Studies on The Epidemiology of Soil Transmitted Helminths and Nutritional Status Among Children Aged 1-4 in Yabo District, Sokoto State North Western Nigeria

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Abstract
This study investigated the prevalence of soil-transmitted helminthiasis and the nutritional status of children in Yabo District, Sokoto State, North-Western Nigeria. Specifically, the study examined the prevalence and distribution of soil-transmitted helminths, assessed the nutritional status of children, identified associated risk factors, and determined the patterns of infection according to age and gender. A descriptive cross-sectional research design was adopted. The study covered ten wards in Yabo District, with 49 samples collected from each ward. Data were obtained using structured questionnaires, stool sample examinations and anthropometric measurements. Stool samples were examined using the formol-ether concentration technique, while data were analysed using descriptive statistics and Chi-square tests with SPSS version 26.0. The findings revealed an overall soil-transmitted helminth infection prevalence of 56.94%. Ascaris lumbricoides was the most prevalent species (26.94%), followed by Trichuris trichiura (15.31%), hookworms (9.59%) and Strongyloides stercoralis (5.10%). Male children recorded a higher prevalence (59.39%) than females (55.02%), while children aged 21–30 months were the most affected. Ruggar Iya recorded the highest prevalence of infection. Significant associations were also established between infection and deworming practices, footwear usage, fingernail cleanliness and availability of toilet facilities.

Introduction

Soil-transmitted helminths (STHs), also referred to as geohelminths, are intestinal parasitic nematodes transmitted through contact with contaminated soil. They are classified as neglected tropical diseases (NTDs) and remain a major public health concern, particularly in low- and middle-income countries with poor sanitation and hygiene (WHO, 2023). Transmission occurs mainly through ingestion of infective eggs or penetration of infective larvae through the skin following contamination of soil with human faeces (Jourdan *et al.*, 2018; Ngwese *et al.*, 2021). The major species responsible for human infections include *Ascaris lumbricoides*, *Trichuris trichiura*, *Necator americanus*, *Ancylostoma duodenale*, and *Strongyloides stercoralis* (Hotez *et al.*, 2020). These parasites have a direct life cycle and do not require intermediate hosts. Infective

stages develop in warm and moist soil, conditions commonly found in tropical regions such as north-western Nigeria (WHO, 2022).

Globally, it is estimated that over 1.5 billion people are infected with soil-transmitted helminths, with children bearing the greatest burden of disease (WHO, 2023). STH infections contribute significantly to iron-deficiency anaemia, malnutrition, impaired physical growth, reduced cognitive development, and poor school performance (Bain *et al.,* 2019; Hotez *et al.,* 2020). Although mortality is relatively low, morbidity remains substantial and long-lasting.

In Nigeria, STH infections are endemic and closely associated with poverty, inadequate sanitation, unsafe water sources, and poor personal hygiene practices (Awasthi & Hotez, 2019; Bala *et al.,* 2019). School-aged children are particularly vulnerable due to frequent exposure to contaminated environments and inadequate hygiene awareness (WHO, 2022). Despite mass drug administration (MDA) programmes using albendazole and mebendazole, reinfection remains common because chemotherapy alone does not prevent re-exposure to contaminated soil (Campbell *et al.,* 2019; WHO, 2021). Therefore, understanding the epidemiology of STH infections alongside nutritional status is critical for designing sustainable control strategies. Nutritional status refers to the physical condition of an individual as influenced by the intake, absorption, and utilization of nutrients (WHO, 2022). Poor nutritional status, particularly under nutrition, remains a major public health challenge among children in developing countries and is strongly associated with parasitic infections, including soil-transmitted helminthiasis (Bain *et al.,* 2019). STH infections contribute to malnutrition through multiple mechanisms, including nutrient depletion, reduced appetite, intestinal blood loss, mal absorption, and increased metabolic demands (Awasthi & Hotez, 2019). Conversely, malnourished children are more susceptible to severe helminth infections, creating a vicious cycle of infection and under nutrition. The Mid-Upper Arm Circumference (MUAC) is a widely accepted anthropometric indicator used to assess acute malnutrition among children aged 6–59 months (WHO & UNICEF, 2023). MUAC is simple, rapid, cost-effective, and suitable for community-based field studies, particularly in rural settings. The health and socio-economic implications associated with STHs are enormous particularly in rural communities of the developing countries (Nigeria inclusive) where mal-nutrition and other factors influence the impacts of the infections (WHO, 2022; Ughava and Okon, 2016).

STHs are transmitted by contaminated soil, food and drinking water as a result of poor hygiene, habits like indiscriminate disposal of human and animal faeces (Bala *et al.,* 2019). They cause human infection through contact with their eggs or larvae that thrive in the warm and moist soils, particularly in the tropics. The STHs are acquired either by larvae burrowing through intact skin (*Strongyloides stercoralis,* the hookworms *Ancylostoma duodenale* and *Necator americanus*) or by the faecal oral route (*Ascaris lumbricoides* and *Trichuris trichiura*) (Bala *et al.,* 2019). The mature female worm STHs family produces 100,000–200,000 eggs per day. Eggs excreted in feces need a period of maturation in soil. Under good environment, of warm, moist soils, the embryo develops within the eggshell. The eggs need from 2 to several weeks in the soil for the development process into infective egg. The larvae that emerge from ingested eggs in the jejunum penetrate the intestinal wall and migrate through the hepatic venules to the right side of pulmonary circulation where they break into alveolar spaces and undergo further moults. From the alveoli, the 1.5 mm long larvae ascend to the trachea, and are swallowed, undergo a last moult in the intestine, and develop to adults. From the ingestion of infective eggs to the production of eggs by mature adult worms, takes about 8–12 weeks. The adult worm has a life span of about 1-2 years (Hotez *et al.,* 2019). The presence or absence of sanitary facilities at

home had been established as a strong determinant of the prevalence of gastro-intestinal parasites (De Silva, 2012; Abossie and Seid, 2014; Mathewos *et al.*, 2014). The STHs are often clinically asymptomatic and neglected until serious complications or chronic clinical features appear, however, they can be associated with eosinophilia and/or prolonged gastrointestinal symptoms (Schulte *et al.*, 2002; Gill *et al.*, 2004; O'Brien *et al.*, 2006; Becker *et al.*, 2011; Naidu *et al.*, 2013; Calderaro *et al.*, 2014). There could be single or multiple infections of these parasites. Children of school age and immuno-deficient (immuno-compromised or immuno-suppressed) individuals are particularly vulnerable to these infections, with heavy infections associated with cognitive impairment, iron-deficiency anaemia, growth retardation, mal-absorption, and mal-nourishment (Teklemariam *et al.*, 2014). They also cause different levels of tissue damage and ill-health to humans, but they rarely cause death (Stephenson *et al.*, 2000; Stoltzfus *et al.*, 2004). In addition to their health effects, they also impair physical and mental growth of children, educational achievement, and hinder economic development (Drake *et al.*, 2000; Guyatt, 2000). Also Transmission of STHs to humans occurs by the ingestion of the embryonated eggs which release larvae that burrow into the colonic epithelia when reaching the cecum where they develop into adult worms. The anterior portion of the adult parasite becomes embedded in epithelial tunnels it creates by secreting pore forming proteins (Drake et al., 2003), Inflammation at the site of attachment results both from disruption of the normal colonic texture as well as macrophages and proinflammatory cytokines in the lamina propria (MacDonald et al., 1994). The adult life span of Trichuris worm is 1-2 years, and the development time to the infective egg is 20-100 days. While the development period from ingested egg to adult worm takes about 8-12 weeks. The pathology and clinical manifestations of STH infections differ according to the species. Moreover, the clinical manifestations of STH infections are proportional to the intensity of infection. The clinical features of STH infections are classified into the acute sign and symptoms associated with early larval migration through the skin and viscera, and the chronic symptoms resulting from parasitism of the gastrointestinal tract by the adult worms.

Epidemiological surveys have demonstrated that poor sanitary conditions such as defecation and fecal contamination of water bodies are the most important factors leading to STHs worm infestation. The spread is due to personal hygiene. Nigeria is endemic for helminthes infections, in which *Ascariasis*, *trichuriasis*, and hookworm were incriminated as the major cause, with estimated cases of 55 million, 34 million, and 38 million, respectively.

The soil-transmitted helminthes are one of the world's most important causes of physical and intellectual growth retardation. Yet, despite their educational, economic, and public-health importance, they remain largely neglected by the medical and international community. Even with low cost of treatment, many developing countries have not mobilized resources and institutions to achieve a high coverage rate of deworming (WHO, 2020). For instance, WHO report showed that Bangladesh, India, Indonesia, and Thailand all had national coverage of treatment for school-age children below 25%, with coverage in Thailand lower than 1% WHO (2020). It is estimated that at least one third of the world's population is chronically affected by STHs and the prevalence of infections varies from one country to another and sometimes from one area to another in the same country (WHO, 2021). Significant associations of STH infections with malnutrition, poor cognitive and educational performance have been reported in several previous studies especially among children in rural areas of under developed countries (Nigeria inclusive), (Ahmed *et al.*, 2012; Al-Mekhlafi *et al.*, 2005a; Dreyfuss *et al.*, 2000). Soil-transmitted helminth infections can lead to malnutrition by depleting the host's nutrients or impairing nutrient absorption (Bain *et al.*, 2013). According to the Nigeria Demographic and

Health Survey (NDHS) 2008, 23% of children aged 6–59 months were underweight, 40.6% were stunted, and 13.9% were wasted. A decade later, the NDHS 2018 reported that 22% of children in the same age group were underweight, 37% were stunted, and 7% were wasted (Osaro BO *et al.,* 2023). The prevention, treatment and control of these parasites are mainly by mass drug distribution. However, chemotherapy alone does not solve the problems, and the role of other measures such as sanitation and health education should also be considered. The success or failure of control measures may depend mainly on man's behavioral attitude and practices. Therefore, the participation of the community in active programme directed towards the improvement of their health and standard of living is of significant importance (WHO, 2021).

A single dose of albendazole tablets twice a year is the recommended regimen for mass drug administration (WHO, 2020). However, main challenges to this strategy are that chemotherapy does not kill immature worms and cannot prevent the re-infection which can occur soon after treatment (Campbell *et al.,* 2019; Jia *et al.,* 2018).

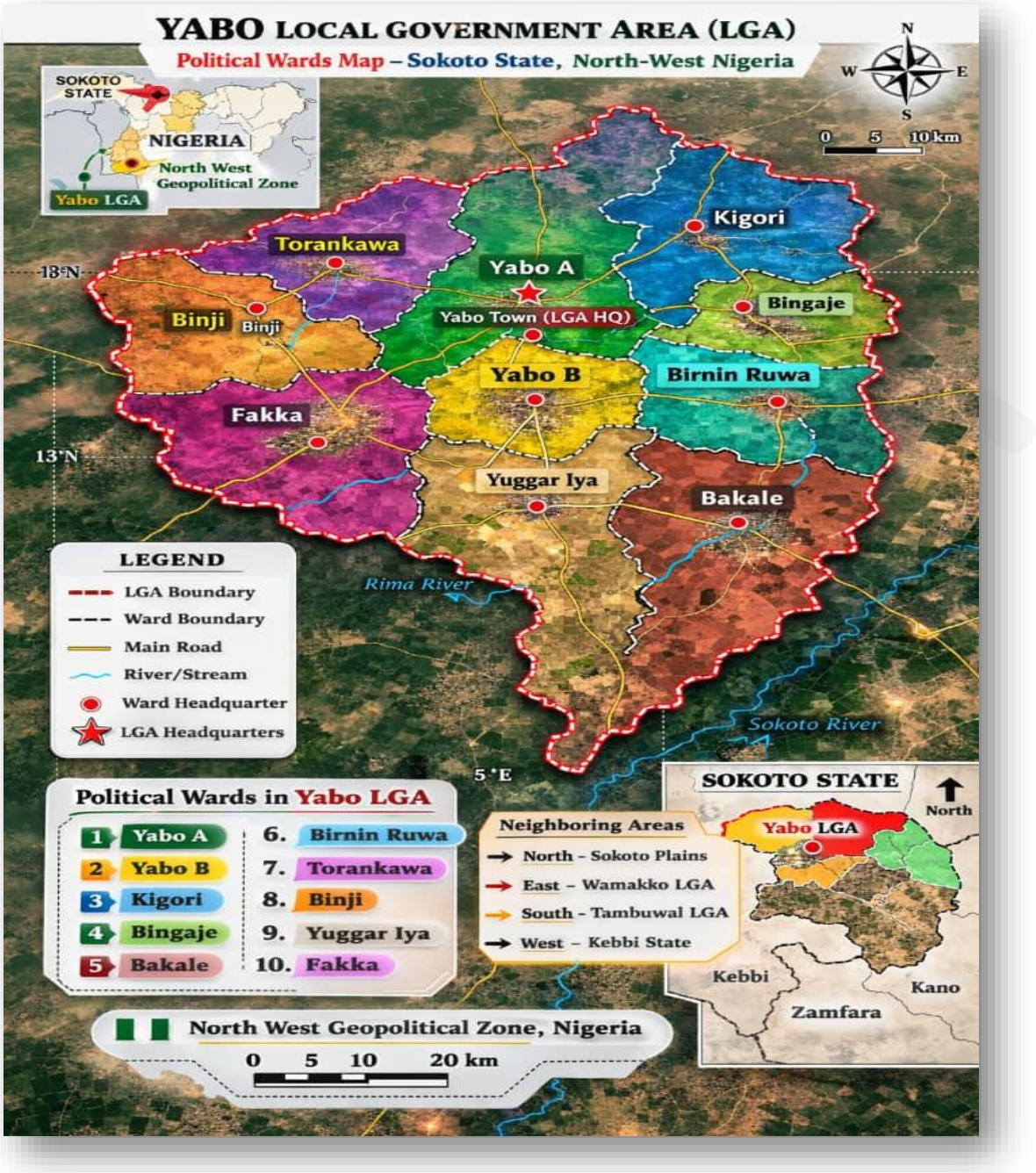
Some studies on intestinal helminthic infections were carried out in Sokoto State but there is dearth of information about the infections among orphanages and Almajiri schools in the study area. Most of the studies in Sokoto State were either conducted among the school-age children (Ibrahim *et al.,* 2000; Singh and Idris, 2014; Muhammad *et al.,* 2018; Bala *et al.,* 2019), among the Almajiris (Iduh *et al.,* 2015), or among the infantile geo-helminth infections (Isyaku *et al.,* 2015). Bala *et al.* (2019) worked on prevalence and risk factors of soil-transmitted helminthiasis among students of Government Day Secondary School Gidan Igwe Area, Sokoto State, Nigeria and reported a total prevalence of 60.00%; Muhammad *et al.* (2018) worked on the correlation of nutritional status and prevalence of intestinal helminthiasis among primary school pupils in Wamakko Local Government, Sokoto State, Nigeria and reported a total prevalence of 33.50%; Singh and Idris (2014) worked on prevalence of soil transmitted helminths among boarding school children in Sokoto, Nigeria and reported a total prevalence of 74.00%; Ibrahim *et al.* (2000) worked on intestinal helminthic infestations among primary school children in Sokoto and reported a total prevalence of 74.80%; Iduh *et al.* (2015) worked on prevalence of intestinal parasites among the "Almajiris" in Sokoto Metropolis, Sokoto Nigeria and reported a total prevalence of 74.50%; Isyaku *et al.* (2015) worked on status and risk factors associated with infantile geo-helminth infections in Sokoto State, Nigeria and reported a total prevalence of 1.40%, respectively.

Methodology

The Study Area

The study was conducted in Yabo Local Government Area. Yabo is located in the semi-arid region of Sokoto State, with a tropical climate characterized by high temperatures ranging from 38°C to 42°C between March and May. The area lies at longitude and latitude coordinates of 12°43'51.6"N (12.6476700°N) and 5°04'18.4"E (5.0717800°E). Rainfall in the area is generally scanty, commencing late in April and ending early in September (FOH, 2005). Yabo experiences a typical savanna climate with distinct wet and dry seasons lasting approximately six months each. Yabo Local Government Area consists of several districts and communities, including Kilgori, Binji, Bakale, Bingaje, Birnin Ruwa, Fakka, Ruggar Iya, Yabo I, Yabo II, and Torankawa. The headquarters of the Local Government Area is located in Yabo town. Historically, Yabo is among the oldest Local Government Areas in Sokoto State, dating back to the period when Kebbi State and Zamfara State were part of the old Sokoto Province. During that period, Yabo, Tambuwal, and Shagari areas were collectively referred to as Yabo.

The Local Government Area shares boundaries with Tambuwal, Wamakko, Shagari, Bodinga, and Silame Local Government Areas. Yabo covers a land area of approximately 789 km² and had a population of 115,302 according to the National Population Commission census (NPC/FRN, 2007), projected to about 144,020 by 2013 using an annual exponential growth rate of 2.78%. The inhabitants of the area are predominantly Hausas and Fulanis, and Islam is the major religion practiced in the area (NPC/FRN, 2007; WHS, 2006).



Source: Arc GIS Lab. Department of Geography UDUS 2017(artificially enhanced for better visualization)

Sample Size Determination

The sample size was determined based on 95% confidence limits and 5% sampling errors using the following formula (Trushfield, 2005). The sample size was calculated using the formula for cross sectional survey,

$N= [Z^2 -P (Q)] / D^2$

N= Number of sample size

Z= Standard normal deviation at 95% confidence interval 1.96 (confidence interval)

P = Prevalence from previous study in the area (Bala *et al.*2019.) (No=620, 60.2%) = 0.620

D = Degree of confidence at 0.05

Q= 1-P= 1- 0.620 = 0.380

Q = 0.380

N= 3.8416 – 0.62 (0.38) /0.0025

N= 3.2326(0.38)/0.0025

N= 1.228388/0.0025

N = 490.3552 = 490.

3.3. Study Design

Kilgori, Binji, Torankawa, and other nearby villages make up the Yabo District, where the research was carried out. A total of 490 subjects were given questionnaires and 490 stool samples were taken. The study used a cross-sectional study design to examine the district's children's nutritional status and soil-transmitted helminthiasis.

Community sensitization was carried out prior to data collection with the assistance of staff from the Primary Health Care (PHC) personals within the study area. Household sampling was performed through random selection of houses within the communities. From each selected household, a maximum of three or a minimum of one eligible child aged 1–4 years was recruited into the study following parental consent. Parents or caregivers of eligible children were provided with sterile stool containers and applicator sticks and were educated on proper stool sample collection procedures on the day of the visit. Stool samples were taken from each participant and sent to a central site, often the home of the village leader (Hakimi or ward leader). A systematic questionnaire was used to interview parents or caregivers whose children gave sufficient stool specimens, and the children's nutritional status was evaluated at the same site. The questionnaire was used to record details about each child's age and gender, family cleanliness, and personal hygiene habits. On the day of collection, every stool sample was analyzed at the research area's central health institution.

Population Sampling

The study was carried out among children in Yabo district, which involve under aged male and female children of 12- 48 months or 1- 4 years old and were randomly selected in the study area. A total number of 261 male and 229 females were captured in this study.

Methods of Data Collection

In order to evaluate the nutritional status and the main sociodemographic risk factors for human helminths among children in the research region, questionnaires were created and printed.

Administration of Questionnaires

Details about the subject's age, gender, and sociodemographic characteristics, such as where they get their drinking water from (protected or unprotected), how they handle water, whether or not their home has latrines, what kind of latrines they use, whether they wash their fruits or vegetables before eating, whether they eat raw vegetables, the condition of their fingernails, and whether they swim A systematic questionnaire that was pre-tested outside the research region was used to collect data on the study participants' nutritional condition, interaction with animals, shoe wearing habits, and environmental cleanliness. The team members translated the English-language questionnaire into the native tongue. In this case, the guardians or caregivers of the research participants were interviewed since they were too young to complete the questionnaire. All of them were carried out with the Head of Ward's (Hakimi) approval. Following the collection of the stool sample container, questionnaires were distributed in the research region. The feces sample container's serial numbers were kept the same.

Inclusion and Exclusion Criteria

Any ward participants who satisfied the requirements and willingly consented to provide informed permission for sample collection were included in the research. However, even with the interpretation and assistance of their guardians or caregivers, individuals from the wards who refused to grant informed permission for sample collection and who would not be able to provide correct answers during questionnaire administration were omitted.

Stool Sample Collection

A period of two to three days was used for community visitation and sensitization activities. The first day was dedicated to visitation and awareness creation among the ward heads (Hakimi) and parents or guardians of the study participants. During this visit, questionnaires and stool sample containers were distributed to the respective parents or caregivers in each ward to enable proper preparation for stool collection and questionnaire administration scheduled for the following day. Stool samples were collected and, if needed, questionnaires were given out on the third day. Every parent or guardian of the research participants received instruction on how to properly collect their children's feces samples in the early morning (Bala et al., 2019).

On the second and third days, the research team visited the wards early in the morning to collect stool samples, administer questionnaires, and assess the nutritional status of the children accordingly. All collected stool samples were properly labelled and arranged serially in containers before being transported to the diagnostic Centre at the Local Government health facility for laboratory examination on the same day of collection after each ward visitation within the district.

Determination of Nutritional Status of Children

Mid-Upper-Arm Circumference Tape (MUAC TAPE): The Mid-Upper Arm Circumference (MUAC) tape, also called the Shakir tape, was used to measure the children's nutritional status. Each research participant's mid-upper arm circumference was measured using the MUAC tape at the midway of their left arm's shoulder and elbow. A quick, easy, and accurate anthropometric test called MUAC is used to detect malnutrition in children between the ages of six months and five years who are more likely to experience morbidity and death. The measurement involves wrapping a colour-coded measuring tape around the child’s left upper arm to determine nutritional status. Children whose arm circumference measurements fell within the red or yellow

zones on the coloured tape were classified as having severe acute malnutrition and moderate malnutrition, respectively, while measurements within the green zone indicated a normal nutritional status.

3.9.1 Measuring MUAC Procedure

Mid-Upper Arm Circumference (MUAC) screening can be carried out on individuals older than six months of age and is commonly applied to children aged 6–59 months (six months to five years). In this study, MUAC measurement was conducted among children within this age range, particularly those who appeared sick, thin, or weak. Before the measurement was taken, the procedure was carefully explained to the child's mother or caregiver to ensure understanding and cooperation. The child's left upper arm was exposed by removing any clothing covering the arm or by rolling the sleeve up to the shoulder. The child was then positioned standing upright and sideways to the measurer. The midpoint of the upper arm was identified as the distance between the tip of the shoulder (acromion) and the elbow (olecranon), and this point was marked using a pen. The child was asked to relax the arm so that it hung naturally by the side of the body. The MUAC tape was positioned at the marked midpoint, placing the zero mark (0 cm) against the arm. While one hand held the tape steady, the other hand wrapped the tape around the arm and passed it through the opening in the tape. The tape was gently tightened until it fitted securely around the arm without compressing the soft tissues. The measurement was then read at the indicator window of the MUAC tape and recorded to the nearest centimetre.

The recorded measurement corresponded to colour-coded nutritional categories on the MUAC tape. Measurements falling within the red zone (5.5–11.5 cm) indicated severe acute malnutrition, while measurements within the yellow zone (11.6–12.5 cm) indicated moderate malnutrition. Measurements within the green zone (12.6–21 cm) represented normal nutritional status, whereas values above this range suggested overweight or obesity (ECT, 2023).

Laboratory Analysis of Stool Sample

According to WHO (2008), National Committee for Clinical Laboratory Standard (2018), Cheesbrough (2000), Arora and Arora (2005), Oyeyipo et al. (2013), and Demeke et al. (2021), the Formalin-Ether Concentration Technique (FECT) standard operating procedure was used to find the eggs/ova or larvae of the STHs in the fecal samples. A stool sample weighing around 1.0 g was suspended in 10 milliliters of a 10% formaldehyde solution and combined with an applicator stick. To eliminate debris, the suspension was transferred into a larger tube via a gauge-covered funnel. After measuring out around 3 milliliters of ether solution (diethyl ether), the tube was filled and sealed. After giving the suspension a good shake, the mixture was put into a 15 ml conical centrifuge tube and centrifuged for three minutes at 2000 rpm. The distinctive layer in the centrifuge tube was removed using an applicator stick. To get rid of the contents that left the sediments, the tube was swiftly and carefully reversed. Using a microscope set to 10× and 40× objectives, the sediments were then inspected for the presence of intestinal helminths ova by placing a drop on a clean, grease-free glass slide covered with a cover slip (Taiwo et al., 2017; Demeke et al., 2021).

Data Analysis

After entering all of the collected data into a spreadsheet using Microsoft Excel 2013, SPSS (Statistical Package for the Social Sciences) version 26.0 was used to do statistical analysis. Chi-square (X2) tests and a simple distribution of the research variables were used; $P < 0.05$ was deemed statistically significant.

Using the formula (Number Infected/Number Examined) × 100, the prevalence of the STHs was determined and reported as a percentage. The formula: total number of individuals of a certain parasite species in a sample of a host species / number of infected individuals of the host species in the sample was used to determine mean intensity (Nnatuanya et al., 2023).

The correlation between the risk variables for infection and the prevalence of infection across all wards was examined using the Chi-square (X2) test. The relationship between the wards, the individuals' age and gender, and the prevalence of infection was ascertained using the odds ratio (OR).

Results

Prevalence of Soil Transmitted Helminthes Species among the Total Communities of Yabo District

The frequency of soil-transmitted helminth (STH) infections among 490 children assessed in 10 Yabo District wards is shown in Table 4.1 below. The findings showed that 279 children had at least one STH species infection, resulting in a 56.94% total frequency. The distribution of STH infections differed considerably amongst the wards under investigation, according to a Chi-square test ($\chi^2 = 70.75$, DF = 9, $p < 0.001$). This suggests that the incidence of STH infections was strongly correlated with the ward of residency and that the frequency of infection was not consistent across the district. Variations in ambient cleanliness, personal hygiene habits, availability to clean drinking water, socioeconomic circumstances, health education, and the execution of deworming programs across the wards might all be responsible for the observed disparities. Among the helminth species identified, *Ascaris lumbricoides* was the most prevalent parasite, infecting 132 (26.94%) children. This was followed by *Trichuris trichiura*, which infected 75 (15.31%) children, while hookworms (*Ancylostoma duodenale*/*Necator americanus*) were detected in 47 (9.59%) children. *Strongyloides stercoralis* was the least prevalent parasite, occurring in 25 (5.10%) children. The predominance of *A. lumbricoides* suggests that environmental contamination with infective eggs and poor sanitation may be important factors influencing transmission within the study area.

Marked variations in infection prevalence were observed among the wards. The highest overall prevalence was recorded in RGR IYA, where 44 of 50 children (88.00%) were infected. This was followed by FKK with 37 of 48 children (77.08%), BNJ and KLGR, each with 33 infected children (67.35%), and BNGJ with 32 infected children (64.00%). In contrast, the lowest prevalence was observed in YB B, where only 14 of 49 children (28.57%) were infected, followed by BRN RW with 15 of 48 children (31.25%) and YB A with 17 of 47 children (36.17%). With respect to individual parasite species, the highest prevalence of *A. lumbricoides* was observed in RGR IYA (40.00%), followed by KLGR (38.78%) and TRNKW (34.00%), whereas the lowest prevalence occurred in YB A (14.89%). For *T. trichiura*, the highest prevalence was recorded in RGR IYA (26.00%) and FKK (25.00%), while the lowest prevalence was observed in YB B (4.08%). Hookworm infections were most common in RGR IYA (18.00%), followed by FKK (16.67%) and BNJ (16.33%), whereas the lowest prevalence occurred in YB B (2.04%) and BRN RW (2.08%). The prevalence of *S. stercoralis* ranged from

0.00% in BRN RW to 8.33% in FKK, indicating relatively low occurrence throughout the study area.

Overall, the findings demonstrate that STH infections remain a major public health concern among children in Yabo District, with *A. lumbricoides* being the dominant parasite species. The significant variation in prevalence among wards highlights the need for targeted intervention strategies, particularly in highly affected wards such as RGR IYA, FKK, BNJ, KLGR, and BNGJ. Regular mass deworming, better sanitation facilities, clean water supply, and ongoing health education targeted at lowering exposure to infectious stages of the parasites are also suggested control approaches.

4.1 Prevalence of Soil Transmitted Helminthes Species among the Total Communities of Yabo District

Key: YB A = Yabo A; YB B = Yabo B; BKL= Bakale; BRN RW =Birnin ruwa; BNGJ=Bingaje; BNJ =Binji; FKK= Fakka; RGR IYA= Ruggar Iya; KLGR= Kilgori; TRNKW= Torankawa; N = Number Examined; % = Percentage; X^2 = Chi-Square; = 70.75, P-Value = 0.001 and df = 9

Wards	**No. Examined (N)**	***Ascaris lumbricoides* (%)**	***Trichuris trichiura* (%)**	**Hookworms (*Ancylostoma duodenale/ Necator americanus*) (%)**	***Strongyloidiasis stercoralis* (%)**	**Total Prevalence (%)**
YB A	47	07 (14.89)	04 (8.51)	03 (6.38)	03 (6.38)	17 (36.17)
YB B	49	08 (16.32)	02 (4.08)	01 (2.04)	03 (6.12)	14 (28.57)
BKL	50	10 (20.00)	08 (16.00)	04 (8.00)	04 (8.00)	26 (52.00)
BRN RW	48	11 (22.92)	03 (6.25)	01 (2.08)	00 (0.00)	15 (31.25)
BNGJ	50	15 (30.00)	10 (20.00)	05 (10.00)	02 (4.00)	32 (64.00)
BNJ	49	12 (24.49)	09 (18.35)	08 (16.33)	04 (8.16)	33 (67.34)
FKK	48	13 (27.08)	12 (25.00)	08 (16.67)	04 (8.33)	37 (77.08)
RGR IYA	50	20 (40.00)	13 (26.00)	09(18.00)	02 (4.00)	44 (88.00)
KLGR	49	19 (38.78)	08 (16.33)	04 (8.16)	02 (4.08)	33 (67.34)
TRNKW	50	17 (34.00)	06 (12.00)	04 (8.00)	01 (2.00)	28 (56.00)
Total	**490**	**132 (26.94)**	**75 (15.31)**	**47 (9.59)**	**25 (5.10)**	**279 (56.94)**

4.2 Prevalence of Soil Transmitted Helminthes in Relation to Gender among Children in Yabo District

Table 4.2 below reveals that, out of the 490 children examined across the study wards, 261 (53.27%) were males and 229 (46.73%) were females. 56.53% of people had helminth infections that were spread via the soil. Compared to female children (55.02%), male children had a slightly greater frequency of infection (57.85%).

With 28.35% of infections in men, Ascaris lumbricoides was the most common parasite, followed by Trichuris trichiura (15.33%), hookworms (10.73%), and Strongyloides stercoralis (3.45%). In a similar vein, the most common parasite among females was A. lumbricoides (25.33%), followed by hookworms (8.30%), T. trichiura (15.28%), and S. stercoralis (6.11%).

According to statistical research, male children were 1.12 times more likely than female children to be infected (OR = 1.12; 95% CI: 0.79–1.60). Nevertheless, there was no statistically

significant correlation between gender and STH infection ($\chi^2 = 0.42$, P = 0.52), suggesting that there was no significant difference in the incidence of infection between male and female children in the research region. Consequently, among the children studied, gender was not shown to be a major risk factor for soil-transmitted helminth infection.

Table 4.2.1 Overall prevalence of STHs in relation to gender

Gender	No. Examined	*A. lumbricoides* n (%)	*T. trichiura* n (%)	Hookworms (*A. duodenale/N. americanus*) n (%)	*S. stercoralis* n (%)	Total Infected n (%)
Male	261	74 (28.35)	40 (15.33)	28 (10.73)	9 (3.45)	151 (57.85)
Female	229	58 (25.33)	35 (15.28)	19 (8.30)	14 (6.11)	126 (55.02)
Total	**490**	**132 (26.94)**	**75 (15.31)**	**47 (9.59)**	**23 (4.69)**	**277 (56.53)**

Odds Ratio (Male vs. Female) = 1.12
95% Confidence Interval = 0.79–1.60
P-value = 0.52
Chi square = 0.42

Table 4.2.2 Chi-square Analysis for Overall STH Infection by Gender

Gender	Examined	Infected (%)	Uninfected (%)	OR (95% CI)	χ^2	P-value
Male	261	151 (57.85)	110 (42.15)	1.12 (0.79–1.60)	0.42	0.515
Female (Reference)	229	126 (55.02)	103 (44.98)	1.00		

4.3: Prevalence of Soil Transmitted Helminthes in relation to Age among Children in Yabo District

The distribution of soil-transmitted helminth (STH) infections in children by age group in Yabo District is shown in Table 4.3. Four age groups—12–20 months, 21–30 months, 31–40 months, and 41–50 months—were created from the examination of 490 children. Children between the ages of 12 and 20 months had the greatest overall frequency of STH infection, with 60 out of 97 children (61.86%) having at least one helminth species infection. Children between the ages of 21 and 30 months came in second, with 97 out of 161 children (60.25%) having the infection. The overall incidence for children aged 31–40 months was 50.79% (96/189), while the prevalence for children aged 41–50 months was 51.16% (22/43). Ascaris lumbricoides was the most common parasite species found in all age groups. Its frequency peaked in children between the ages of 12 and 20 months, when 30 children (30.93%) were infected. As children grew older, it progressively decreased, reaching 18.60% among those between the ages of 41 and 50 months.

This pattern implies that younger kids were more prone than older kids to get A. lumbricoides. The prevalence of *Trichuris trichiura* was also highest among children aged 12–20 months (19.59%) and decreased to 12.16% among those aged 31–40 months. However, a slight increase to 18.60% was observed in the 41–50 months age group. With prevalence rates of 9.27%, 9.94%, 8.47%, and 6.98% in the 12–20, 21–30, 31–40, and 41–50 months age categories, respectively, hookworm infections were also more prevalent in younger children. The least common helminth species found in the research population was Strongyloides stercoralis. Children between the ages of 21 and 30 months had the greatest incidence of this parasite (6.82%), while children between the ages of 12 and 20 months had the lowest frequency (2.06%).

Age and the prevalence of soil-transmitted helminth infections among the children under study were significantly correlated, according to statistical analysis ($\chi^2 = 14.27$, $p = 0.002$). The null hypothesis that age has no effect on STH infection was rejected since the p-value fell below the 0.05 threshold of significance. This result suggests that the risk of STH infection in children in Yabo District is significantly influenced by age.

Inadequate hand washing techniques, frequent playtime contact with contaminated dirt, poor personal hygiene, and greater exposure to infectious stages of the parasites might all contribute to the higher incidence seen in younger children. As children grow older, improved hygiene behavior, better parental supervision and the gradual development of immunity may contribute to the reduction in infection prevalence observed in some age groups.

Overall, the findings demonstrate that younger children, particularly those aged 12–30 months, constitute the most vulnerable group to soil-transmitted helminth infections in Yabo District and should therefore be prioritized in deworming, health education, and sanitation intervention programmes.

Table 4.3.1: Prevalence of Soil-Transmitted Helminths According to Age among Children in Yabo District overall summary

Age Group (Months)	No. Examined	A. lumbricoides n (%)	T. trichiura n (%)	Hookworm's n (%)	S. stercoralis n (%)	Total Infected n (%)
12–20	97	30 (30.93)	19 (19.59)	9 (9.27)	2 (2.06)	60 (61.86)
21–30	161	45 (27.95)	25 (15.53)	16 (9.94)	11 (6.82)	97 (60.25)
31–40	189	48 (25.39)	23 (12.16)	16 (8.47)	9 (4.76)	96 (50.79)
41–50	43	8 (18.60)	8 (18.60)	3 (6.98)	3 (6.98)	22 (51.16)
Total	**490**	**131 (26.73)**	**75 (15.31)**	**44 (8.98)**	**25 (5.10)**	**275 (56.12)**

Table 4.3.2 Overall statistical analysis for age group using 41-50 as reference group

Age Group (Months)	No. Examined	Total Infected n (%)	OR (95% CI)	χ^2	P-value
12–20	97	60 (61.86)	1.55 (1.12–2.87)		
21–30	161	97 (60.25)	1.43 (1.05–2.54)		
31–40	189	96 (50.79)	1.28 (0.94–2.20)		
41–50 (Ref.)	43	22 (51.16)	1.00	14.27	0.002

X2= 14.27
P value = 0.002

Table 4.3.3 Statistical Analysis base on Ward Format

Ward	OR (95% CI)	χ^2	P-value	Interpretation
YB A	1.12 (0.63–1.98)	11.42	0.008	Significant
YB B	0.73 (0.49–1.09)	5.86	0.120	Not Significant
BKL	0.85 (0.58–1.26)	9.12	0.029	Significant
BRN RW	0.74 (0.29–1.87)	9.58	0.023	Significant
BNGJ	1.31 (0.84–2.03)	9.74	0.021	Significant
BNJ	1.21 (0.82–2.03)	8.91	0.031	Significant
FKK	1.21 (0.82–2.03)	11.86	0.009	Significant
RGR IYA	1.68 (1.11–2.54)	14.27	0.002	Significant
KLGR	1.57 (1.08–2.29)	12.83	0.005	Significant
TRNKW	1.34 (0.91–1.99)	9.41	0.024	Significant

Table 4.4 Risk Factors that Significantly Contribute to the Transmission of Soil Transmitted Helminthes in the Study Area.

Chi-square (χ^2) statistics were used to analyze the association between several environmental, behavioral, and hygiene factors and soil-transmitted helminth (STH) infection among research participants. A confidence level of $p < 0.05$ was used to evaluate statistical significance.

Infection status and knowledge of soil-transmitted helminths were statistically substantially correlated ($\chi^2 = 0.003$, $p = 0.034$), suggesting that participants' or caregivers' awareness levels had a major impact on the incidence of infection. Similarly, a history of past STH infection diagnosis showed a significant correlation with infection status ($\chi^2 = 0.003$, $p = 0.039$), indicating that current infection patterns within the research group may be connected to prior exposure or diagnosis. Wearing shoes was substantially linked to STH infection ($\chi^2 = 0.002$, $p = 0.021$). Children who did not wear shoes on a regular basis were more likely to come into contact with polluted soil, which raised their risk of illness. In a similar vein, fingernail status demonstrated a statistically significant correlation with infection ($\chi^2 = 0.002$, $p = 0.022$), suggesting that untrimmed fingernails may promote transmission via ingestion of infectious eggs as a result of inadequate personal hygiene. Despite being near the significance level, there was no statistically significant correlation between hand washing before or after meals and infection ($\chi^2 = 0.003$, $p = 0.055$). On the other hand, hand washing after feces demonstrated a statistically significant correlation with infection status ($\chi^2 = 0.022$, $p = 0.032$), underscoring the significance of good hygiene practices in avoiding transmission.

Important correlations were also found in factors linked to sanitation. STH infection was substantially correlated with the kind of latrine or toilet facility utilized ($\chi^2 = 0.004$, $p = 0.049$), indicating that better sanitation infrastructure lowers the risk of infection. Similarly, there was a statistically significant correlation ($\chi^2 = 0.004$, $p = 0.044$) between the availability of latrines and toilet facilities and environmental pollution and increased exposure. Additionally, there was a significant correlation between latrine/toilet use patterns and infection ($\chi^2 = 0.002$, $p = 0.029$), indicating that inconsistent or non-use of accessible sanitation facilities increased susceptibility to infection. Open defecation behaviors were shown to be significantly associated with STH infection ($\chi^2 = 0.002$, $p = 0.024$), confirming that it is a major transmission mechanism in the research region. Children's infection prevalence may be influenced by the frequency or

consistency of anthelminthic therapy, as seen by the statistically significant correlation between deworming practices and infection status ($\chi^2 = 0.003$, $p = 0.033$). Furthermore, there was a significant correlation ($\chi^2 = 0.021$, $p = 0.034$) between contact with sewage or garbage and STH infection, suggesting a higher risk of exposure in polluted surroundings.

Overall, most behavioural and sanitation-related variables including awareness of STHs, history of diagnosis, shoe-wearing habits, fingernail status, hand washing after defecation, type and availability of latrine facilities, latrine usage, open defecation, deworming practices, and contact with refuse or sewage showed statistically significant associations with STH infection ($p < 0.05$). Only hand washing before or after meals did not show a statistically significant difference, although it approached significance

Table 4.4 Risk Factors that Significantly Contribute to the Transmission of Soil Transmitted Helminthes in the Study Area.

Variables	Categories	Frequency	Percentage (%)	X^2	P-Value
Awareness of STHs	Yes	98	98(24.50)	0.003	0.034
	No	392	392(98.00)		
History of diagnosis for STHs	Yes	100	100(25.00)	0.003	0.039
	No	390	390(97.50)		
Shoe Wearing Habits	Always	94	94(23.50)	0.002	0.021
	Sometimes	162	162(40.50)		
	Not at all	234	234(58.50)		
Status of Fingernails	Trimmed	191	191(47.75)	0.002	0.022
	Not trimmed	299	299(74.75)		
Hand Washing Before/After a Meal	Always	96	96(24.00)	0.003	0.055
	Sometimes	230	230(57.50)		
	Not at all	164	164(41.00)		
Hand Washing After Defecation	Always	103	103(25.75)	0.022	0.032
	Sometimes	216	216(54.00)		
	Not at all	171	171(42.75)		
Type of Latrine/Toilet	Water closet	48	48(12.00)	0.004	0.049
	Pit latrine	187	187(46.75)		
	Refuse dump	255	255(63.75)		
Latrine/Toilet Availability	Available	139	139(34.75)	0.004	0.044
	Not available	351	351(87.75)		
Latrine/Toilet Usage	Always	98	98(24.50)	0.002	0.029
	Sometimes	141	141(35.25)		
	Not at all	252	252(63.00)		
Open Defecation	Engaged	310	310(77.50)	0.002	0.024
	Not engaged	180	180(45.00)		
Taking Deworming	Monthly	68	68(17.00)	0.003	0.033
	Yearly	80	80(20.00)		
	Not at all	342	342(85.5)		
Contact with Refuse or Sewage	Yes	282	282(70.5)	0.021	0.034
	No	208	208(52.00)		

4.5 Nutritional Status of the Children in Yabo District.

In line with the results in table 4.5, 371 children in the study area are at normal condition with 75.7%, then 82 children were at moderate condition with 16.7% and 37 children were at severe condition with 7.6%. Also based on the results, the nutritional status of the children in the study area, children with green colour indicator is at normal condition (Green = Normal), while yellow are at moderate malnutrition (Yellow = Moderate) and Red colour children are under severe malnutrition (Red = Severe).

Table 4.5 Present Nutritional Statuses of the Children in Yabo District.

Nutritional status	Frequency	Percent (%)
Normal	371	75.7
Moderate	82	16.7
Severe	37	7.6
Total	**490**	**100**

KEY: Green = Normal, Yellow = moderate (MM), and Red = severe (SM)

Table 4.6 Present Nutritional Statuses based on Wards in Yabo District

The nutritional condition of children in the ten wards of Yabo District is shown in Table 4.6 using three categories: Red (severe malnutrition), Yellow (moderate malnutrition), and Green (normal nutritional status). The findings revealed that the majority of the children examined were within the Green category, with a total of 390 children out of 490 sampled. Bakale and Binji wards recorded the highest number of children with normal nutritional status, having 49 children each, while Fakka ward recorded the lowest with 26 children. In the Yellow category, which represents moderate malnutrition, a total of 69 children were identified. Fakka ward recorded the highest number with 20 children, followed by Bingaje with 13 children and Yabo A with 10 children. Binji ward recorded no child in the Yellow category. For the Red category, indicating severe malnutrition, a total of 31 children were affected across the district. Yabo A, Yabo B, and Torankawa recorded the highest number with 6 children each, while Bakale and Binji recorded no severe malnutrition cases. Overall, the table indicates that although most children in Yabo District maintained a healthy nutritional status, some wards, particularly Fakka, Yabo A, Yabo B, and Torankawa, showed relatively higher levels of malnutrition and may require targeted nutritional intervention program

Table 4.6 Present Nutritional Statuses based on Wards in Yabo District

Nutritional Status	Yabo A	Yabo B	Birnin Ruwa	Bakale	Binji	Kilgori	Ruggar Iya	Fakka	Torankawa	Bingaje	Total
Green	31	36	46	49	49	42	45	26	34	32	**390**
Yellow	10	7	1	1	0	5	2	20	10	13	**69**
Red	6	6	1	0	0	2	3	2	6	5	**31**
Total	**47**	**49**	**48**	**50**	**49**	**49**	**50**	**48**	**50**	**50**	**490**

Table 4.7 Relationship between Soil-Transmitted Helminth Infection and Nutritional Status among Children in the Study Area

Table 4.7 Relationship between Soil-Transmitted Helminth Infection and Nutritional Status among Children in the Study Area

Ward	No. examined	No. Infected (%)	Green (Normal)	Yellow (Moderate Malnutrition)	Red (Severe Malnutrition)	Total Malnourished	Observation
Yabo A	47	17 (36.17)	33	10	6	16	Moderate infection with relatively high malnutrition level.
Yabo B	49	14 (28.57)	36	7	6	13	Lower infection but notable severe malnutrition cases.
B/ Ruwa	48	15 (31.25)	47	1	1	2	Low malnutrition and relatively low infection prevalence.
Bakale	50	26 (52.00)	49	0	0	0	Moderate infection despite absence of malnutrition.
Binji	49	33 (67.34)	49	0	0	0	High infection but all children nutritionally normal.
Kilgori	49	33 (67.34)	42	5	2	7	High infection with moderate malnutrition
Ruggar Iya	50	44 (88.00)	45	2	2	4	Highest infection but relatively few malnourished.
Fakka	48	37 (77.08)	26	20	3	23	High infection with the highest malnutrition burden.
Torankawa	50	28 (56.00)	33	10	6	16	Moderate to high infection with high malnutrition.
Bingaje	50	32 (64.00)	32	12	5	17	High infection associated with increased malnutrition.
Total	**490**	**279 (56.94)**	**392**	**67**	**31**	**98**	**Evidence of relationship**

Table 4.7: The association between nutritional status and soil-transmitted helminth (STH) infections in children in Yabo District showed significant epidemiological trends in all of the wards examined. A MUAC evaluation revealed that 98 (20.00%) of the 490 children evaluated were malnourished, and 279 (56.94%) had one or more types of soil-transmitted helminth infections. Among the malnourished children, 67 (13.67%) were moderately malnourished (yellow MUAC category), whereas 31 (6.33%) were severely malnourished (red MUAC category).

Wards with High Infection and High Malnutrition

Fakka ward demonstrated the clearest relationship between helminth infection and poor nutritional status. The ward recorded a very high infection prevalence of 77.08% alongside the

highest number of malnourished children (23 cases). Of these, 20 children were moderately malnourished and 3 were severely malnourished. This finding suggests that persistent exposure to helminth infections may contribute significantly to nutritional deficiencies among children within the ward. Similarly, Bingaje ward recorded 64.00% infection prevalence together with 17 malnourished children, including 12 moderately malnourished and 5 severely malnourished cases. Torankawa also showed a similar trend, with 56.00% infection prevalence and 16 malnourished children. These findings indicate that children living in wards with high prevalence of STH infections tend to experience poorer nutritional outcomes, likely due to chronic nutrient depletion, intestinal blood loss, reduced appetite, malabsorption of nutrients, and increased metabolic demands caused by helminth infections.

Wards with High Infection but Lower Malnutrition

Interestingly, Ruggar Iya recorded the highest infection prevalence of 88.00%, yet only 4 children were malnourished. Likewise, Binji recorded high infection prevalence of 67.34% without any recorded malnutrition cases.

This observation suggests that although helminth infections may contribute to malnutrition, other factors such as dietary intake, parental care, socio-economic status, food availability, healthcare access, and environmental sanitation may also play significant roles in determining the nutritional status of children.

Wards with Lower Infection and Better Nutritional Status

Birnin Ruwa ward recorded relatively low infection prevalence (31.25%) and only 2 malnourished children, while Yabo B recorded the lowest infection prevalence of 28.57% with comparatively fewer malnourished children than some other wards.

The relatively lower prevalence of infection and malnutrition in these wards may reflect better hygiene practices, improved sanitation, cleaner water supply, or better nutritional care among caregivers.

Overall Relationship

Overall, the results of the research show that malnourished children were more common in wards where soil-transmitted helminth infections were more common. This lends credence to the theory that STH infections affect children's nutritional health.

Helminth infections such as *Ascaris lumbricoides*, *Trichuris trichiura*, hookworms, and *Strongyloides stercoralis* are known to interfere with nutrient absorption, reduce appetite, cause intestinal inflammation, and contribute to chronic blood and protein loss. These effects may ultimately result in moderate or severe malnutrition, especially among young children who are already nutritionally vulnerable.

Therefore, the results highlight the need for integrated control measures, such as periodic deworming, improved sanitation, health education, appropriate hygiene practices, and nutritional intervention programs, and suggest a significant epidemiological relationship between soil-transmitted helminth infections and poor nutritional status among children in the study area.

Discussion

With an overall incidence of 56.94%, the current research found a significant prevalence of soil-transmitted helminth (STH) infections among children in Yabo District, Sokoto State. The World Health Organization (WHO) states that this prevalence is in the high-transmission category,

meaning that STH infection is still a serious public health issue in the research region. Poor environmental sanitation, insufficient personal hygiene, open defecation, frequent barefoot walking, untreated water intake, improper hand washing techniques, and irregular deworming among youngsters may all contribute to the high incidence seen.

The results of Bala et al., who reported an overall prevalence of 62.0% among schoolchildren in Sokoto State, are similar to the prevalence seen in this research. However, compared to data from a number of previous studies carried out in Nigeria and other countries, the prevalence is much greater. For instance, Ughava and Okon found a frequency of 9.0% among prisoners in Jos, Nigeria, but Isyaku et al. reported a prevalence of 1.4% among babies in Sokoto State. In a similar vein, Nwaneri and Omuemu found that 20.7% of children in Benin City's orphanages had this condition. Lower prevalence rates have also been reported internationally, including 3.2% in Iran, 14.3% in Thailand, 17.3% in Ghana, and 6.3% in Cameroon. The observed differences may be due to variations in environmental conditions, sanitation infrastructure, socioeconomic status, health education, implementation of deworming programmes, and study populations.

On the other hand, compared to other previous studies conducted in Sokoto State and other regions of Nigeria, the prevalence found in this research is lower. Almajiri children in Sokoto Metropolis had a prevalence of 74.5%, according to Iduh et al., while elementary school students had a frequency of 74.8%, according to Ibrahim et al. In a similar vein, Taiwo et al. observed prevalence rates of 78.0% and 71.0% in intervention and non-intervention areas, respectively, while Singh and Idris reported 74.0% among boarding school students. The current study's comparatively reduced prevalence might be attributed to the progressive effects of recurring deworming efforts and increased knowledge of hygiene practices in some groups.

The most common helminth species, according to species-specific study, was Ascaris lumbricoides, which was followed by Trichuris trichiura, hookworms (Ancylostoma duodenale and Necator americanus), and Strongyloides stercoralis. This result is in line with data from other studies conducted in Nigeria that found A. lumbricoides to be the predominant intestinal helminth because of its high fecundity, environmental resilience, and ease of transmission in unsanitary environments. However, studies conducted in some regions of southwestern Nigeria have reported *T. trichiura* as the predominant species, while others identified hookworm infection as the most common STH. Such differences may be influenced by climatic conditions, soil characteristics, sanitation practices, and local behavioural patterns.

Males had a greater prevalence of infection than females, according to gender-related study. Given that male youngsters are often more engaged in outdoor activities that enhance interaction with polluted soil, this result may be explained by behavioral differences. Males may also be more prone to participate in unsanitary play activities and walk barefoot. The results are in line with those of Taiwo et al. (2017), who found that male children had greater infection rates than female children. However, other studies have reported higher prevalence among females, suggesting that gender alone may not be a consistent predictor of infection and that exposure-related behaviors are likely more important determinants.

Age-specific prevalence demonstrated that children aged 21–30 months and 31–40 months were the most infected groups. This finding may be explained by increased mobility and exploratory behavior during these developmental stages. Children within these age categories frequently play on contaminated soil, place objects in their mouths, and are less likely to adhere to hygienic practices. Furthermore, they are often not included in school-based deworming programmes, making them particularly vulnerable to infection. Similar observations have been reported by previous researchers and supported by WHO reports on preschool-aged children.

Ward-level analysis indicated that Ruggar Iya recorded the highest prevalence of infection, followed by Kilgori, Torankawa, Bingaje, Fakka, Binji, Birnin Ruwa, Bakale, Yabo B, and Yabo A. The elevated prevalence in Ruggar Iya may be associated with poor sanitation, widespread open defecation, inadequate access to clean water, low awareness of preventive measures, and poor utilization of anthelminthic drugs. These findings support previous reports that environmental and socioeconomic conditions strongly influence the distribution of STH infections within communities.

Numerous important risk factors for STH infection were found in this investigation. These included not wearing shoes on a regular basis, having untrimmed fingernails, having limited access to latrines, and using insufficient deworming techniques. Children who did not wear shoes on a daily basis had a higher risk of contracting illnesses, especially hookworm infections, by skin contact with contaminated soil. Untrimmed fingernails may facilitate the accumulation and ingestion of infective eggs, while poor sanitation and open defecation contribute to environmental contamination. Inadequate deworming further increases susceptibility by allowing persistent infections to remain untreated. These findings agree with previous studies that identified sanitation, hygiene, and deworming practices as major determinants of STH transmission. Assessment of nutritional status revealed substantial levels of malnutrition among children across the study wards. Torankawa ward recorded the highest proportion of severely malnourished children, followed by Bingaje, Fakka, Ruggar Iya, and Kilgori. Fakka ward also had the highest number of moderately malnourished children and the lowest proportion of children with normal nutritional status. The significant association observed between STH infection and malnutrition may be explained by the pathological effects of intestinal helminths on nutrient utilization. Helminth infections can impair nutrient absorption, reduce appetite, cause chronic intestinal inflammation, and induce blood loss, all of which contribute to growth retardation, underweight conditions, and poor nutritional outcomes. Thus, children with STH infections are more vulnerable to micronutrient deficits, especially iron deficiency anemia, and protein-energy malnutrition. Overall, the findings of this study demonstrate that soil-transmitted helminthiasis remains highly prevalent among preschool-aged children in Yabo District and is closely associated with poor sanitation, inadequate hygiene practices, limited deworming coverage, and poor nutritional status. These findings highlight the need for integrated control measures, including regular mass deworming, health education, improved sanitation infrastructure, provision of safe water, promotion of personal hygiene, and nutritional intervention programmes targeting vulnerable children in rural communities.

Summary

This research was carried out in Yabo District, Sokoto State, North-Western Nigeria, to evaluate the nutritional condition of children and the epidemiology of soil-transmitted helminthiasis. The study's objectives were to ascertain the prevalence of soil-transmitted helminths in children in various communities within the district, assess the nutritional status of the children in the study area, identify important risk factors contributing to transmission, and evaluate the intensity of infection based on age and gender. Male and female participants were chosen from the study communities, and the study was conducted among youngsters living in Yabo District. A cross-sectional survey with a descriptive design was used. Each of the district's wards—Ruggar Iya, Kilgori, Torankawa, Bingaje, Fakka, Binji, Birnin Ruwa, Bakale, Yabo B, and Yabo A—provided 49 samples. In order to gather demographic and socioeconomic data, including age, sex, use of sanitation facilities, hand washing habits before and after meals, nutritional status,

and sources of drinking water, a structured questionnaire was given to each participant from whom samples were taken. Environmental and behavioral risk factors for infection were evaluated using these variables.

Every participant supplied a stool sample in a sterile container with an applicator that was appropriately labeled. The sample was then sent to the central hospital laboratory in the study region for examination. Using the formol-ether concentration method, stool samples were microscopically inspected for the presence of geohelminth eggs, ova, or larvae. The Shakir tape was used to measure nutritional status as soon as the questionnaire was given out. The Statistical Package for the Social Sciences (SPSS) version 26.0 was used to analyze the data after it was inputted into Microsoft Excel 2014. Chi-square (X^2) tests and descriptive statistics were used, with $P < 0.05$ being the threshold for statistical significance.

The results showed that children in Yabo District had an overall prevalence of soil-transmitted helminths of 56.94%, suggesting a high level of infection. The greatest incidence of four species of soil-transmitted helminths was found to be Ascaris lumbricoides (26.94%), followed by Trichuris trichiura (15.31%), hookworms (Ancylostoma duodenale and Necator americanus) (9.59%), and Strongyloides stercoralis (5.10%). Males had a greater infection rate (59.39%) than females (55.02%), according to gender-based study. Participants between the ages of 21 and 30 months had the greatest infection rate, closely followed by those between the ages of 31 and 40 months, according to age-related analysis. Ruggar Iya had the greatest prevalence of all the wards examined, according to the ward-based distribution.

Chi-square analysis revealed statistically significant correlations between soil-transmitted helminth infection and a number of risk variables, such as the use of deworming pills, shoe wearing habits, fingernail cleanliness, and the presence of latrines or toilet facilities ($P < 0.05$). According to a nutritional evaluation, children from Torankawa ward had the worst malnutrition, followed by those from Kilgori, Bingaje, Fakka, and Ruggar Iya. While normal nutritional status was highest in Bingaje, Yabo B, Yabo A, Ruggar Iya, Kilgori, Binji, Birnin Ruwa, and Bakale in decreasing order, moderate malnutrition was most prevalent in Fakka ward.

Conclusion and Recommendations

According to the research, Yabo District has a high occurrence of STHs infections, with Ruggar Iya having the highest infection rate. Children between the ages of 21 and 40 months were more impacted than other age groups, and male children had a greater frequency of infection than female children. The most common species in the research population was found to be Ascaris lumbricoides. The incidence of infections was shown to be significantly correlated with the availability of sanitation, shoe wearing practices, fingernail cleanliness, and consistent use of deworming drugs. Children in the Torankawa ward have significant malnutrition, according to a nutritional examination. The results show that the persistence of soil-transmitted helminth infections in rural populations is mostly caused by poor sanitation, insufficient hygiene practices, and irregular deworming. Improving child-care practices and caregiver awareness can help reduce worm burden in rural settings. Regular deworming programs conducted at intervals of three to six months are essential for reducing infection prevalence among children in Yabo District.

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