Original Research Article

PREVALENCE AND TRANSMISSION OF SOIL TRANSMITTED HELMINTHS AMONG FARMERS LIVING ALONG THE METROPOLITAN SECTION OF RIVER KADUNA, NIGERIA.

ABSTRACT

Soil-transmitted helminths are one of the world's most important causes of physical and intellectual growth retardation. The study was conducted to determine the prevalence and transmission of ~~soil-transmitted~~ soil-transmitted helminths among farmers living along the metropolitan section of river Kaduna, Nigeria. A total of 210 stool samples were randomly collected from farmers of seven (7) different farms located along the ~~river bank~~ riverbank. The stool samples collected were examined for soil-transmitted helminths using direct wet mount and formal ether sedimentation techniques. Questionnaires were administered to the farmers to assess their ~~personal~~ hygiene, sanitation, and health maintenance. The prevalence of STH based on the ~~farmers~~ farmers' age and gender was also determined. Out of the total stool samples collected, 81(38.6%) were infected with at least one out of the four STH eggs. The eggs of ~~Hokworm~~ hookworm and *Ascaris lumbricoides* were the only helminths eggs detected. Hookworm was found to have a prevalence of 54.3% while *A. lumbricoides* ~~has~~ have a prevalence of 45.7%. *Strongyloides stercoralis* and *Trichuris tichuira* both were found to have 0% prevalence. The risk factors such as personal hygiene and sanitation were found to have a significant influence on the prevalence ($p<0.05$) while health maintenance shows no significant influence ($p>0.05$) on the prevalence of STH among the ~~famers~~ farmers. The age prevalence shows that group 10 – 25 have the highest prevalence of 81.3% while age 36 – 45 shows the lowest prevalence of 2.4%. The gender prevalence shows that male ~~farmer~~ farmers have the highest prevalence of 41.4% out of the total infected farmers (81). The findings could be as a result of farmers' ~~personal~~ hygiene and sanitation on their various farms and their farm tools which acts as a medium for the transmission of the parasite egg, while the younger age group work more hours than the older age group and the male farmer spends more time in the farm than the female.

Keywords: Helminth; Prevalence; Transmission; farmer; water.

1. INTRODUCTION

Soil transmitted helminthiasis ~~are diseases~~ is a disease caused by parasitic helminths whose life cycle ~~include~~ includes ~~the~~ egg/larval incubation in the soil and subsequently becoming infective to man and animals via oral-route or skin penetration. These diseases include ~~Ascariasis, Trichuriasis,~~ ascariasis, trichuriasis, and ~~hook worm~~ hookworm infection ~~(Necatoriasis and Ancyclostomiasis)~~ (necatoriasis and ancyclostomiasis) ~~(1)~~ [1]. These are the most important ~~helmithiasis~~ helminthiasis among the neglected tropical diseases (2). This group of helminthiasis ~~have~~ has been targeted under the joint action of the world's leading pharmaceutical companies and non-governmental organizations through a project launched in 2012 called the London Declaration on Neglected Tropical Diseases, which aims to control or eradicate certain neglected tropical diseases by 2020 (3)~~.Management~~ . Management of some of these parasitic ~~helminthes~~ helminths among farmers varies especially with their level of education, hygiene, and ignorance by which some of these farmers claim that intestinal worms are useful components of food

digestion (4). According to (1), the major ~~soil-transmitted-helminths~~ soil-transmitted helminths (STH) in Nigeria are *Ascaris lumbricoides, Trichuris trichura, Ancylostoma duodenale, Necator americanus, Strongyloides stercoralis, and Toxocara species.* Among these, *A. duodenale, N. americanus, and S. stercoralis* are transmitted by direct skin penetration while others gain entry by ~~oral-route~~ oral route. These have become the most common parasitic disease of ~~human~~ humans worldwide. Approximately two billion people are infected currently, and four billion ~~at~~ are at risk of infection, surpassing even the all-time most prevalent parasitic disease, malaria (5). An increasing number of studies of helminths epidemiology ~~have~~ has shown that it is common for individuals to be infected with more than one species of helminths (6). ~~Soil-transmitted~~ Soil-transmitted helminthiasis is the second largest leading cause of mortality among ~~adult~~ adults in Africa (7). The infection is promoted by poor personal hygiene habits and the use of human and animal feces as manure. ~~These habit allows~~ These habits allow contact with feces and its accompanying microbial load including geo-helminth eggs ~~in soil~~ in the soil and other risk factors such as ~~use~~ the use of unclean water sources and having pools of sewage around houses (4). In Africa, the transmission of intestinal parasitic infection has been considered to increase successfully due to the frequent use of untreated human or animal dung as manure in cultivation by farmers, this also serves as a source of enhancement of zoonotic parasitic infection. (8) The distribution of parasitic infections is determined by several ~~factor~~ factors, such as environmental, food- habit, tradition, social status, economic situations among others. Each parasite has its own natural and social habitat, and ~~favourable~~ a favorable environment is a prerequisite for its transmission. ~~Soil-transmitted-helminths-(STHs)~~ STH or geohelminths are highly prevalent in poor agricultural societies, where human feces are used as fertilizer (9).

1.2 Statement of Research

Despite the increased emphasis on the role of good sanitation and hygiene in the control of ~~soil-transmitted helminths~~ STH, ~~huge~~ a huge number of the population still do not understand the relationship between the two, particularly in rural villages and slums (10). ~~Soil-transmitted~~ Soil-transmitted ~~helmithiasis~~ helminthiasis is associated with chronic and asymptomatic morbidity in ~~human~~ humans. The morbidity associated with ~~Soil-Transmitted-Helminths~~ STH infection ~~include~~ includes iron deficiency anemia, malnutrition, growth and developmental disorders including short stature and cognitive developmental disorders (11). Low hygiene, lack of sanitation, use of both animal and human feces as fertilizers can also expose the farmers to the infective stages of geohelminths. WHO (12) reported that approximately 1.5 billion people are infected with ~~soil-transmitted helminths~~ STH. making it a globally distributed disease. Major control of the disease is still based on periodical deworming to eliminate infecting worms, health education to prevent re-infection, and improved sanitation to reduce soil contamination with infective eggs.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted within ~~Kaduna~~ the Kaduna metropolis. Kaduna State is located in the Northwest Geopolitical zone of Nigeria. It lies longitude 6-9E and 11–30N. It has distinct wet (April to October) and dry ~~season~~ seasons (November to March) and ~~within~~ is within the guinea savannah zone of Nigeria. The state shares geopolitical boundaries with Katsina and Zamfara States to the North, Plateau and Bauchi States to the East, Nasarawa State and Federal Capital to the South, Niger State to the West, and Kano State to the Northwest. It has a population of about 7,474,369 (2013 projection) (13). The state has 23 Local Government Areas. The farmers used for this study are those along river Kaduna farm and in the following location.

1. Barnawa
2. Kabala Doki
3. Kabala West
4. Unguwan Mu'azu
5. Nassarawa
6. Unguwan Rimi
7. Malali

2.2 Sample Size Estimation

Base on the ~~pervious~~ previous study of (14) where the projected prevalence of 2.2% was obtained, the sample size was determined using the formula described below (15).

$$N = \frac{Z^2pq}{D^2}$$

Where N = the number of samples that were collected
Z = the normal deviation (1.96 for an alpha of 0.05) corresponding to a confidence interval of 95%.
P = the proportion of symptomatic and asymptomatic people that were expected to harbor geohelminths (2.2%)

Q = 1 – P (1 – 0.02) = 0.978

D^2 = is the precision of the estimates, which is taken as 5% (.0.05)

Substituting the values in the formula:

$$N = \frac{(1.96)^2 \times 0.022 \times 0.978}{(0.05)^2}$$

$$N = \frac{0.08265587}{0.0025}$$

N = 33.06

N = 33

The sample size was approximated to 30 farmers per farm area. This sum up to a total sample of 210 farmers.

2.3 Sample Collection

Wide-mouth ~~screw-capped~~ screw-capped sample bottles bearing serial numbers and district name was given to the leader of each farm to share among the farmers after a brief explanation on how and when to collect the samples. A brief explanation ~~on~~ of the importance of the research to their health and community at large was given also. The samples were collected in ~~the month of~~ June-July, October-November 2019 because in the months of August and September, the river is usually filled up and the farmers moved away from the river banks river-banks.

Comment [FIMH1]: delete

2.4 Laboratory Analysis of Fecal Sample

The fecal samples were preserved with 10% formalin and transported to the laboratory of the Nigeria Defence Academy (NDA) Hospital, Afaka Kaduna. The collected specimen ~~were~~ was examined for the ~~colour~~ color consistency (Formed/Semi formed/unformed/watery) and presence of blood/worm/segment. The analysis was carried out via direct the direct smear method and formal ether concentration technique (16).

2.4.1 Direct Smear Method

A drop of normal saline was placed on a clean slide with the aid of a clean dropper and one gram (1g) of feces was placed on the slide and mixed using a glass rod to obtain a thin smear, the slide was then ~~cover~~ covered with a ~~cover slip~~ coverslip and a drop of ~~lugol's~~ Lugol's iodine added at the edge of the ~~cover slip~~ coverslip to diffuse into the saline mount. The smear was examined under a binocular light microscope for the presence of geohelminth using the X10 objective lens and X40 objective lens **(**16**).**

2.4.2 Formalin Ether Concentration Technique

Two ~~gram~~ grams (2g) of feces ~~was~~ were mixed into a test tube containing 10ml of distilled water, and strained through a ~~gauce sieve~~ gauze-sieve into a centrifuge tube, and centrifuged at approximately 2,500rpm for 3 min, the supernatant was decanted. 10% normal saline was added to the sediments and mixed with a glass rod for 30 seconds. 3ml of ether was added and shaken vigorously, the mixture centrifuged again for about 2min at 2000rpm: after which the debris was poured away and ~~2 drop of lugol's iodine was~~ 2 drops of Lugol's iodine were added and shaken. A pipette was used to collect the sediments and placed on a slide to examine under ~~light~~ a light microscope using x10 objective lens and x40 objective lens (16**)**.

2.5 Identification of Parasite

Laboratory diagnosis and atlas ~~was~~ were used to identify the parasite egg/larvae based on morphological characterization. (16).

2.6 Administration of Questionnaires

A structured questionnaire was administered to the farmers to obtain information on their age sex, level of education, source of water, type of fertilizer used, contact activities, and personal hygiene, Farmers who were not able to read were helped by the researcher to read the questionnaires out and ~~also~~ translate it as this enables the farmer to answer the questions, correctly.

2.7 Data Analysis

Data obtained in the study ~~was~~ were analyzed using ~~statistical~~ the statistical package for social science (SPSS version 16.0), Chi-square test was used to compare the prevalence of STH among farmers and associated risk factors at 95% significance level (P < 0.05).

Comment [FIMH2]: and what about "T-test", that the authors used it in Table3.2

3. RESULTS

3.1 Overall prevalence of ~~soil-transmitted helminths~~ STH detected among farmers in the study area.

The overall prevalence of ~~soil-transmitted helminths~~ STH detected among farmers in the study area presented in (table 3.1) shows that out of 210 farmers examined, 81(38.6%) are infected with at least one species of the helminth parasites. The highest prevalent species was hookworm with a prevalence of 45.3% where T. *trichiura* and *S. stercoralis* have zero 0% prevalence irrespectively.

Comment [FIMH3]: it should be 54.3%

Comment [FIMH4]: Italic

Table 3.1: Overall prevalence of ~~soil-transmitted helminthes~~ STH farmers sampled in different locations.

Locations	Number of ~~Sample~~ samples examined	No Positive	% Positive	*Ascaris lubricoides*	~~Hook worm~~ Hookworm	*Stongyloides Stercoralis*
Barnawa	30	19	63.3	07	12	0
Kabala Doki	30	18	60.0	10	08	0
Kabala West	30	10	33.3	06	04	0
U/Mu'azu	30	15	50.0	09	06	0
Nasarawa	30	09	30.0	01	08	0
U/Rimi	30	05	16.7	03	02	0
Malali	30	05	16.7	01	04	0
Total	**210**	**81**	**38.6**	**37**	**44**	**0**

Comment [FIMH5]: Their percentages should be calculated

Comment [FIMH6]: Should be deleted

Comment [FIMH7]: Their percentages should be calculated

3.2 Prevalence of ~~soil-transmitted helminths~~ STH ~~in relation to~~ concerning risk factors.

The prevalence of ~~soil-transmitted helminths~~ STH ~~in relation to~~ concerning risk factors is presented in table 3.2. Results ~~shows~~ show that based on personal hygiene, 158 farmers farm without gloves and boots, 168 farmers eat in their farms, 180 farmers clean up at the river after farming, 178 farmers spend more time at the farm and 151 eat raw vegetables directly from the farms.

Based on sanitation, the result shows that 154 farmers make use of water from the river ~~to farm after rainy~~ on the farm after the rainy season, 185 of the farmers make use of organic fertilizers, and 176 farmers use their hands directly to apply the organic fertilizer in the farm. Due to lack of ~~toilet,~~ toilets,190 of these farmers practice open defecation and 136 of the farmers use ~~the rivers water~~ the river's water for other activities such as washing, cleaning of farm tools, and sometimes bathing.

Based on the health maintenance, the study shows that 113 farmers were aware of STH as a disease, 142 do develop symptoms ~~which are~~ that are related to those of STH, 117 farmers practice self-medication, 71 farmers visit ~~hospital~~ hospitals when sick and 94 farmers prefer to take herbal medications.

Comment [FIMH8]: What are basics on which the authors identified these factors as risk factors

Table 3.2: Distribution of ~~soil-transmitted helminthes~~ STH ~~in relation to~~ concerning risk factors

Risk factors	Total	Number of. Yes	%	P-Value	T	df
Cultural practices personal hygiene	210	158	75.2	0.000	10.8	4
Farming without gloves and boots	210	163	77.6			
Eating while farming	210	180	85.7			
Cleaning up at the river	210	178	84.8			
More time at the river	210	151	71.9			

Comment [FIMH9]: Certain parameters or "habits, sanitation and health maintenance"

Comment [FIMH10]: The title should be changed because the table doesn't show statistical analysis concerning "Odds Ratio"

Comment [FIMH11]: No need for that column, total examined can be mentioned in footnote

Comment [FIMH12]: T- test had not been mentioned in the data analysis

Eating raw vegetables						
Sanitation	210	154	73.3	0.03	6.232	4
River water to farm	210	185	88.1			
Organic fertilizer	210	176	83.8			
Application of fertilizer with hands	210	190	90.5			
Open defecation	210	136	64.8			
User river for other activities						
Health maintenance	210	113	53.8	0.850	0.202	4
Knowledge of STH	210	142	67.6			
Symptoms	210	117	55.7			
Self medication	210	71	33.8			
Visit the doctor	210	94	44.8			
Herbal treatment						

Comment [FIMH14]: Please Revise the statistical analysis

Comment [FIMH13]: It can be changed into: Self-medication

3.3 Prevalence of ~~soil transmitted helminths~~ STH ~~in relation to~~ concerning age and gender.

Table 3.3 presents the prevalence of ~~soil transmitted helminths~~ STH ~~in relation to~~ concerning gender and age. Results ~~shows~~ show that the highest prevalence in the male gender was recorded in the age 10 – 25 (100.0%) and the least percentage ~~in 36 – 45~~ the 36 – 45 (13.8%) age bracket. The highest prevalence in the female was recorded also ~~in 10 – 25~~ in the 10 – 25 (50.0%) age bracket and the least prevalence in the 36 – 45 (6.25%) age bracket.

Table 3.3: Prevalence of ~~soil transmitted helminths~~ STH in relation to age and gender

Age group	Male			Female		
(Years)	No. examined	No. infected	% infected	No. examined	No. infected	% infected
10 – 25	10	10	100.0	6	3	50.0
26 – 35	30	29	96.9	8	3	37.5
36 – 45	29	4	13.8	16	1	6.3
46–Above	100	27	27.0	11	4	36.4
Total	169	70	41.4	41	11	26.8

Comment [FIMH15]: 96.7

3.4 Prevalence of ~~soil transmitted helminths~~ STH ~~in relation to~~ concerning gender.

Table 3.4 presents the prevalence of ~~soil transmitted helminths~~ STH ~~in relation to~~ concerning gender. The table shows that ~~out a total~~ out of a total 210 samples examined containing 169 males and 41 females, 70 males and 11 females were positive to at least one of the ~~soil transmitted helminths~~ STH accounting ~~to~~ for 41.4% and 26.8% percentage prevalence respectively. The result shows that the male percentage prevalence is higher than the female.

Table 3.4: Prevalence of ~~soil-transmitted helminthes~~ STH ~~in relation to~~ concerning gender

Gender	No. of samples exam	No. positive	%+ve
Male	169	70	41.4
Female	41	11	26.8
Total	**210**	**81**	**38.6**

Comment [FIMH16]: That table should be deleted because it is repeated in table 3.3

3.5 Prevalence of ~~soil transmitted helminths~~ STH ~~in relation to~~ concerning age.

Table 3.5 presents the prevalence of ~~soil transmitted helminths~~ STH ~~in relation to~~ concerning age. Results ~~shows~~ show that the highest prevalence was recorded in ~~age~~ the age group 10 – 25 years with 81.3%. This is followed by ~~age~~ the age group 26 – 35 (15.2%) and ~~age~~ the age group above ~~46 year~~ 46 years (14.8%). The lowest prevalence was recorded in ~~age~~ the age group 36 – 45 years with 11.1%.

Table 3.5: Prevalence of ~~soil transmitted helminthes~~ STH ~~in relation to~~ concerning age.

Age group (Yrs)	No. examined	No.+ve (%)
10-25	16	13 (81.3)
26-35	38	32 (84.2)
36-45	45	05 (11.1)

46-Above	111	31 (27.9)
Total	**210**	**81**

3.6 Distribution of different species of ~~soil-transmitted-helminths~~ STH ~~in-relation-to~~ concerning age.

The prevalence of different species of ~~soil-transmitted-helminths~~ STH ~~in-relation-to~~ concerning age as (table 3.6) shows that age group 10 – 25 has the highest prevalence of ~~Hook-worm~~ hookworm and 36 – 45 years has the lowest with a prevalence of *A. lumbricodes.*

3.6: Distribution of different species of ~~soil-transmitted-helminthes~~ STH ~~in-relation-to~~ concerning age.

Age group (Yrs)	*A. lumbricoides*	*T. trichiura (%)*	Hookworm (%)	*S. Stercoralis (%)*
10-25	9 (24.3%)	0	8 (18.1%)	0
26-36	16 (43.2%)	0	29 (65.9%)	0
36-45	5 (13.5%)	0	3 (6.8%)	0
46-Above	7 (18.9%)	0	4 (9%)	0
Total	**37**	**0**	**44**	**0**

Comment [FIMH17]: Should be deleted

Comment [FIMH18]: Should be deleted

Comment [FIMH19]: 18.2

Comment [FIMH20]: 9.1

4. DISCUSSION

In this study, the overall prevalence (38.6%) of ~~soil-transmitted-helminths~~ STH detected ~~is~~ was higher than 34.2% detected by (17). The high prevalence detected ~~maybe~~ may be due to ~~the-presences-of-water~~ the presence of a water body along the study area which the farmer ~~result-to~~ results to whenever there ~~are-in-need-of~~ need water (18). Assessing some of the risk factors such as personal hygiene and sanitation ~~by-the-use-of~~ using questionnaires shows that some of these farmers do not use ~~hand-~~gloves and farming boots while at the farm, do not wash their hands properly and some of the farmers consume raw vegetables directly from the farm. The results also show that most of these farmers ~~spend~~ spent more time ~~in~~ on the farm than at home and while at the farm, such farmers make use of the water obtained from the river for many different activities.

Farmers who do not have proper hygiene are more at risk of the infection than farmers who practice proper personal hygiene such as wearing ~~of~~ shoes and gloves. Gloves wearing reduced the risk of infection from the eggs of the helminths by preventing the parasite from penetrating ~~into~~ the skin pores or attaching themselves to the nails of the farmers for oral consumption. This study shows the presence of *A. lumbricoides* and Hookworm among the farmers. ~~This-findings-is~~ These findings are in agreement with the findings of (19) who reported that hookworms and *T. trichiura* are the major types of ~~helminthes~~ helminths found in farmers that have direct contact ~~to~~ with the soil. Also in ~~agreement~~ the agreement were studies reported by (20) and (21) who both stated that ~~farmer~~ farmers who make use of organic fertilizers in their farms such as human and animal feces to improve the soil are more likely to be infected with STH. (22) stated in his study and reported that farmers who used cattle dung in their farmland showed positive results for helminths infection. (21) reported that the consumption of raw untreated food will also increase helminths infection. The absence of ~~good-latrine-to-famers~~ a good latrine to farmers is accompanied ~~with-high~~ by a high risk of acquiring helminths infection (23) and the use of soap and water in washing hands and bathing by farmers can reduce the risk of infection from the parasite (24).

(25) reported that transmission of STH is related to the climate with adequate moisture and warm temperature essential for larval development in the soil. The high prevalence of ~~these-parasite-could-therefore-~~ these parasites could therefore be due to lack of personal hygiene and poor sanitation, such as farming and applying fertilizer without ~~hand-~~gloves and ~~-boot~~ boots, direct eating of raw unwashed ~~vegetable~~ vegetables from the farm, and swimming and bathing in the river after farming. The findings in this study ~~i~~ ~~in-agreement-with~~ agree with (26, 27). (28) also reported that infection multiply among individuals who lack good hygiene, educational background, health maintenance, and ~~good~~ a good source of water.

Gender prevalence shows that ~~the-male~~ males (86.4%) ~~are~~ were more infected than ~~female~~ females (13.6%). This could be ~~as-a-result-of~~ because of the time female spend on the farms which is lesser when ~~compare~~ compared to the male who nearly spend all day at the farms. ~~Female~~ Females also have work specifications during the farming activities and therefore do not engage in all farming activities. Also, ~~the-male~~ males engage in outdoor activities more, thereby making them more susceptible to STH infections than ~~female~~ females (29). This result agrees with (30, 31 and 32) in their research among ~~school-age~~

school-age pupils where ~~each researchers have attribute their finding~~ each researcher has attributed their findings to gender differences in activities.
Generally, some of these farmers might ~~have contacted~~ get infections through ingestion of helminths eggs in contaminated raw vegetables, drinking untreated water, or while engaging in farming with no gloves or boots on ~~farm lands~~ farmlands where untreated human and animal waste are ~~use~~ used as fertilizers to increase farm products (33). The comparison ~~the~~ of the expected and observed values according to the ~~chi square~~ chi-square test ~~show small discrepancy on the farmers health~~ shows a small discrepancy in the farmers' health management as a risk factor that could ~~possible~~ prone them to contacting ~~soil transmitted helminths~~ STH.

5. CONCLUSION

In conclusion, ~~Soil Transmitted Helminths (STH)~~ STH is prevalent among farmers along the metropolitan section of river Kaduna and that *Ascaris lumbricoides* and Hookworm are the most common species as they ~~werre~~ were found to be present in the study population. Male sex due to their outing activities ~~on farm~~ on the farm, personal hygiene like consumption of unwashed vegetables/fruits on the farm, sanitation, and defecation on farmland which is conversely used as manure and health maintenance increase the risk of STH infections.

ETHICAL APPROVAL

The experiment management, sample handling and care were approved by the Research and Ethics Committee of the Department of Biological Sciences, Nigeria Defence Academy, Kaduna, Kaduna State.

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