Journal of Advances in Microbiology

21(12): 88-97, 2021; Article no.JAMB.77909
ISSN: 2456-7116

Prevalence and Transmission of Soil Transmitted Helminths among Farmers Living Along the Metropolitan Section of River Kaduna, Nigeria

Salamatu Abdulmalik Mohammed [a], Philip Anthony Vantsawa [a], A. A. Haroon [a], Karderam Bukar Dikwa [a], Adam Musa Bature [a*] and B. Sani Dari [b]

[a] Department of Biological Sciences, Nigerian Defence Academy, Kaduna, Nigeria.
[b] Kaduna State University, Kaduna, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors SAM and PAV design the study. Author SAM performed the statistical analysis. Authors SAM and AMB wrote the protocol, and wrote the first draft of the manuscript. Authors SAM, AMB, PAV and AAH managed the analyses of study. Author SAM and AMB managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMB/2021/v21i1230417
Editor(s):
(1) Dr. Ana Cláudia Correia Coelho, University of Trás-os-Montes and Alto Douro, Portugal.
Reviewers:
(1) Faika Ibrahim Mohamed Hassanein, Pharos University in Alexandria, Egypt.
(2) Chukuwchindun Benjamin Azike, Cameroon.
Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here: https://www.sdiarticle5.com/review-history/77909

Original Research Article

Received 07 October 2021
Accepted 14 December 2021
Published 14 December 2021

ABSTRACT

Soil-transmitted helminths (STHs) 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 helminths among farmers living along the metropolitan section of river Kaduna, Nigeria. Two billion people are infected globally and four billion at risk of infection to STH. Nigeria ranking first globally, accounts for about 156 million cases of STH. A total of 210 stool samples were randomly collected from farmers of seven (7) different farms located along the riverbank. The stool samples collected were examined for STHs using direct wet mount and formal ether sedimentation techniques. Questionnaires were administered to the farmers to assess their hygiene, sanitation, and health maintenance. The prevalence of STH based on the farmers' age and gender was also determined. Out of the total stool samples collected, 81(38.6%) were infected with

**Corresponding author: E-mail: adambature@nda.edu.ng;*

at least one out of the four STH eggs. The eggs of hookworm and *Ascaris lumbricoides* were the only helminths eggs detected. Hookworm was found to have a prevalence of 54.3% while *A. lumbricoides* 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, sanitation and health maintenance were found to have a significant influence on the prevalence (38.6%) (P<0.05) of STH among the 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 farmers have the highest prevalence of 41.4% out of the total infected farmers (81). The findings could be as a result of farmers' hygiene, sanitation and health maintenance on their various farms and their use of contaminated farm tools which acts as a medium for the transmission of the parasite eggs, 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 is a disease caused by parasitic helminths whose life cycle includes 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, and hookworm infection (necatoriasis and ancyclostomiasis) [1]. These are the most important helminthiasis among the neglected tropical diseases [2]. This group of helminthiasis 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 of some of these parasitic 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 (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. These have become the most common parasitic disease of humans worldwide. Approximately two billion people are infected currently, and four billion are at risk of infection, surpassing even the all-time most prevalent parasitic disease, malaria [5,6]. Nigeria ranking first globally, accounts for 38 million case of hookworm, 29 million cases of schistomiasis, 55 million cases Ascariasis and 34 million cases of Trichiuriasis [7]. An increasing number of studies of helminths epidemiology has shown that it is common for individuals to be infected with more than one species of helminths [8]. Soil-transmitted helminthiasis is the second largest leading cause of mortality among adults in Africa [9]. The infection is promoted by poor personal hygiene habits and the use of human and animal feces as manure. These habits allow contact with feces and its accompanying microbial load including geo-helminth eggs in the soil and other risk factors such as 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 [10]. The distribution of parasitic infections is determined by several factors, such as environmental, food- habit, tradition, social status, economic situations among others. Each parasite has its own natural and social habitat, and a favorable environment is a prerequisite for its transmission. STH or geohelminths are highly prevalent in poor agricultural societies, where human feces are used as fertilizer [11].

1.2 Statement of Research

Despite the increased emphasis on the role of good sanitation and hygiene in the control of STH, a huge number of the population still do not understand the relationship between the two, particularly in rural villages and slums [12]. Soil-transmitted helminthiasis is associated with chronic and asymptomatic morbidity in humans. The morbidity associated with STH infection includes iron deficiency anemia, malnutrition, growth and developmental disorders including

short stature and cognitive developmental disorders [13]. 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 [15] reported that approximately 1.5 billion people are infected with 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 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 seasons (November to March) and 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) [14]. 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

The sample size was estimated base on a previous study [16] where the projected prevalence of 2.2% was obtained. The sample size was determined using the formula described below [17].

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

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 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 of how and when to collect the samples. A brief explanation of the importance of the research to their health and community at large was given also. The samples were collected in 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.

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 was examined for the color consistency (Formed/Semi formed/unformed/watery) and presence of blood/worm/segment. The analysis was carried out via the direct smear method and formal ether concentration technique [18].

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 covered with a coverslip and a drop of Lugol's iodine added at the edge of the 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 [18].

2.4.2 Formalin ether concentration technique

Two grams (2g) of feces were mixed into a test tube containing 10ml of distilled water, and strained through a 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 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 a light microscope using x10 objective lens and x40 objective lens [17].

2.5 Identification of Parasite

Laboratory diagnosis and atlas were used to identify the parasite egg/larvae based on morphological characterization [18].

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 translate it as this enables the farmer to answer the questions, correctly.

2.7 Data Analysis

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

3. RESULTS

3.1 Overall Prevalence of STH Detected among Farmers in the Study Area

The overall prevalence of 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 54.3% while *T. trichiura* and *S. stercoralis* both had 0% prevalence.

3.2 Prevalence of STH Concerning Risk Factors

The prevalence of STH concerning risk factors is presented in Table 3.2. Results show that based on personal hygiene, 75.2% farmers farm without gloves and boots, 77.6% farmers eat in their farms, 85.7% farmers clean up at the river after farming, 84.8% farmers spend more time at the farm and 71.9% eat raw vegetables directly from the farms.

Based on sanitation, the result shows that 73.3% farmers make use of water from the river on the farm after the rainy season, 88.1%) of the farmers make use of organic fertilizers, and 83.8% farmers use their hands directly to apply the organic fertilizer in the farm. Due to lack of toilets, 90.5% of these farmers practice open defecation and 64.8% of the farmers use 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 53.8% farmers were aware of STH as a disease, 67.6% do develop symptoms that are related to those of STH, 55.7% farmers practice self-medication, 33.8% farmers visit hospitals when sick and 44.8% farmers prefer to take herbal medications.

3.3 Prevalence of STH Concerning Age and Gender

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

Table 3.1. Overall prevalence of STH farmers sampled in different locations

Locations	Number of samples examined	Number of Positive	% Positive	*Ascaris lubricoides*	% positive	Hookworm	% positive
Barnawa	30	19	63.3	07	36.8	12	63.2
Kabala Doki	30	18	60.0	10	55.6	08	44.4
Kabala West	30	10	33.3	06	60.0	04	40.0
U/Mu'azu	30	15	50.0	09	60.0	06	40.0
Nasarawa	30	09	30.0	01	11.1	08	88.9
U/Rimi	30	05	16.7	03	60.0	02	40.0
Malali	30	05	16.7	01	20.0	04	80.0
Total	210	81	38.6	37	45.7	44	54.3

Table 3.2. Distribution of STH concerning Personal Hygiene, Sanitation and Health maintenance

Risk factors	Number of. Yes	%	P-Value	T	DF
Personal Hygiene					
Farming without gloves and boots	158	75.2	0.000	10.80	4
Eating while farming	163	77.6			
Cleaning up at the river	180	85.7			
More time at the river	178	84.8			
Eating raw vegetables	151	71.9			
Sanitation					
River water to farm	154	73.3	0.03	6.232	4
Organic fertilizer	185	88.1			
Application of fertilizer with hands	176	83.8			
Open defecation	190	90.5			
User river for other activities	136	64.8			
Health maintenance					
Knowledge of STH	113	53.8	0.001	8.633	4
Symptoms	142	67.6			
Self-medication	117	55.7			
Visit the doctor	71	33.8			
Herbal treatment	94	44.8			

Table 3.3. Prevalence of STH in relation to age and gender

Age group (Years)	Male			Female		
	No. examined	No. infected	% infected	No. examined	No. infected	% infected
10 – 25	10	10	100.0	6	3	50.0
26 – 35	30	29	96.7	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

Table 3.4. Prevalence of STH 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

Table 3.5. Distribution of different species of STH concerning age

Age group (Yrs)	*A. lumbricoides*	Hookworm (%)
10-25	5 (13.5%)	8 (18.2%)
26-36	3 (8.1%)	29 (65.9%)
36-45	2 (5.4%)	3 (6.8%)
46-Above	27 (72.9%)	4 (9.1%)
Total	37	44

3.4 Prevalence of STH Concerning Age

Table 3.4 presents the prevalence of STH **concerning** age. Results show that the highest prevalence was recorded in the age group 10 – 25 years with 81.3%. This is followed by the age group 26 – 35 (15.2%) and the age group above 46 years (14.8%). The lowest prevalence was recorded in the age group 36 – 45 years with 11.1%.

3.5 Distribution of Different Species of STH Concerning Age

The prevalence of different species of STH **concerning** age as (Table 3.5) shows that age group 26 – 36 had the highest prevalence of hookworm and 36 – 45 years had the lowest prevalence. The highest prevalence of *A. lumbricoides* occurs in 46 – above and the least prevalence in 36 -45 age group.

4. DISCUSSION

In this study, the overall prevalence (38.6%) of STH detected was higher than 34.2% detected by [19]. The high prevalence detected may be due to the presence of a water body along the study area which the farmer results to whenever there is need water [20]. Assessing some of the risk factors such as personal hygiene, sanitation and health maintenance using questionnaires shows that some of these farmers do not use gloves and farming boots on the farm, wash their hands properly and consume raw vegetables directly from the farm. The results also show that most of these farmers spent more time on the farm than at home and while at the farm make use of the water obtained from the river for many different activities like drinking, washing of fruits and others.

Farmers who do not have proper hygiene are more at risk of the infection than farmers who practice proper personal hygiene such as wearing shoes and gloves. Gloves wearing reduced the risk of infection from the eggs of the helminths by preventing the parasite from penetrating 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.

These findings are in agreement with the findings of [21] who reported that *Ascaris* and hookworms infections were the most frequent parasitic infections and *T. trichiura* was the least in his study. Also in the agreement were studies reported by [22] and [23] who both stated that 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. [24] stated in his study and reported that farmers who used cattle dung in their farmland showed positive results for helminths infection. [23] reported that the consumption of raw untreated food will also increase helminths infection. The absence of a good latrine to farmers is accompanied by a high risk of acquiring helminths infection [25] and the use of soap and water in washing hands and bathing by farmers can reduce the risk of infection from the parasite [26].

[27] 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 parasites could therefore be due to lack of good personal hygiene and poor sanitation, such as farming and applying fertilizer without gloves and boots, direct eating of raw unwashed vegetables from the farm, and swimming and bathing in the river after farming. The findings in this study agree with [28, 29]. [30] also reported that infection multiply among individuals who lack good hygiene, educational background, health maintenance, and a good source of water. The high prevalence of the parasite reported in older age could be as a result their activities associated with water contact [31].

Gender prevalence shows that males (86.4%) were more infected than females (13.6%). This could be because of the time female spend on the farms which is lesser when compared to the male who nearly spend all day at the farms. Females also have work specifications during the farming activities and therefore do not engage in all farming activities. Also, males engage in outdoor activities more, thereby making them more susceptible to STH infections than females [32]. This result agrees with [33,34 and 35] in their research among school-age pupils where each researcher has attributed their findings to gender differences in activities.

Generally, some of these farmers might 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 farmlands where untreated human and animal waste are used as fertilizers

to increase farm products [36]. The comparison of the expected and observed values according to the chi-square test shows a small discrepancy in the farmers' health management as a risk factor that could prone them to contacting STH.

5. CONCLUSION

In conclusion, 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 were found to be present in the study population. Male sex due to their outing activities 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.

ACKNOWLEDGEMENT

Profound appreciation goes to my parents who have contributed morally and financially to the success of this research. My sincere appreciation goes to my supervisor, my H.O.D., lecturers and laboratory assistant for their understanding, words of encouragement, intense research corrections and guides. The Project was funded completely by Author SAM.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Cheesebrough M. District Laboratory Practice in tropical countries. Parts Journal Edinburgh Cambridge University Press. 2006;428.
2. Centre for Disease Control. Laboratory Identification of Parasites of public health concern. Atlanta, Center for Disease Control and prevention. USA;2011.
3. London Deceleration. London Decleration on Neglected Tropical Disease;2012.
4. Phiri K, Whitty CJ, Graham SM, Ssembatya-Lule G. Urban/rural differences inprevalence and risk factors for intestinal helminth. Infection in southern Malawi. Annual Tropical Medical Parasitology. 2000;94:381 – 7.
5. Centre for Disease Control. Intestinal protozoan parasites;2014. Available:http://www.dpd.Cdc.gov/dpdx (assessed in 2009).
6. Bature AM, Dikwa KB, Alhaji AI, Dibal DM. Phytochemical analysis and *invivo* evaluation of individual activity of ethanolic leaf extracts of *Azadirachta indica*, *Senna occidentalis* and *Momordica balsamina* against *Plasmodium berghei* infected mice. Journal of Advances in Microbiology. 2021: 21(9):39-49.
7. Hotex PJ, Kamath A. Neglected tropical diseases in Sub-Saharan African: Review of their prevalence, distribution and disease burden. PLOS Neglected Tropical Diseases. 2009;3(8): e412
8. Fleming FM, Brooker S, Geiger SM, Caldas IR, Correa-Oliveira R, Hotez PJ, Bethony JM. Synergestic associations between hookworm and other helminths species in a rural area community in Brazil. Tropical Medicine International Health. 2006;11(1):56 – 64.
9. Ogbe MG, Edit EE, Isichei MN. Intestinal helminth in primary school children in areas of operation of shell Petroleum Development Company of Nigeria (SPDC), Western Division in Dalta State. Nigeria. Journal of Parasitology. 2002;23:3-10.
10. Ngowi HA, Mushi PE, Lupindu AM, Mtambo MMA, Muhairwa AP. Prevalence of intestinal parasite in pig manure and the potential for zoonotic transmission in urban/peri-urban areas of Morogoro municipality, Tanzania. Livestock Research for Rural Development. 2017; 29(29):2.
11. Horton J. Global anti helmintic chemotherapy programs: learning from history. Trends Parasitology. 2003;19:405-409.
12. WHO. World Health Orgnization. Soil transmitted helminth infections;2017.
13. Bogoch II, Speich B, Lo NC, Moser W, Croll D, Ali SM. Clinical evalusiton for morbidity associated with soil-transmitted helminths in school age children on Pemba Island, Tanzania. PLoS Neglected Tropical Disease. 2019;13(7):e0007581

14. World Health Organization. Soil Transmitted Helminths Fact Sheet;2020.
15. Muhammad N, Mpyet C, Adau MD, William A, Umar MM, Goyol M, Muazu H, Onyebuchi U, Isiyaku S, Flueckiger RM, Chu BR, Willis R, Pavluck AL, Alhassan A, Olobio N, Gordon BA, Solomon AW. Mapping Trachoma in Kaduna State, Nigeria: Result of 23 Local Governemnt Area-Level, Population-Based Prevalence Surveys. Ophthalmic Epidemilogy. 2016;23(1):46– 54.
16. Ahmed A. Prevalence of intestinal Helminths infection among school children in rural community. South Nigeria. Nigeria Journal of Parasitology. 2004;2223:11-18
17. Charan J, Biswas T. How to calculate sample size for different study design in medical research. Indian Journal Psychology Medicine. 2013;35(2):121 – 126.
18. Nikolay B, Brooker SJ, Pullan RL. Sensitivity of diagnostic test for human soil transmitted helminths infections: a meta-analysis in the absence of a true gold standard. International Journal of Parasitology. 2014;44(11):765 – 74.
19. Anunobi JT, Okoye IC, Aguzie IO, Ndukwe YE, Okpasuo OJ. Risk of soil-transmitted helminthiasis among Agrarian communities of Kogi State, Nigeria. Pub Med. 2019;85(1):120.
20. Alan Lindquist HD, Cross JH. Infectious Diseases. Science Direct. 2017;2(2017):1763 – 1779.
21. Mogaji HO, Dedeke GA, Bada BS, Bankole S, Adeniji A, Fagbenro MT, Omitola MT, Oluwole A. s, Abe EM, Mafiana CF. Distribuyion of Ascariasis, Trichuriasis and hookworm infections in Ogun State, Southwestern Nigeria. PLos ONE. 2020;15(6):e0233423
22. Fuhrimann S, Winkler MS, Pham-Duc P, Do-Trung D, Schindler C, Utizinger J, Cisse G. Intestinal parasite infections and associated risk factors in community espouse to waste water in urban and peri urban transition zones in Hanoi, Vietnam, Parasite vectors. 2016;9:10.1186/s 13071-016-1809-6
23. Prayitno H, Hanafi AS, Solihah Q. Factors associated with heminthiasis among vegetable farmers in Baroti Kuala District. Asian Journal of Epidemiology. 2017;10:108–115.
24. Seo HLS, Filho LCPM, Honorrato LA, da silva BF, do Amarante AFT, Bricarello PA. The effect of gastrointestinal nematode infection level on grazing distance from dung. PLoS One. 2015;10. DOI:10.1371/Journal. Pone.0126340
25. Admasie A, Debebe A. Estimating assess to drinking water supply, sanitation and hygiene facilities in Wolaita Sodo Town, southern Ethiopia, in reference to national covrage. Journal Environment Public Health;2016. DOI:10.1155/2016/8141658.
26. Worrell CM, Wiegand RE, Davis SM, Odero KO, Blackstock A. A cross-sectional study of water, sanitation and hygiene-related risk factors for soil-transmitted helminth infection in urban school-and preschool-age children in Kibera, Nairobi. PLoS One. 2016;11. DOI:10.1371/Journal. Pone. 0150744.
27. De Silva NR, Brooker S, Hotez PJ, Montressor A, Engels D, Savioli L. Soil-transmitted helminths infections: updating the global picture. Trends in Parasitology. 2003;19(12):547 – 51.
28. Olusola O, Francis AA, Adekunle OO, Babatunde MO, Oluwasheyi AA. Prevalence of soil transmitted Helminths infections in a tertiary institutions in western Nigeria. New York Science Journal. 2010;3(1):1 – 5.
29. Adeyaba OA, Akinlabi AM. Intestinal parasitic infections among school children in a rural community, southwest Nigeria, Nigerian Journal of Parasitology. 2002;23:11–8.
30. Sam –Wobo SO, Mafiana CF, Idowu AB. Re-infection patterns of ascariasis among school children in Ogun State, Nigeria. Nigerian Journal of Parasitology. 2004;25:7 – 13.
31. Masaku J, Mutungi F, Cichuki PM, Okoyo C, Njomo DW, Njenga SM. High prevalence of helminths infection and associated risk factors among adults living in a rural setting, central Kenya: a cross sectional study. Tropical Medicine and Health. 2017;45:15(2017).
32. Kache R, Phasuk N, Viryavejakul P, Punsawad C. Prevalence of soil transmitted helminths infections and associated risk factors among elderly individual living in rural areas of southern Thailand. BMC Public Health. 2020;20:1882.
33. Punsawad C, Phasuk N, Thongtup K, Nagavirochana S, Viriyavejakul P. Prevalence of parasitic contamination of raw vegetables in Nakhon Si Thammarat

province, southern Thailand. BMC Public health. 2019;19:34.

34. Laorakasawong P, Sanpool O, Rodpal R, Thanchomnang T, Kaarkard W, Maeewong W, Kraiklang R, Intapan PM. Current high prevalence of *Strongylides stercoralis* and *Opisthorcis viverrini* infections in rural communities in northeast Thailand and associated risk factors. BMC Public Health. 2018;18:940.

35. Ogomaka IA, Nwoke BEB, Ukaga CN, Nwokeji CM, Ajero CMU, Nwachukwu MI. Prevalence of soil transmitted helminths among primary school pupils in Owerri West Local Government Area in Imo State, Nigeria. Nigerian Journal of Parasitology. 2012;33(1):37 – 43.

36. Mahmud ZH, Das PK, Khanum H, Hossainey MRH, Islam E. Time temperature model for bacterial and parasitic annihilation from cow dung and human feacal sludge: A forth coming bio-fertilizer. Journal of Bacteriology and Parasitology. 2016;7(10): 4172

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/77909