water sources within the LGAs. However, the high prevalence of underweight BMI (78.4%) among school children highlights an urgent nutritional concern. To address these issues sustainably, continuous periodic deworming programs should be extended beyond children to all age groups, complemented by health and sanitary education delivered in local languages by teachers and health authorities. Furthermore, government provision of essential amenities such as safe potable water remains crucial, while additional studies should be undertaken by local authorities to investigate the factors contributing to the persistently high prevalence of underweight BMI among primary school children.

Declaration by Authors

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REFERENCES

1. Aboosie, A. and Seid, M. (2014). Assessment of the prevalence of intestinal parasites and associated risk factors among Primary School Children in Clench Town, Southern Etopia, *BioMed Clinic*, Public Health. 14:166.
2. Adams, V.J., Lombard, C.J., Dhansay, M.A., Markus, M.B. and Fincham, J.E. (2004). Efficacy of albendazole against the whipworm *Trichuris trichiura*: a randomised, controlled trial. *South African Medical Journal*, 94: 972–976.
3. Addo, H.O., Addo, K.K. and Bimi, L. (2014). Water handling and hygiene practices on the transmission of diarrhoeal diseases and soil-transmitted helminthic infections in communities in rural Ghana. *Intern Knowledge Sharing Platform*, 6(1): 68–79.
4. Adefioye, O.A., Efunshile, A.M. and Ojuronbe, O. (2011). 'Intestinal helminthiasis among school children in Ilie, Osun State, Southwest, Nigeria,' *Sierra Leone Journal of Biomedical Research*, 3(1): 36–42.
5. Albonico, M., Ramsan, M., Wright, V., Jape, K., Haji, H.J., Taylor, M., Savioli, L. and Bickle, Q. (2002). Soil-transmitted nematode infections and mebendazole treatment in Mafia Island schoolchildren. *Annals of Tropical Medicine and Parasitology*, 96: 717–726.
6. Albonico, M., Stoltzfus, R.J. and Savioli, L.(1998). Epidemiological evidence for a differential effect of hookworm species, *Ancylostoma duodenale* or *Necator americanus*, on the iron status of children. *International Journal of Epidemiology*, 27: 530–537.
7. Ananthakrishnan, S. and Das, P. K. (2001). Integrated programme for control of geohelminths: A perspective. *The National Medical Journal of India*, 14:3.
8. Anderson, R.M. and May, R.M.(1982). Population dynamics of human helminth infections: control by chemotherapy. *Nature*, 297:557–563.
9. Andrade, C., Alava, T., De Palacio, I.A., Del Poggio, P., Jamoletti, C., Gulletta, M. and Montresor A. (2001). Prevalence and Intensity of Soil-transmitted Helminthiasis in the City of Portoviejo (Ecuador), *Mem Inst Oswaldo Cruz, Rio de Janeiro*, 96(8): 1075-1079.

10. Andy, E.O. and Palmer, A.D. (2005). Soil-transmitted helminthiasis among school-age children
11. Anunobi, J.T., Okoye, I.C., Aguzie I.O., Ndukwe, Y.E. and Okpasuo, O.J. (2019). Risk of Soil-Transmitted Helminthiasis among Agrarian Communities of Kogi State, Nigeria. *Annals of Global Health*, 85(1): 120, 1–13.
12. Appleton, C.C., Mosala, T.L., Levin, J., and Olsen, A. (2009). Geohelminth Infection and Re-infection after Chemotherapy among Slum-dwelling children in Durban, South Africa. *Annals of tropical and medical parasitology*, 103 (3):249-261.
13. Bennett, A. and Guyatt, H. (2000). Reducing intestinal nematode infection: efficacy of albendazole and mebendazole. *Parasitology Today*, 16: 71–74.
14. Bethony, J., Brooker, S., Albonico, M., Geiger, S.M., Loukas, A., Diemert, D. and Hotez, P.J. (2006). Soil-transmitted helminth infections: Ascariasis, trichuriasis, and hookworm. *Lancet*, 367:1521–1532.
15. Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., Uauy, R. (2013). Maternal and Child Nutrition Study Group. Maternal and child undernutrition and overweight in low and middle-income countries. *Lancet*, 382(9890):427-451.
16. Brooker S. and Bundy D.A. P. (2009). Soil-transmitted Helminths (Geohelminths). In: Cook
17. Brooker, S., Clements, A.C. and Bundy, D.A. (2006). Global epidemiology, ecology, and control of soil-transmitted helminth infections. *Advanced Parasitology*, 62: 221–261. 10.1016.
18. Brooker, S., Clements, A.C. and Hotez, P.J. (2006). The co-distribution of *Plasmodium falciparum* and hookworm among African school children. *Malaria Journal*, 5:99.
19. Brooker, S., Hotez, P.J. and Bundy, D.A. (2008). Hookworm-related anaemia among pregnant women: a systematic review. *PLoS Neglected Tropical Diseases*, 2(9): 291
20. Bundy, D.A.P. and Cooper, E.S. (1989). Trichuris and trichuriasis in humans. *Advances in Parasitology*, 28: 107–173.
21. Cheesebrough, M. (2006). *District Laboratory practice in Tropical countries*, Part 2, Second edition, Cambridge University press, United Kingdom, Pp 98-104.
22. Christian, P., Khattry, S.K. and West, K.P. Jr. (2004). Antenatal anthelmintic treatment, birthweight, and infant survival in rural Nepal. *Lancet*, 364: 981–983.
23. Croke, K. (2014). The Long Run Effects of Early Childhood Deworming on Literacy and Numeracy: Evidence from Uganda. *Unpublished Manuscript*.
24. Crompton, D.W. (2001). Ascariasis and ascariasis. *Advanced Parasitology*, 48:285, 375.
25. Crompton, D.W. and Nesheim, M.C. (2002). Nutritional impact of intestinal helminthiasis during the human life cycle. *Annual Revised Nutrition*, 22:35–59.
26. Dayan, A.D. (2003). Albendazole, mebendazole and praziquantel. Review of non-clinical toxicity and pharmacokinetics. *Acta Tropica*, 86: 141–159.
27. de Silva, N., Ahmed, B.N., Casapia, M., de Silva, H.J., Gyapong, J. and Malecela. (2015). Cochrane Reviews on Deworming and the Right to a Healthy, Worm-Free Life. *PLoS Neglected Tropical Diseases*, 9(10): 0004203.
28. de Silva, N.R., Brooker, S. and Hotez, P.J. (2003). Soil-transmitted helminth infections: updating the global picture. *Trends in Parasitology*, 19:547–551.
29. Despommier, D., Gwadz, R.W., Hotez, P.J. and Knirsch, C.A. (2005). *Parasitic diseases*. 5th edn, New York, Apple Tree Production.
30. Drake, L.J., Lukes, M.C.H., Sternbery, R.J and Bundy, D.A.P (2000). Geohelminth infections (Acariasis, Trichuriasis and hookworm) cognitive and development impacts. *Seminar of Pediatric Infectious Disease*, 11:245-251.
31. Ezeamama, A.E., Friedman, J.F., Acosta, L., Bellinger, D.C., Langdon, G.C. and Manalo, D.L. (2006). Helminth infection and cognitive impairment among Filipino

- children. *American Journal of Tropical Medicine Hygiene*. 72:540-548.
32. Faust, E.C. and Russell, P.F. (1964). *Craig and Faust's clinical parasitology*. Philadelphia: Lea and Febiger.
 33. Food and Agriculture Organization (FAO). (2005) *Anthropometric Assessment of Nutritional status*.
 34. Galvani, A.P. (2005). Age-dependent epidemiological patterns and strain diversity in helminth parasites. *Journal of Parasitology*, 91(1): 24-30.
 35. Gillespie S., Kevany J. and Mason, J. (1991). *Controlling Iron Deficiency*, Geneva:
 36. Global Atlas of Helminth Infections (GAHI). (2017)
 37. Hall, A., Zhang, Y., Macarthur, C. and Baker, S. (2012). The role of nutrition in integrated programs to control neglected tropical diseases. *BMC Medicine*, 10:41. doi: 10.1186/1741-7015-10-41.
 38. Harpham, T. (2009). Urban Health in developing countries: what do we know and where do we go? *Health Place*, 15 (1):107-116
 39. Hicks, J.H., Kremer, M. and Miguel, E. (2015). The Case for Mass Treatment of Intestinal Helminths in Endemic Areas. *PLoS Neglected Tropical Diseases*, 9(10):0004214.
 40. Holland, D. (2011). *Measuring malnutrition: Individual assessment* [Internet][Accessed on 28 may, 2012] available at <http://www.enonline.net/resources/776>
 41. Horton, J. (2003). Global anthelmintic chemotherapy programs: learning from history. *Trends in Parasitology*, 19: 405–499.
 42. Hotez, P. (2008). Hookworm and poverty. *Annals of New York Academics Sciences*. 1136: 38–44.
 43. Hotez, P., Raff, S., Fenwick, A., Richards, F. Jr. and Molyneux, D.H. (2007). Recent progress in integrated neglected tropical disease control. *Trends in Parasitology*, 23(11):511-514.
 44. Hotez, P.J. (2004). Hookworms (*Ancylostoma* and *Necator americanus*). In: Behrman R, E., Kliegman, R.M. and Jenson, H.B, (editors). *Nelson textbook of paediatrics* 17th ed., Philadelphia, Pennsylvania: Saunders the Curtis centre, pp 1156-1158.
 45. Hotez, P.J. (2009). Mass drug administration and integrated control for the world's high-prevalence neglected tropical diseases. *Clinical Pharmacology and Therapeutics*, 85, 659–664.
 46. Hotez, P.J. and Pritchard, D.I. (1995). Hookworm infection. *Scientific American Journal*. 272: 68-74.
 47. Hotez, P.J., De Silva N., Brooker S. and Bethony J. (2003). Soil Transmitted Helminth
 48. Igagbone, I.F and Olagunje, (2006). Intestinal Helminthes Parasites in School Children Iragbiji, Boripe Local Government, Osun State, Nigeria. *African Journal of Biomedicine*, 9(1):63-65
 49. John, D., Williams, T. and Petri, J.R. (2006). *Markell and vague's medical parasitology*, 9th edition, Saunders Elsevier Press, 32:345-349
 50. Kabatereine, N., Brooker, S. and Tutahebwa, E. (2004). Epideminology and geography of *S.mansoni* in Uganda: implications for planning. *Tropical Medical and International Health*, 9:370-380
 51. Kabatereine, N.B. and Takahebwa, E.M. (2005). Soil-Transmitted Helminthes is in Uganda: Epidemilogy and cost of Control. *Tropical Medicine and International Health*, 10 (2):1187-1189.
 52. Kelechi, K.O., Emeka, C.N., Francis. M., Alfreda C.I., and Seline, O. (2015). Prevalence and Pattern of soil-Transmitted Helminthetic infection among children in a Rural Community in Imo State. *Journal of Tropical Medicine*, Vol.2015; 349439.
 53. Khuroo, M.S. (1996). Ascariasis. *Gastroenterology Clinic North America*; 25: 553–577.
 54. Khuroo, M.S., Zargar, S.A. and Mahajan, R. (1990). Hepatobiliary and pancreatic ascariasis in India. *Lancet*. 335: 1503–1506.
 55. Knopp, S., Mgeni, A.F., Khamis, I.S., Steinmann, P., Stothard, J.R., Rollinson, D., Marti, H.

56. Lacey, E. (1990). Mode of action of benzimidazoles. *Parasitology Today*, 6: 112–115.
57. Map of Nigeria: <https://latitude.to/map/ng/nigeria/cities/>
58. Maxwell, C., Hussain, R., Nutman, T.B., Poidexter, R.W., Little, M.D., Schad, G.A. and Ottesen, E.A. (1987). The clinical and immunologic responses of normal human volunteers to low dose hookworm (*Necator americanus*) infection. *American Journal of Tropical Medicine and Hygiene*; 37: 126–134.
59. May Loo, M. D., (2009). *Integrative Medicine for Children*
60. Meremekwu, M. M., Anita-obongi, O.E., Asind, A.A. and Ejezia, G.C.(1995). Prevalence and intensity of intestinal helminthiasis in Pre-School children of peasant farmers in Calabar Nigeria. *Journal of Medicine*,4(2):40-46.
61. Monto, A.S., Higashi, G.I and Marrs, C.F. (1991). *Infectious agents: In Oxford Textbook of Public Health*.Vol (2nd ed.), Oxford Medical Publications.
62. Montresor, A., Awasthi, S. and Crompton, D.W. (2003). Use of benzimidazoles in children younger than 24 months for the treatment of soil-transmitted helminthiasis. *Acta Trop*. 86: 223–232.
63. Montresor, A., Crompton, D.W.T., Gyorkos, T.W. and Savioli, L. (2002). Helminth control in school-age Children: *A guide for managers of control Programmes*, WHO.
64. Montresor, A., Crompton, D.W.T., Hall, A., Bundy, D.A.P. and Savioli, L. (1998). Guidelines for the Evaluation of Soil-Transmitted Helminthiasis and Schistosomiasis at the community level, WHO/CTD/SIP/1.
65. Muller (2002). *Worms and human disease*.2nd (ed).Wallingford: Cambridge Publisher London, Uvain Hyman. Pp. 204-205.
66. Murray, C.J.L. and Lopez, A.D. (1990). *The global burden of disease: a comprehensive assessment of mortality and morbidity from disease, injuries, and risk factors in 1990 and projected to 2020*. Cambridge, MA; Harvard University Press, 1996.
67. Murray, C.J.L., and Lopez, A.D. (1994). Global and regional cause of death patterns in 1990. *Bulletine. World Health Organization*, 72(93):447-448
68. National Bureau of Statistics. (2010). Tanzania Demographic and Health Survey, *Preliminary report, Dar-es-Salaam, Tanzania*.
69. Nigeria Centre for Disease Control (NCDC). (2017) *Soil-Transmitted Helminths*: Published: 2017-01-14 23:35:38.
70. Nokes, C., Grantham-McGregor, S.M. and Sawyer, A.W. (1992). Parasitic helminth infection and cognitive function in school children. *Proc Biological Science*.247:77–81.
71. Norhayati, M., Fatmah, M.S., Yusof, S. and Edariah, A.B. (2003). Intestinal parasitic infections in man, *Medical Journal Malaysia*. 58(2):296-305
72. Obiukwu, M.O., Umeanaeto, P.U., Eneanya, C.I., and Nwaorgu, G.O. (2008) 'Prevalence of gastro-intestinal helminths in school children in Mbaukwu, Anambra State, Nigeria.' *Nigerian Journal of Parasitology*, Vol. 29, No. (1), 15–19.
73. Ojuronbe, O., Oyesiji, K.F., Ojo, J.A. (2015). Soil-transmitted helminth infections among primary school children in Ile-Ife Southwest, Nigeria: A cross-sectional study. *Intern Res J Med Medical Science*. 2(1): 6–10.
74. Ozier, O.(2014). Exploiting externalities to estimate the long-term effects of early childhood deworming. *Policy Research working paper*; no. WPS 7052. Washington, DC: World Bank.<http://documents.worldbank.org/curated/en/2014/10/20258469/exploiting-externalities-estimate-long-term-effects-early-childhood-deworming>
75. PAHO (2010). *Control and Elimination of five Neglected Disease in Latin America and the Caribbean,2010-2015*. Analysis of progress, Priorities and lines of action for lymphatic filariasis, Schistosomiasis, Onchocerciasis, Trachoma and Soil-Transmitted Helminthiasis, Washinton, D.C., PAHO, 2010.
76. Pawlowski Z.S., Schad, G.A. and Stott, G.J. (1991). Hookworm infection and

- anemia - in Ethiopia East Local Government Area, Delta State, Nigeria, *African Journal of Biotechnology*, 4 (9): 938-941.
77. Saathoff, E., Olsen, A., Kvalsvig, J.D. and Appleton, C.C. (2004). Patterns of geohelminth infection, impact of albendazole treatment and re-infection after treatment in schoolchildren from rural KwaZulu-Natal/South Africa, *BMC Infectious Diseases*, 4:27.
78. Shin, J.L., Gardiner G.W., Deitel, W. and Kandel, G. (2004). Does whipworm increase the pathogenicity of *Campylobacter jejuni*? A clinical correlate of an experimental observation. *Canadian Journal of Gastroenterology* 18: 175–177.
79. Smith, J.L. and Brooker, S. (2010). Impact of hookworm infection and deworming on anaemia in non-pregnant populations: a systematic review. *Tropical Medicine of Internal Health*. 15(7):776-795.
80. Steinbaum, L., Kwong, L.H., Ecrumen, A., Negash, M.S., Lovely, A.J., Njenga, S.M., Boehm, A.B., Pickering, A.J. and Nelson, K.L. (2017). Detecting and Enumerating Soil-Transmitted helminth eggs in soil: New method development and results from field testing in Kenya and Bangladesh. *PLOS Neglected Tropical Diseases*, 11(4)
81. Stephenson, L.S., Latum, M. C. and Ottesen, E.A. (2000). Malnutrition and parasitic helminthes infections *Parasitology*, 121:23-38
82. Stoltzfus R.J., Dreyfuss M.L., Chwaya H.M. and Albonico M. (1997). Hookworm Control as a Strategy to Prevent Iron Deficiency, *Nutr Rev* 55, 223–232.
83. Taraba Government. (2010) "facts about Taraba" *Taraba State*. Retrieved on 2015-09-17.
84. Taraba State Government (2014). "Local Government Area". State Government Retrieved on 2019-09-16
85. Taraba State: <http://tarabastate.gov.ng/local-govt-chairmen/>
86. Taren, D.L., Nesheim, M.C. and Crompton, D.W. (1987). Contributions of ascariasis to poor nutritional status in children from Chiriqui Province, Republic of Panama. *Parasitology*, 95: 603–613.
87. Taylor-Robinson, D.C., Maayan, N., Soares-Weiser, K., Donegan, S. and Garner, P. (2015). Deworming drugs for soil-transmitted intestinal worms in children: effects on nutritional indicators, haemoglobin, and school performance. *Cochrane Database of Systematic Reviews*, Issue 7. Art. No.: CD000371. DOI: 10.1002/14651858.CD000371.pub6.
88. Ukpai, M.O., and Ugwu, C.D. (2003). "The prevalence of gastro-intestinal tract parasites in primary school children in Ikwuano Local Government Area of Abia State Nigeria," *Nigerian Journal of Parasitology*, Vol. 24, pp. 129–136,
89. Vercruysse, J., Behnke, J.M., Albonico, M., Ame, S.M., Angebault, C., Bethony, J.M., Engels, D., Guillard, B., Hoa, N.T. V., Kang, G., Kattula, D., Kotze, A.C., McCarthy, J.S., Mekonnen, Z., Montresor, A., Periago, M.V., Sumo, L., Tchuenté, L.A.T., Thach, D.T.C., Zeynudin, A. and Levecke, B. (2011). Assessment of the Anthelmintic Efficacy of Albendazole in School Children in Seven Countries Where Soil-Transmitted Helminths Are Endemic, *PLoS Neglected Tropical Diseases*.
90. Villamizar, E., Mendez, M., Bonilla, E., Varon, H. and de Onatra, S. (1996). *Ascaris lumbricoides* infestation as a cause of intestinal obstruction in children: experience with 87 cases. *Journal of Pediatric Surgery*: 31: 201–204.
91. WHO (2002a) *Report of the World Health Organization Informal Consultation on the use of praziquantel during Pregnancy/lactation and albendazole/mebendazole in Children under 24 months*
92. WHO (2002b) Prevention and control of schistosomiasis and Soil –transmitted helminthiasis, *WHO technical report series*, 912, Geneva, Switzerland.
93. WHO (2005) Deworming for Health and Development. *Report of the Third Global Meeting of the Partners for Parasite Control*; World Health Organization: Geneva, Switzerland.
94. WHO (2006) *Preventive chemotherapy in human helminthiasis: coordinated use of anthelmintic drugs in control interventions: a manual for health*

- professionals and programme managers. Geneva: World Health Organization press.
95. WHO (2010)? Working to overcome the global impact of neglected tropical diseases, *First WHO report on neglected tropical diseases* 1: 135 – 140.
96. WHO (2012)? *Helminthes Control in School –age Children: A guide for Managers of Control programmes.*(2.ed),WHO Press, World Health Organization, Geneva Swizerland.Pp1-75.ISBN 9782-4-154826-7..
97. WHO (2016)? Soil transmitted helminth infections: *Factsheet*. <http://www.who.int/mediacentre/factsheets/fs366/en/>.
98. WHO (2017a) *Fact sheet on soil-transmitted helminthiasis*
99. WHO (2017b) *Soil-transmitted helminth infections*. Geneva: World Health Organization: <http://www.who.int/mediacentre/factsheet/s/fs366/en/>
100. WHO expert committee. (2002). *Technical Report Series* 912, Geneva, Switzerland
101. WHO, (2004)? *Prevention and control of schistosomiasis and soil transmitted helminthiasis*. Geneva: World Health Organization.
102. WHO, (2015)? Soil-transmitted helminthiasis: number of children treated in 2013, *Weekly Epidemiologic Record*, 10(90) 89–96.
103. WHO, (2003)? http://whqlibdoc.who.int/hq/2003/WHO_CDS_CPE_PVC_2002.4
104. WHO, (2021)? https://www.who.int/intestinal_worms/epidemiology/strongyloidiasis/en
105. World Health Report (2002). World health report: annex table 2: deaths by cause, sex, and mortality stratum in WHO regions and annex table 3: burden of disease in DALYs by cause, sex and mortality stratum in WHO regions. Geneva: World Health Organization:186–93
106. Ziegelbauer K, Speich B, Mausezahl D, Bos R, Keiser J, Utzinger J (2012) Effect of sanitation on soil-transmitted helminth infection: systematic review and meta-analysis. *PLoS Med* 9.

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