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Research Article

Prevalence of Hookworm and *Strongyloides stercoralis* Infestation and Associated Factors among Patients Visiting the Department of Medical Laboratory for Stool Examination, Northwest Ethiopia, 2020

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ABSTRACT

Background: *Strongyloides stercoralis* and hookworms are parasitic intestinal nematodes that belong to the group of soil-transmitted helminths; the two parasitic infections occur when larvae living in faecally-polluted soil penetrate intact skin.

Hookworm infection is caused by *Helminth nematode* parasites *Necator americanus* and *Ancylostoma duodenale* whereas, *Strongyloidiasis* is caused by parasitic nematodes of the genus *Strongyloides stercoralis*, *Strongyloides* fuelleborni, and *Strongyloides* fuelleborni kellyi known to parasitize humans.

Autoinfection allows S. *stercoralis* to last in the human host for prolonged periods. *Strongyloides* and hookworm larvae migrate to the lungs to be coughed up and swallowed, thus entering the gut where they mature.

Methods: Institutional-based cross-sectional studies design to assess the prevalence and associated factors of hookworm and *Strongyloides stercoralis* infestation at Debre Tabor Town, Northwest Ethiopia.

Results: From the total of 422 study subjects who participated, 220 (52.1%) were males and 202 (47.9%) were females. Among the participants, 169 (40%), 105(24.9%), 38(9%), 9(2.1%) were farmers, students, daily laborers, and children respectively. Regarding the residence, 237(56.2%) were rural and 185 (43.8%) urban dwellers. The prevalence of hookworm was found to be 78(18.5%), 95% CI: 14.9, 21.9% whereas the prevalence of *Strongyloides stercoralis* was 23(5.5%) with (95% CI: 3.3%-7.8%) and co infestation of both was 6(1.4%) with (95% CI: 0.5%, 2.7%).

The study pointed out that there were other intestinal parasite infestations namely: Entamoeba histolytica, (12.1%), Giardia lamblia 6.9%, and Ascaris lumbricoides 5.9%. Frequent wearing of shoes practice and availability of toilet and its usage habit for *Strongyloides stercoralis* and availability of toilet, regularly wearing of shoes were found to be associated with both hookworm and *Strongyloides stercoralis* infestation.

Conclusion: The existence of both hookworms and *Strongyloides stercoralis* infestation was relatively high in the study area. Hookworm infestation was more prevalent than *Strongyloides stercoralis* infestation.

Keywords: *Strongyloides*; Hookworms; Parasites; Debre tabor; Nematodes

ABBREVIATIONS

BOFED: Bureau of Finance Economy Development; Disseminated Disease (DD); Disseminated *Strongyloidiasis* (DS); Direct Smear Examination (DSE); Debre Tabor University (DTU); Ethiopian Birr(ETB); Ethical Review Committee (ERC); Federal Ministry of Health (FMOH); Human Immune Virus (HIV); Hyper infection Syndrome (HS); kilo-Meter (Km); Mass Drug Administration (MDA); Master of Science (MSc); Neglected Tropical Diseases (NTDs); Pre School-Aged Children (PSAC); School-Aged Children (SAC); Statistical Package for the Social Sciences (SPSS); Simple Random Sampling (SRS); Sub-Saharan Africa (SSA); Soil Transmitted Helminths (STH); Stool Exam(SE)

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INTRODUCTION

Strongyloides stercoralis and hookworms are parasitic intestinal nematodes that belong to the group of soil-transmitted helminths; the two parasitic infections occur when larvae living in faecally-polluted soil penetrate intact skin [1,2]. Hookworm infection is caused by *helminth nematode* parasites *Necator americanus* and *Ancylostoma duodenale* and is transmitted through contact with contaminated soil [3-5]. *Necator americanus* is the most common hookworm worldwide [3,6]. *Strongyloidiasis* is caused by parasitic nematodes of the genus *Strongyloides stercoralis*, *Strongyloides* fuelleborni, and *Strongyloides* fuelleborni kellyi known to parasitize humans [7]. The most common and globally distributed human pathogen of clinical importance is *Strongyloides stercoralis* [8].

It shows two life cycles depending on the environment: a free-living, non-parasitic sexual life cycle and a parasitic asexual life cycle [9]. The filariform larva is the infective stage and it penetrates the human host skin to initiate the parasitic infestation cycle [8,10]. Autoinfection allows S. stercoralis to last in the human host for prolonged periods [11]. *Strongyloides* and hookworm larvae migrate to the lungs to be coughed up and swallowed, thus entering the gut where they mature. [7,8,12]. *Strongyloides stercoralis* replicates indefinitely inside the human host, causing lifelong infection if untreated [13].

MATERIALS AND METHODS

Study design

An institutional-based cross-sectional study design to assess the prevalence and associated factors of hookworm and *Strongyloides stercoralis* infestation were used.

Study area and period

The study was conducted in the South Gondar administrative zone which is located in Amhara regional state, northwest Ethiopia, from November 1, 2019, to March 30, 2020.

Debre Tabor town is the capital town of the zone in north-central Ethiopia. The town has a total population of 83,082 of whom, 39,781 are males and 43,301 are females (BoFED 2015).

Atseseyifard health center is one of the urban health centers found in Debre Tabor town. Atseseyifard health center serves about 40,000 people and 50-70 patients are visiting per day.

Source population: All patients who are visiting at Atseseyifard Health Center.

Study population: All patients who visit the medical laboratory for a stool examination at Atse seyifarid health center during the study period.

Variables of the study

Dependent variable: Prevalence of hookworm and *Strongyloides stercoralis* infestation

Independent variables: Socio-demographic factors

- Feeding habit
- Source of drinking water
- Hand washing practice
- Liquid human waste management
- Availability of toilet
- Wearing of shoes

Sample size determination and sampling procedure

The sample size was determined using a single population proportion formula. The sample size was calculated with the assumptions of 95% confidence level, 5% margin of error, and we use the proportion from a cross-sectional study done in the rural highland of Northwestern Ethiopia; Hookworms (54.5%) and *Strongyloides stercoralis* (20.7%) [14].

Thus, by taking the highest sample size using both prevalence and associated factors, 384 patients who have Hookworms infestation will be selected. Considering the 10% unresponsive rate, the final sample size was 422.

After obtaining verbal consent or assent from each participant, a systematic random sampling technique for every three patients was employed to select the study subjects (k=N/n=> 1320/422=3).

Operational definition

Prevalence of Hookworm and *Strongyloides* infestation is defined as the presence of *Strongyloides* and hookworm infestation in an average and above of the study participants.

Data collection procedure

Before sample collection, a brief explanation was given to participants for the purpose and benefit of the study. The information on demographic characteristics, lifestyle, and environmental factors were collected using a pretested structured questionnaire and each participant was interviewed in the local language.

Stool sample collection

Clean plastic containers and wooden applicator sticks were provided and instructed to bring enough amount of fresh stool specimens to the laboratory and stored them in separate labeled containers and leveled accordingly. Both saline direct smear examination and formalin-ether concentration techniques were used.

Data quality control

Before starting the actual work, the quality of reagents and instruments was checked by a quality control test. The information was collected using a pre-tested structured questionnaire. The stool specimens were also checked for the serial number, name of the patient, age, sex, and collection procedure. During the data collection, 5% of the collected data were randomly taken and checked for its completeness and correctness by both the supervisors and principal investigator daily.

Data processing and analysis

The obtained data were checked, edited manually, then coded and entered into Computer using Epi info 7 and exported to the Statistical Package for the Social Sciences (SPSS). Frequency of distribution, tables, percentages, graphs, and figures were used for descriptive statistics.

Bivariable and multivariable logistic regression analyses were carried out to describe the association of the potential factors with hookworms and *S. stercoralis* infestation. Factors that had bivariable associations with (p-value<0.2) were entered into multivariate logistic regression for further analysis. Variables associated with the prevalence of hookworms and *S. stercoralis* infestation with (p-value

≤ 0.05) was considered as significant factors.

RESULTS

General characteristics of the study participants

A total of 422 study subjects participated in the study; among them 220 (52.1%) were males and 202 (47.9%) were females. The mean age was 31.1 with the STD ± 16.51 years and the age range was 3-90 years. Almost all of the participants were Orthodox Christian (97.4%), followed by Muslim11 (2.6%).

Among the participants, 169 (40%) were farmers. Regarding the residence, 237(56.2%) were in rural and 185 (43.8%) were urban dwellers; regarding the family size most (84.1%) and most of them (78.4%).

Prevalence of hookworm and *strongyloides* infestation

The prevalence of Hookworms was found to be more frequent infestation with 78(18.5%), 95% CI: 14.9%-21.9%); whereas the prevalence of *Strongyloides stercoralis* was 23(5.5%) with (95% CI: 3.3%-7.8%) and we found co infestation of both (Figure 1).

From the participants age group, the least prevalence rate was found at the age group of fewer than 10 years (0.47%) for hookworms; the age group greater than or equal to 50 years for *S. stercoralis*. Considering occupation, farmers were found to be more infested other variables (Tables 1 and 2).

(9.5%, 2.61%) for hookworms and *S. stercoralis* respectively.

Moreover, intestinal and gut parasites, Entamoeba histolytica, (12.1%) (95% CI: 8.9%-15.6%) were the most frequent infestation and Giardia lamblia 6.9% (95% CI: 4.5%-9.6%), Ascaris lumbricoides 5.9% (95% CI: 4%-8.5%) were the second and the third most frequent infestation respectively. Based on educational status, the most prevalence was found in primary school for hookworm infection and at secondary education level for *Strongyloides stercoralis*.

Factors associated with hookworm and *Strongyloides stercoralis* infestation

Age, Occupation, Education, Residence, availability of toilet and usage habit, Type of latrine, regularly wearing of shoes for hookworms infestation; marital status, availability of toilet and usage habit, type of latrine, regularly wearing of shoes, presence of dog and cat at the home for *Strongyloides stercoralis* infestation have met the criteria (P<0.2) for Bivariable analysis to be further analyzed in multivariable logistic regression analysis.

Factors strongly associated with the prevalence of hookworms in multivariable logistics regression analysis (p ≤ 0.01) were frequent wearing of shoes practice and availability of toilet and its usage habit for *S. stercoralis*. Types of a toilet, regularly wearing of shoes were associated with hookworm and *S. stercoralis* infestation. However, there was no significant association observed with the

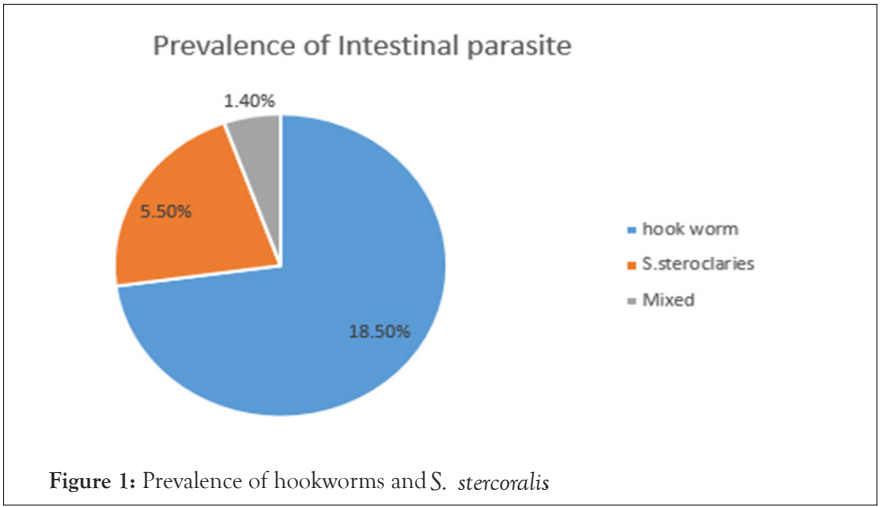

Figure 1: Prevalence of hookworms and *S. stercoralis*

Table 1: Bivariable and multivariable analysis for factors associated with hookworm infestation.

Variable		Hookworms		Crude OR (95% CI)		Adjusted OR (95% CI)	
		No (%)	Yes (%)				
Marital status	Married			198 (46.92%)	48 (11.4%)	1.974 (0.847,4.600)	1.971 (0.599, 6.486)
	Single	89 (21.1%)	23 (5.5%)	2.104 (0.848,5.223)		2.225 (0.694, 7.134)	
	Age not enough to marry	57 (13.51%)	7 (1.66%)	1		1	
Occupation	Farmer	139 (32.94%)	39 (9.24%)	2.463 (1.134,5.349)*		0.632 (0.191, 2.089)	
	Merchant	46 (10.9%)	10 (2.4%)	1.908 (0.723,5.039)*		2.314 (0.661, 8.101)	
	Governmental employees	46 (10.9%)	7 (1.66%)	1.336 (0.466, 3.827)		0.902 (0.225, 3.620)	
	Daily laborer	34 (8.1%)	13 (3.1%)	3.356 (1.311,8.593)*		2.028 (0.649, 6.338)	
	Student	79 (18.72%)	9 (2.13%)	1		1	

Educational status	Unable to read and write	40 (9.5%)	15 (3.6%)	2.250 (0.831,6.093)*	1.075 (0.248, 4.670)
	Able to read and write	56 (13.3%)	15 (3.6%)	1.607 (0.602,4.292)	0.642 (0.146, 2.815)
	Primary school	125 (29.6%)	31 (7.4%)	1.488 (0.610,3.629)	1.003 (0.265, 3.800)
	Secondary school	81 (19.2%)	10 (2.4%)	0.741 (0.263,2.086)	0.344 (0.084 , 1.408)
	Diploma and above	42 (10%)	7 (1.7%)	1	1
Residence	Rural	186 (44.1%)	51 (12.1%)	1.605 (0.961,2.678)*	1.210 (0.541, 2.707)
	Urban	158 (37.44%)	27 (6.4%)	1	1
Availability of toilet	No	93 (2203%)	43 (10.2%)	3.316 (2.000,5.498)**	2.408 (1.079, 5.374)*
	Yes	251 (59.5%)	35 (8.3%)	1	1
Types of toilet	Open defecation	228 (54.03%)	34 (8.1%)	0.419 (0.214,0824)*	0.869 (0.349, 2.161)
	Pit latrine	71 (16.83%)	28 (6.64%)	1.109 (0.541,2.276)	0.815 (0.363,1.828)
	Water carriage	45 (10.7%)	33 (7.82%)	1	1
Wearing of shoes	No	9 (2.13%)	8 (1.9%)	4.254 (1.586,11.409)*	3.143 (1.021,9.677)*
	Yes	335 (79.4%)	70 (16. 6%)	1	1
How often wearing shoe	Regularly	274 (64.93%)	40 (9.5%)	0.269 (0.161, 0.450)**	0.287 (0.136,605)**
	Some time	70 (16.6%)	38 (9.01%)	1	1

Note: ** is P-value=< 0.01,* is P value<0.05.

Table 2: Bivariable and multivariable analysis for factors associated with *Strongyloides stercoralis* infestation.

Variable		*Strongyloides*		Crude OR (95% CI)	Adjusted OR (95%CI)
		No (%)	Yes (%)		
Marital status	Married	235 (55.7%)	11 (2.61%)	0.381 (0.142,1.027)*	0. .325 (0.110,0.963)*
	Single	107 (25.4%)	5 (1.2%)	0.381 (0.116,1.253)*	0358 (0.102, 1.262)
	Age, not Enough to marry	57 (13.51)	7 (1.7%)	1	1
Availability of toilet	No	125 (29.62)	11 (2.61)	2.009 (0.863,4.678)*	4.114 (1.137, 14.893)*
	Yes	274 (64.93%)	12 (2.84%)	1	1
Type of toilet	Open defecation	247 (58.53%)	15 (3.56%)	3.644 (0.472, 28.129	9.715 (1.034, 91.255)*
	Pit latrine	92 (21.8%)	7 (1.66%)	4.565 (.548, 38.048)*	3.074 (0.353, 26.758)
	Water carriage latrine	60 (14.22%)	1 (0.24%)	1	1
Wearing of shoes	No	14 (3.32%)	3 (0.71%)	4.125 (1.096,15.527)*	2.665 (0.645, 11.017)
	Yes	385 (91.23%)	20 (4.74%)	1	1
How often wearing shoe	Regularly	301 (71.33%)	13 (3.1%)	0.423 (0.180,0.996)*	0.438 (0.158, 1.215)
	Some times	98 (23.22%)	10 (2.37%)	1	1

Note: ** is P-value=<0.01,* is P value<0.05.

DISCUSSION

Prevalence of hookworm and *Strongyloides stercoralis* infestation

The overall prevalence of hookworm infestation was 78(18.5%) with (95% CI: 14.9%, 21.9%); whereas the prevalence of *Strongyloides stercoralis* was 23(5.5%) with (95% CI: 3.3%, 7.8%) and co infestation of hookworms and *Strongyloides stercoralis* was found to be 6(1.4%) with (95% CI: 0.5%-2.7%).

The finding of this study is in line with the study conducted in different areas of Ethiopia like Dera District, South Gondar [4], Gamo, the University of Gondar Hospital, Northwest-Ethiopia, East Wollega, Oromia [15-18], and in Abeokuta, Nigeria[19], in Rural Communities of Chachoengsao province, Thailand [20], in Central [21], in southeast [22], in Wudil General Hospital, Kano State [23], Agrarian Communities of Kogi State, in Nigeria [24], in Tanzania [25], In Madinah, Kingdom of Saudi Arabia [26], Federal University of Bahia, Brazil [27] for the prevalence of both hookworm and *Strongyloides* infection.

The result of this study is higher than the studies conducted in different areas of Amhara region Ethiopia like Dera District, South Gondar, [4], Teda Health Centre [28], the University of Gondar Hospital [29], and in other regions of Ethiopia, Butajira [30], East Wollega, Oromia [18] Gamo [16] at Jimma, South West Ethiopia [31] and central Kenya[32], Kakamega County, Western Kenya [33] Zambia [34], a study was done in Tanzania [25], in rural areas of Nakhon Si Thammarat, southern Thailand, [35], in Abeokuta [19], in Central and Rural Community, [21], in Plateau State [36], in Port Harcourt City of Nigeria [37] in Cuba southwestern Angola [38], in Lake Victoria Basin, Tanzania [39], in Rural Communities of Chachoengsao province, Thailand, [20], in Cusco Region Peru [11], in a rural community of Gisagara District, Southern Province, Rwanda [40], in Bahia, Brazil [27]. The probable reason for this could be decreased awareness of transmission especially in the

rural community, lack of environmental sanitary conditions of the study area; low socioeconomic status of the population could be mentioned.

The prevalence of the current study is much lower than the study conducted in the rural highland of the north-western part [14], in the southern part [5]. in Asendabo town, Jimma zone [3], in the rural community of Ethiopia [41] and Cuba Western Angola [42], in Cuba southwestern Angola [38], in southeast Nigeria [22], in Rural and Semi-Urban Communities in Nigeria [43], in Kintampo North Municipality, Ghana [44], in southern Uganda [45], in Wudil General Hospital, Kano State, Nigeria [23], worldwide, in Cusco Region, Peru [11]; furthermore in Preah Vihear Province, Cambodia [2], in Bolivia [46], in Thasala district, Nakhon Si Thammarat province, Southern Thailand [47], in the central institution of southern Iran [48]. This difference might be due to the difference in the geographical area, time of study period.

Factors associated with hookworms and *S. stercoralis* infestation

The variables significantly associated with the prevalence of hookworms in multivariable logistics regression analysis ($p \leq 0.05$) were: availability of toilet and its usage habit, wearing of shoes, the regular wearing of shoes wheras marital status, availability of toilet and its usage habit, type of latrine were found to be associated with the prevalence *S. stercoralis*; the availability of toilet and its usage habit was found to be a significant factor associated with both the prevalence of hookworms and *S. stercoralis* infestation. Participants who had no toilet with AOR (95% CI: 2.408 (1.079-5.374)) were 2.4 times more likely to have hookworm infestation as compared to those who had a toilet. Participants who had no toilet AOR (95% CI: 4.114 (1.137-14.893)) were 4.1 times more likely to have *S. stercoralis* infestation as compared to those who had a toilet. This result is consistent with the study conducted in Ethiopia like the University of Gondar Hospital [17,29], in the Southern part [5], in East Wollega, Oromia [18], Jimma Town Health Centers [31], and Rural Debre Tabor [49]. Participants who had practiced open defecation with AOR (95% CI: 9.715 (1.034-91.255)) were 9.7 times more likely to have *S. stercoralis* infestation as compared to those who had water carriage latrine. This result is inconsistent with the study done in Kintampo, Ghana [44], in East Wollega, Oromia, Ethiopia [18].

Participants who did not practice wearing of shoes with AOR (95% CI: 3.143(1.021-9.677)) were 3.1 times more likely to have hookworms infestation as compared to those who wore shoes. This result is consistent with the study conducted in Bangladesh [15] and Jimma Town [31], Teda Health Centre [28] Zegie in Ethiopia [50], but inconsistent with a study conducted in Kintampo, Ghana [44]. Being farmers and daily laborer with OR (95% CI: 2.463 (1.134-5.349)), OR (95%CI: 5.349(1.311-8.593)) were 2.5, 4.4 times more likely to have hookworm infestation as compared to students.

CONCLUSION

The existence of both hookworms and *Strongyloides stercoralis* infestation was relatively high in the study area. Hookworm infestation was more prevalent than *Strongyloides stercoralis* infestation. The study pointed out that there were other intestinal parasite infestations namely: Entamoeba histolytica, (12.1%), Giardia lamblia 6.9%, and Ascaris lumbricoides 5.9%. Frequent wearing of shoes practice and availability of toilet and its usage habit for *Strongyloides stercoralis* and availability of toilet, regularly wearing of shoes were found to be associated with both hookworm and *Strongyloides stercoralis* infestation.

LIMITATION OF THE STUDY

Collecting a single stool sample from the participants may underestimate the prevalence of hookworms and *Strongyloides stercoralis* infestation and there may be a failure to detect larvae that have a long-lasting period to multiply within the susceptible human host.

DECLARATION

Authors' contributions

YA designed the study, participated in the data quality control, performed analysis, and interpretation of the draft of the paper, and prepared the manuscript. AH, and TW assisted the design, assist in the analysis and interpretation of the draft of the paper, and revised the manuscript. The authors contributed to and approved the final manuscript.

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DATA AVAILABILITY

The data set and other resources will be available online as per the rule and regulations of the journal.

CONSENT FOR PUBLICATION

Not applicable

Ethical approval and consent to participants

Ethical clearance was obtained from Debre Tabor University of Ethical Review Board; oral consent was being taken from the clients after the necessary explanation about the purpose of the study and its procedure was given to the clients and the guardians.

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