DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

BOOK OF PROCEEDINGS

IHCFS – 2025 WEBSITE: fos.fugusau.edu.ng

1ST INTERNATIONAL HYBRID CONFERENCE OF FACULTY OF SCIENCE

(A PUBLICATION OF FACULTY OF SCIENCE, FEDERAL UNIVERSITY GUSAU, NIGERIA)

STUDIES ON WATER, SANITATION AND HYGIENE IN ASSOCIATION WITH SOIL TRANSMITTED HELMINTHS PARASITE IN ZAMFARA STATE, NIGERIA

*[1]Na'ala, S. I., [2]Adamu, T., [2]Singh, K., [3]Ladan, M. J. and [1]Ladan, M. U.

[1]Department of Biological Sciences, Federal University Gusau, Zamfara State Nigeria.

[2]Department of Zoology, Usmanu Danfodiyo University, Sokoto, Nigeria.

[3]Department of Biochemistry, Usmanu Danfodiyo University, Sokoto, Nigeria.

***Correspondence: sadiyainaala@gmail.com** **Tel: +2348060361599**

ABSTRACT

Soil-transmitted helminth (STH) infections remain a major public health challenge in low- and middle-income regions, especially where water, sanitation, and hygiene (WASH) conditions are inadequate. This study investigated the prevalence of STH infections and their association with WASH conditions, community knowledge, perceptions, and treatment practices among pupils in nine Local Government Areas (LGAs) of Zamfara State, Nigeria. A multistage sampling technique was used to select 36 public primary schools across 18 wards, and 1,558 stool samples from children aged ≤5 to >15 years were examined using the Kato–Katz technique. Structured questionnaires captured sociodemographic characteristics and community knowledge, attitudes, and practices (KAP). Data were analyzed using descriptive statistics, Chi-square tests, relative risk, and logistic regression at $p < 0.05$.

The overall STH prevalence was 85.55%, with *Ascaris lumbricoides* being the most common (73.04%), followed by hookworm (26.63%), *Strongyloides stercoralis* (13.99%), and *Trichuris trichiura* (11.81%). Prevalence varied across LGAs, highest in Maru (95.62%), Gummi (89.33%), and Gusau (88.65%), and differed significantly by age and gender. Pupils using tap water had the lowest prevalence (55.55%), although water source and sanitation type showed no significant association. Poor hygiene behaviours, including inadequate handwashing and walking barefoot, increased infection risk. Approximately 79.28% of respondents were aware of STHs in the study area.

The study highlights the high burden of STH infections and identifies key behavioural and environmental risk factors. Strengthening school and community WASH facilities, promoting health education, encouraging routine deworming, and implementing behaviour change interventions are recommended to reduce STH transmission.

Keywords: Soil-transmitted, helminthiasis, WASH, prevalence, Primary, pupil, Zamfara

1.0 INTRODUCTION

Water, sanitation, and hygiene (WASH) practices play a critical role in preventing water- and sanitation-related diseases and are considered fundamental human rights (Mohammad et al., 2023). Access to safe drinking water is strongly linked to hygiene behaviours and overall health, forming a core component of global strategies to combat neglected tropical diseases (NTDs) (WHO, 2022). The WASH framework aims to enhance community access to safe water, sanitation facilities, and sustainable hygiene practices (Dery *et al.,* 2020).

Soil-transmitted helminths (STHs) are among the most widespread parasitic infections globally, particularly affecting impoverished communities with poor sanitation (Noor et al., 2023; Akinsanya *et al*., 2021). They are primarily transmitted through contaminated soil, with major species including *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale*, *Necator americanus*, and *Strongyloides stercoralis* (Weinstock & Leung, 2022). Transmission is driven by open defecation, unsafe water sources, lack of footwear, inadequate handwashing, and favourable environmental conditions such as warm temperatures and

DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

moist soil (Mahmoud, 2025; Tobon Ramos *et a*l., 2021; Else *et al*., 2020).

Globally, an estimated 1.5 billion people are at risk of STH infections, including over 900 million children who live in endemic areas and require regular treatment (WHO, 2023). Children in low-income, rural settings bear the highest burden of morbidity due to high exposure and poor hygiene (Idowu *et al*., 2022; Akinsanya *et a*l., 2021). Infection intensity and associated morbidity depend on worm load, age, immunity, and environmental factors (Schlosser *et al*., 2023).

In Nigeria, particularly in Zamfara State, STH transmission is exacerbated by open defecation, inadequate sanitation, limited access to potable water, and widespread poverty (Amadi *et al*., 2024; UNICEF, 2024). Misconceptions such as beliefs that worms come from sweet foods or naturally occur in the body further contribute to poor health-seeking behaviour (Ojo, 2023; Chindo *et al*., 2025). Low levels of awareness, cultural practices, and inadequate health education also impede adoption of preventive measures (Akinyele & Odugbemi, 2024; WHO, 2020; Okoyo, 2020).

Public health interventions, including handwashing promotion, improved sanitation, safe water supply, and mass deworming with drugs such as albendazole and mebendazole, have shown effectiveness, though reinfection remains high in many regions (Keiser, 2023; Bekele et al., 2024; Wong *et al*., 2020; Chong *et al*., 2021). Traditional remedies continue to be widely used alongside modern treatments (Akram et al., 2021; 2023).

Despite ongoing control efforts, Nigeria lacks a coordinated national school-based STH program, and baseline data for many regions remain scarce (Imalele *et al*., 2023; Usang *et al*., 2025). In Zamfara State, socio-economic conditions and environmental factors heighten the risk of persistent transmission (FMoH, 2021). Misconceptions, low awareness, and insufficient community engagement continue to undermine control strategies (Ugbomeh *et al*., 2020; Ojo, 2023). STH infections contribute significantly to malnutrition, anaemia, impaired physical and cognitive development, and poor academic performance among children (Oduneye *et al*., 2023).

This study therefore *assesses* WASH conditions and their association with STH infections among school-aged children in Zamfara State, providing vital baseline data to guide control strategies and improve public health outcomes.

3.0. MATERIALS AND METHODS

3.1 The Study Area

The study was conducted in selected Local Government Areas (LGAs) across Zamfara State, located in northwestern Nigeria. Zamfara lies within latitude 10°50′–13°38′N and longitude 4°16′–7°13′E, with an estimated population of 5.6 million. The state comprises three senatorial zones (North, Central, and West) and is predominantly rural, with agriculture as the major occupation.

DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

BOOK OF PROCEEDINGS

IHCFS – 2025 WEBSITE: fos.fugusau.edu.ng

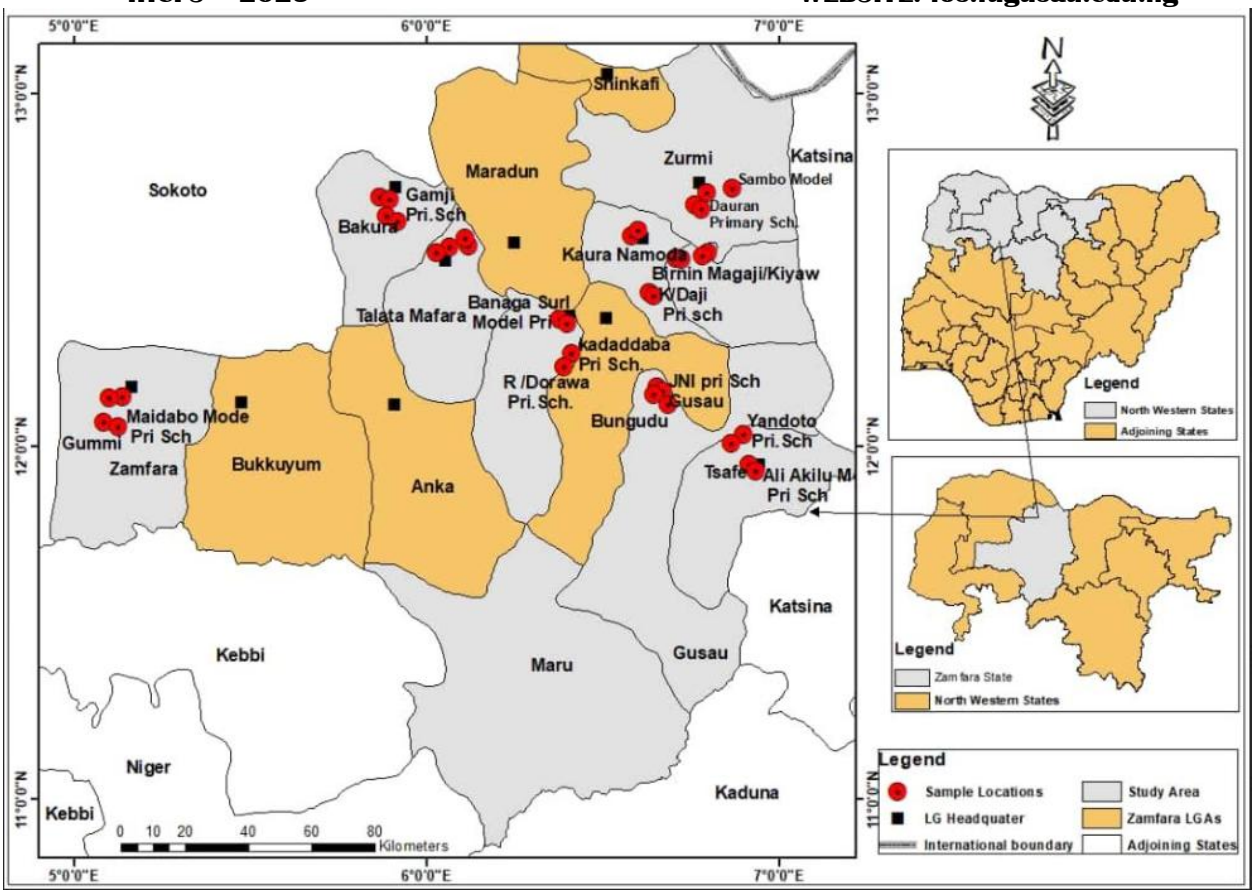

Figure 1.1: Map of North Western Nigeria Showing the Selected LGAs of Zamfara State for the Study.
(Source: - GIS 2023).

Study Population

The study population consisted of pupils from selected public primary schools. Nine LGAs were included: Gusau, Tsafe, Maru, Kaura Namoda, Birnin Magaji, Zurmi, Talata Mafara, Gummi, and Bakura. Two wards were randomly selected per LGA, giving a total of 18 wards.

Sampling

A multistage random sampling approach was used. Three LGAs were selected from each senatorial zone, followed by random selection of two wards per LGA. Slovin's formula (N = 3,990,615; e = 0.05) yielded a minimum sample size of 400, which was expanded to 1,800 (100 pupils per ward) to ensure adequate representation.

Stool Sample Collection

A total of 1,800 stool samples were obtained from pupils in the selected wards. Samples were collected using labeled sterile containers (age, sex, and questionnaire ID) with the assistance of trained health personnel. Specimens were preserved in 10% formalin and transported to the Department of Biological Sciences Laboratory, Federal University Gusau.

Stool Examination

Stool specimens were processed using the Kato–Katz technique following WHO protocols (WHO, 1994). Slides were prepared using a standard template, cleared with glycerol–malachite green, and examined microscopically under ×10 and ×40 objectives. Parasites were identified morphologically using WHO Bench Aids (1994; reprinted 2000, 2003, 2021).

Ethical Approval

Ethical approval was obtained from the Zamfara State Health Research Ethics Committee. Permission was granted by the

DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

Ministry of Health and school authorities. Written informed consent and assent were obtained from parents/guardians and pupils before participation.

Data Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 20. Descriptive statistics were used to determine STH prevalence. Chi-square tests assessed associations between STH infection and behavioural or environmental variables, while Relative Risk (RR) compared infection across exposure categories. Binary logistic regression identified independent predictors of STH infection. Statistical significance was set at $p < 0.05$ with a 95% confidence interval.

4.0 RESULTS

A total of 1,558 stool samples were collected from school-aged children across 36 schools in nine LGAs of Zamfara State and analyzed using the Kato-Katz technique. Of these, 1,333 samples were positive for helminth infection, yielding an overall prevalence of 85.6%. Four STH species were identified: *Asca* (73.0%), Hookworm (26.6%), *Strongyloides stercoralis* (14.0%), and *Trichuris trichiura* (11.8%). Non-STH parasites detected included *Schistosoma mansoni*(*Luggage* (2.3%) (Table 4.1, Plates 1–4).

STH prevalence varied across LGAs, with Maru recording the highest (95.6%) and Bakura the lowest (73.0%). A Chi-square test showed a significant association between infection rates and LGA ($\chi^2 = 41.377$, $p < 0.001$), indicating regional differences in STH distribution (Table 4.2).

STH prevalence varied by water source, with the lowest among tap water users (55.6%) and higher rates among borehole (88.4%) and well water users (85.6%), though the association was not statistically significant ($\chi^2 = 6.557$, $p = 0.087$) (Figure 4.1). Infection rates also differed by toilet type, highest among pupils using pit latrines (89.8%) and lowest among water system toilets (60.0%), but this difference was not significant ($\chi^2 = 5.049$, $p = 0.168$), suggesting that factors beyond toilet type, such as hygiene practices and environmental contamination, influenced infection (Table 4.3).

Regarding shoe-wearing, pupils who wore shoes had lower prevalence (48.2%) compared to those who did not (87.9%). Relative risk analysis indicated a slightly higher infection among shoe wearers (RR = 1.019), and the association was statistically significant ($\chi^2 = 85.317$, $p < 0.001$) (Table 4.4).

Figure 4.2 presents the results on the level of community awareness regarding soil-transmitted helminth (STH) infections among respondents in Zamfara State. Out of 507 participants, 402 individuals (79.3%) indicated that they are aware of STH infections, while 105 respondents (20.7%) reported having no awareness. Among the 507 respondents in the study area, 29.58% identified the presence of worms in stool as a symptom of soil-transmitted helminth (STH) infections, 27.61% reported abdominal pain, and 20.71% mentioned diarrhea. Additionally, 16.17% recognized weight loss as a symptom, while 5.91% had no knowledge (Table 4.5).

DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

BOOK OF PROCEEDINGS

IHCFS – 2025 WEBSITE: fos.fugusau.edu.ng

Table 4.1: Prevalence of STH infection in the study Area

Intestinal Helminth	Frequency	Prevalence
Ascaris lumbricoides	1138	73.04
Hook worm	415	26.63
Strongyloides stercoralis	218	13.99
Trichuris trichiura	184	11.81
Schistosoma mansoni	102	6.54
Entamoeba histolytica	36	2.31
TOTAL	**1333**	**85.55**

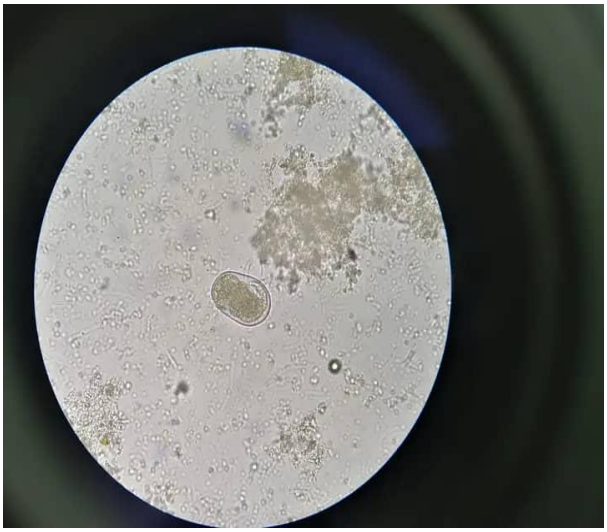

Plate 4.1: Fertile egg of *Ascaris lumbricoides* identified in a stool sample collected

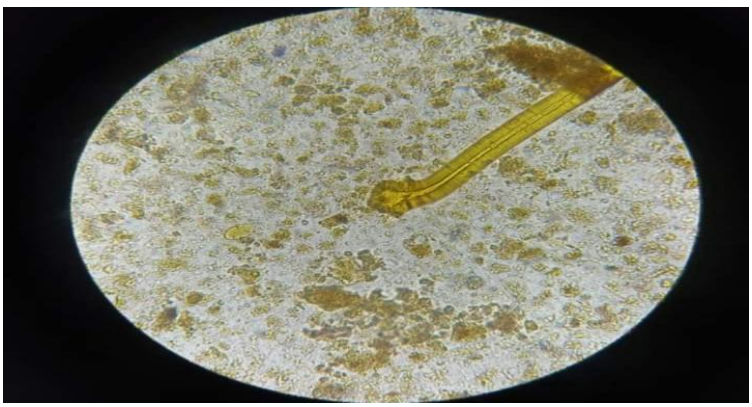

Plate 4.2: *Strongyloides stercoralis* seen in a stool sample

DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

BOOK OF PROCEEDINGS

IHCFS – 2025 WEBSITE: fos.fugusau.edu.ng



Plate 3: Egg of *Ascaris lumbricoides* (Upper) Egg of *Trichuris trichiura* (Lower)with prominent bipolar plugs identified in a stool sample.



Plate 4.4: Egg of Hookworm identified in a stool sample

Table 4.2: Prevalence of STHs in different LGAs of the Study Area

LGAs	No. Examined	No. Infected	Specific Prevalence (%)
Maru	160	153	95.62
Gummi	150	134	89.33
Gusau	291	258	88.65
T/Mafara	158	140	88.60
Zurmi	155	137	88.38
B/Magaji	141	117	82.97
Tsafe	201	164	81.59
Kaura	154	122	79.22
Bakura	148	108	72.97
Total	**1558**	**1333**	**85.55**
		χ^2= 41.377	**P value 0.001**

DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

BOOK OF PROCEEDINGS

IHCFS – 2025 WEBSITE: fos.fugusau.edu.ng

Table 4.3: Prevalence of STHs Infection in relation to toilet facilities in Schools

Toilet Facilities	No. Examined	No. Infected	Specific (%)	Prevalence
Pit larine	998	896	89.77	
Open Defecation	495	398	80.40	
Water System	65	39	60.0	
Total	**1558**	**1333**	**85.55**	
			χ^2= 5.049	**P value 0.168**

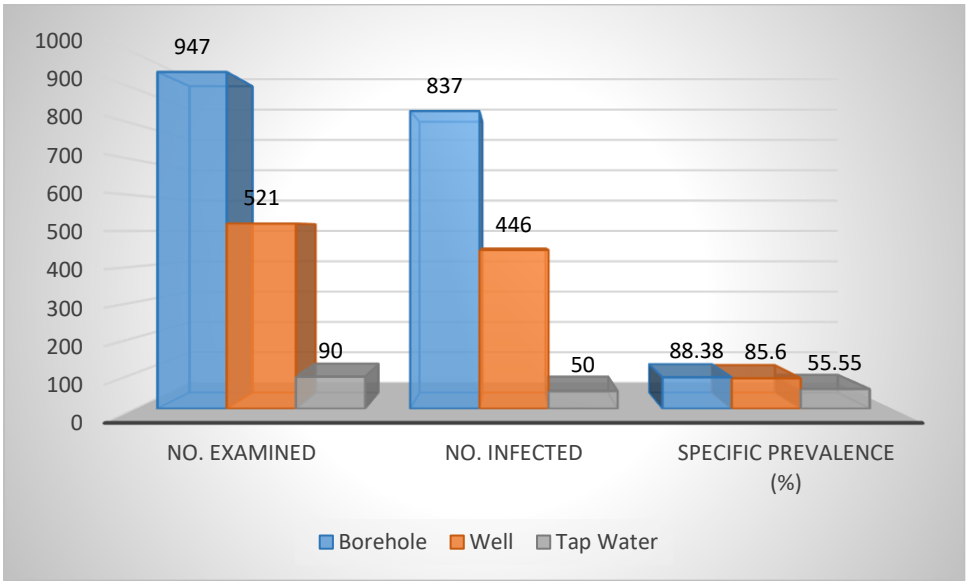

Figure 4.1: Prevalence of STHs Infection with Respect to Source of Drinking Water

Table 4.4 Prevalence of Soil-Transmitted Helminths (STHs) Infection based on Shoe wearing

Shoe Wearing	No. Examined	No. Infected	Specific (%)	Prevalence
Yes	1039	501	48.21	
Not Always	519	456	87.86	**(RR= 1.82, RR>1)**
Total	**1558**	**1333**	**85.55**	**χ^2= 85.317 P value 0.000**

Table 4.5 Prevalence of STHs Infection Based on Defecation Behaviour

Defecation Behaviour	No. Examined	No. Infected	Specific Prevalence (%)
Open Space	493	459	93.10
Pit latrine	970	828	85.36
Water System	95	46	48.42
Total	**1558**	**1333**	**85.55**

DOI: https://doi.org/10.57233/ihcfs.028

ISBN: 978-978-68-07775

BOOK OF PROCEEDINGS

IHCFS – 2025 WEBSITE: fos.fugusau.edu.ng

χ^2= 85.317 P value 0.045

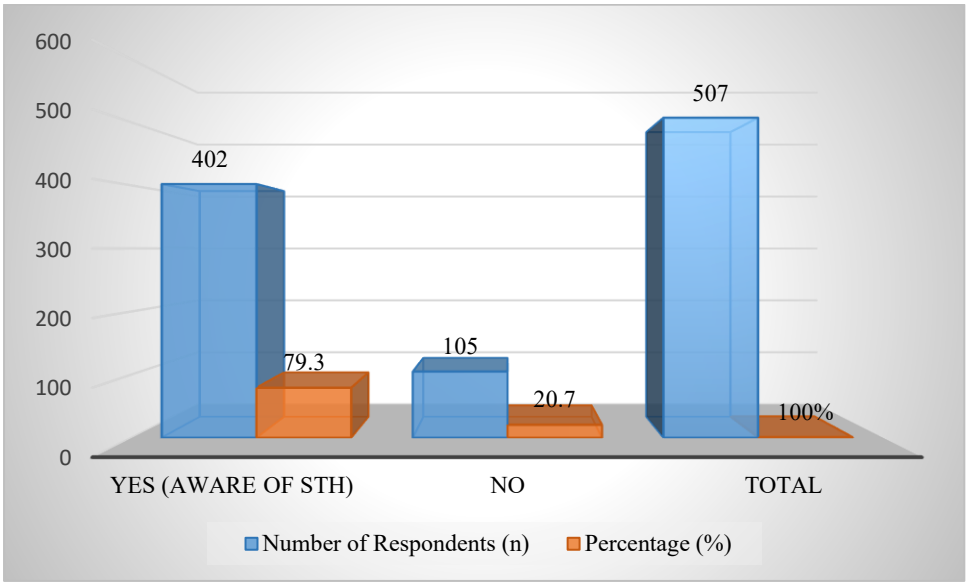

Figure 4.2: Community Awareness of Soil-Transmitted Helminths Infection in Zamfara State

Table 4.6: Community Knowledge of Transmission Routes of Soil-Transmitted Helminths (STHs) in Zamfara State

Transmission Route	Number of Respondents (n)	Percentage (%)
Contact with contaminated soil	170	33.53
Eating unwashed fruits/vegetables	150	29.58
Eating sweetie fruits (e.g., bananas)	73	14.39
Respondents who said "Don't know"	50	9.89
Drinking Contaminated water	34	6.70
Worms exist naturally in the body	20	3.94
Walking barefoot	10	1.97
Total	**507**	**100.0**

5.0 DISCUSSION

The high overall prevalence of STH infections (85.6%) highlights a significant public health burden among school-aged children in Zamfara State. *Ascaris lumbricoides* was the most prevalent species, consistent with its ecological resilience, high reproductive potential, and ability to survive under warm, moist conditions (Steverding, 2020; Chen *et al.*, 2021; Amisu *et al*., 2023). Hookworm and other STH infections were influenced by direct contact with contaminated soil and inadequate protective footwear, reflecting the impact of behavioural risk factors.

Variation in prevalence across LGAs, with the highest in Maru and lowest in Bakura, suggests that local sanitation, population

density, environmental contamination, and access to deworming programs significantly affect transmission. These patterns are consistent with studies from other Nigerian states, including Benue, Kogi, and Akwa Ibom, where differences in WASH conditions and socio-environmental factors drive inter-regional variability (Njoba *et al*., 2022; Anunobi *et al.,* 2019; Udoidung *et al*., 2021). While tap water use and improved toilet facilities were associated with lower infection rates, these differences were not statistically significant, indicating that hygiene practices, environmental contamination, and behavioural factors likely play a more prominent role. Notably, shoe-wearing was strongly protective, underscoring the importance of behavioural interventions in addition to infrastructure improvements. Moderate community awareness and limited knowledge of STH symptoms suggest that health education is critical to enhance participation in preventive programs, including mass deworming.

Overall, these findings emphasize the need for integrated control strategies combining regular deworming, improved WASH infrastructure, and targeted behavioural interventions, particularly promoting handwashing and consistent shoe-wearing, to effectively reduce STH transmission in endemic communities.

REFERENCES

Akinsanya, B., Taiwo, A., Adedamola, M., & Okonofua, C. (2021). An investigation on the epidemiology and risk factors associated with soil-transmitted helminth infections in Ijebu East Local Government Area, Ogun State, Nigeria. *Scientific African*, ***12***, e00757.

Akinyele, T. O., & Odugbemi, B. O**.** (2024). Risk factors and control strategies for soil-transmitted helminths in Apojola, Ogun State, Nigeria. *BMC Infectious Diseases,* ***24***(1), Article 10175.

Amisu, B. O., Okesanya, O. J., Olaleke, N. O., Ologun, C. O., Lucero-Prisno, D. E., Ogunwale, V. O., ... & Mewara, A. (2023). Socio-environmental determinants of parasitic intestinal infections among children: a cross-sectional study in Nigeria. *Journal of Global Health Science*, ***5***(1).

Anunobi, J. T., Okoye, I. C., Aguzie, I. O., Ndukwe, Y. E., & Okpasuo, O. J. (2019). Risk of soil-transmitted helminthiasis among Agrarian communities of Kogi State, Nigeria. *Annals of global health*, ***85***(1), 120

Chen, Y. D., Qian, M. B., Zhu, H. H., Zhou, C. H., Zhu, T. J., Huang, J. L., ... & Group on National Survey of Important Human Parasitic Diseases in China. (2021). Soil-transmitted helminthiasis in China: A national survey in 2014-2015. *PLoS neglected tropical diseases*, ***15***(10), e0009710

Chindo, Z. U., Pukuma, M. S., Qadeer, M. A., Enock, N., & Augustine, L. M. (2025). Parents/Caregivers Of Children's Aged Under Five Knowledge, Attitudes And Practices Towards Soil Transmitted Helminths in Taraba State, Nigeria. *Fudma Journal of Sciences*, ***9***(1), 122-127.

Dery, F., Bisung, E., Dickin, S., & Dyer, M. (2020). Understanding empowerment in water, sanitation, and hygiene (WASH): a scoping review. *Journal of Water, Sanitation and Hygiene for Development*, ***10***(1), 5-15.

Else, K. J., Keiser, J., Holland, C. V., Grencis, R. K., Sattelle, D. B., Fujiwara, R. T., & Cooper, P. J. (2020). Whipworm and roundworm infections. *Nature reviews Disease primers*, *6*(1), 44.

Federal Ministry of Health, Nigeria. (2021). National guidelines for the prevention and control of iron-deficiency anaemia and periodic deworming programme in Nigeria.

Idowu, O. B., Adeoye, B. A., & Oladejo, S. O. (2022). Soil-transmitted helminth infections among under-five children in urban and rural communities of Ogun State, Nigeria: Influence of water source and hygiene practices. *African Journal of Infectious Diseases*, **16**(1), 45–53.

Imalele, E. E., Braide, E. I., Emanghe, U. E., Effanga, E. O., & Usang, A. U. (2023). Soil-transmitted helminth infection among school-age children in Ogoja, Nigeria: implication for control. *Parasitology research*, *122*(4), 1015-1026.

Keiser, J. (2023). Present drugs and future perspectives in treating soil-transmitted helminthiasis. *Frontiers in Tropical Diseases*, *4*, 1282725.

Mohammed, K., Iduh, M. U., Sani, M., & Mohammed, Y. (2023).Detection of Soil-

transmitted Helminths and their Risk Factors in Some Local Government Primary Schools, Sokoto, Nigeria. *International Journal of Pathogen Research*, ***12***(2), 1-8.

Njoba, F. C., Ekejindu, I. M., Ezeagwuna, D. A., & Nnamani, C. P. (2022). Helminthic infections among primary school children in Gboko, Benue State, Nigeria. *Current Medicine Research and Practice*, ***12***(1), 13-19.

Noor, Z., Hossain, B., Khan, S. S., Kabir, M., Bhuiyan, A. T. M. R. H., Alam, M. S & Haque, R. (2023). Prevalence of soil-transmitted helminths at baseline and after albendazole treatment in the school-age children of forcibly displaced Myanmar nationals in Bangladesh. *The American Journal of Tropical Medicine and Hygiene*, *109*(3), 656.

Ojo, O. I. (2023). *Assessment of Intestinal Parasites on Selected Fruits and Vegetables Sold in Major Markets in Ilorin, Kwara State, Nigeria* (Master's thesis, Kwara State University (Nigeria).

Okoyo, C., Campbell, S. J., Williams, K., Simiyu, E., Owaga, C., & Mwandawiro, C. (2020). Prevalence, intensity and associated risk factors of soil-transmitted helminth and schistosome infections in Kenya: Impact assessment after five rounds of mass drug administration in Kenya. *PLoS neglected tropical diseases*, ***14***(10), e0008604.

Schlosser-Brandenburg, J., Midha, A., Mugo, R. M., Ndombi, E. M., Gachara, G., Njomo, D., ... & Hartmann, S. (2023). Infection with soil-transmitted helminths and their impact on coinfections. *Frontiers in Parasitology*, ***2***, 1197956.

Steverding, D. (2020). The spreading of parasites by human migratory activities. *Virulence*, ***11***(1), 1177-1191.

Tobon Ramos, J. A., Berto, C. G., & Coyle, C. (2021). Soil-Transmitted Helminthiasis. In *Neglected Tropical Diseases-North America* (pp. 1-16). Cham: Springer International Publishing.

Udoidung, N. I., Opara, K. N., Yaro, C. A., Okon, H. A., Sampson, S. O., Okoro, P. O., & Ekpo, E. E. (2021). *Epidemiology of co-infection of soil-transmitted helminths and Plasmodium falciparum in school children of Okorombokho, Eastern Obolo Local Government Area, Akwa Ibom State. World Journal of Applied Science and Technology, 13*(2), 191–200.

Ugbomeh, A.P., Okoro, M., & Nwankwo, C.C. (2022). *Assessment of parasitic contamination of vegetables in urban markets*. *Journal of Environmental Health Research,* **22**(1), 55–63.

UNICEF. (2024). *84% of children in Sokoto, Zamfara, Kebbi are poor — UNICEF*. Tribune Online. Retrieved from https://tribuneonlineng.com/84-of-children-in-sokoto-zamfara-kebbi-are-poor-unicef/

Weinstock, J. V., & Leung, J. (2022). Parasitic diseases: Helminths. In *Yamada's textbook of gastroenterology* (6th ed., pp. 3039–3078).

WHO (2022). Guidelines on sanitation and health. *Geneva*: World Health Organization.

World Health Organization (WHO). (2020). *Soil-transmitted helminth infections: Key facts.* Retrieved from https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections

World Health Organization (WHO). (2023). *Soil-transmitted helminth infections: Prevention and control*. Retrieved from https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections