Prevalence of Soil-Transmitted Helminth Infections and Associated Risk Factors Among School Children in Dembecha Town, Ethiopia

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ABSTRACT: Soil-transmitted helminth (STH) infections are among the most common infections that affect the poorest and most deprived communities. In most developing countries, children aged 5 to 15 years are at risk for chronic helminth infection and associated morbidity. This study aimed to determine the prevalence of STH infections and associated risk factors among three government elementary schools in Dembecha town, Ethiopia. We conducted a school-based cross-sectional study involving 316 participants between November 2019 and March 2020. A systematic random sampling method was used to select study participants from the study schools. Data related to the sociodemographic characteristics of the study participants and risk factors for STH infections were collected using a pretested questionnaire survey. Parasitological examinations of stool samples were performed using the formal-ether concentration method. Study participants aged 5 to 15 years were enrolled in this study. The overall prevalence of STH infection was 21.5% (68/316). *Ascaris lumbricoides* ranked highest, with a prevalence of 11.4%, followed by hookworms 7.3%, *Trichuris trichiura* 1.9%, and *Strongloides stercoralis* 0.9%. Age groups of 10-15 years (AOR =3.109; 95% CI: 1.033, 9.350), residence in Kebele 2 (AOR =2.990; 95% CI: 1.082, 8.264), illiterate mothers (AOR =4.689; 95% CI: 1.410, 15.59), and a family size of 4-6 (AOR =3.286; 95% CI: 1.299, 8.313) were significantly associated with STH infections. The prevalence of STH infections remains an important health issue for study participants. Therefore, school deworming programs twice a year are crucially needed until the prevalence falls below the level of public health importance.

KEYWORDS: Dembecha town, Ethiopia, prevalence, risk factors, school-age children, soil-transmitted helminth infections

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Introduction

Soil-transmitted helminth (STH) infections are among the most common infections across the globe that affect the poorest and most deprived communities.[1] STH parasites most commonly associated with humans include *Ascaris lumbricoides*, *Trichuris trichiura*, hookworms (*Necator americanus* and *Ancylostoma duodenale*) and *Strongyloides stercoralis*, all of which contribute to childhood morbidity.[2] *A. lumbricoides* and *T. trichiura* infections result from the ingestion of eggs and contact with fecally contaminated soil. They spread primarily through fecal transmission, usually through the ingestion of parasite eggs in feces. Whereas hookworm and *S. stercoralis* are spread through the skin penetration of infective larvae.

Preschool-aged children (PSAC), school-aged children (SAC), and women of reproductive age are World Health Organization (WHO)-identified risk groups.[3] SAC (5-15 years) in most developing countries are at greater risk for chronic helminth infections and helminth-associated morbidities due to play with the soil and eating habits of the soil.[4] These infections are still major health problems in developing countries, affecting millions of SAC. Therefore, in children, malnutrition and anemia, which have negative impacts on development and educational performance,[5] as well as stunting growth, wasting, and underweight, have also been serious global public health problems in the developing world, including Ethiopia.[6]

The latest estimates indicated that more than 1.5 billion people were infected with at least one of the STH parasites,[7] and 4 billion people were at risk for this infection.[8] Recent estimates suggested that 819 million, 465 million and 439 million people worldwide were infected by *A. lumbricoides*, *T. trichiura*, and hookworm, respectively.[9] Moreover, 100 million people were recorded for *S. stercoralis* infection.[10,11] Globally, more than 267 million PSAC and 568 million SAC live in areas where STH infections are intensively transmitted and need treatment and preventive interventions.[7] STH infections are widely distributed in tropical and subtropical areas, with the highest burden occurring in sub-Saharan Africa (SSA), the Americas, China, and East Asia.[7] Approximately 198, 173, and 162 million people in SSA are infected with hookworm, A. *lumbricoides*, and *T. trichiura*, respectively.[12]

In Ethiopia, the number of people living in STH-endemic areas is estimated to be 81 million, comprising 9.1 million people with PSAC, 25.3 million with SAC, and 44.6 million adults.[13] The approximate numbers of people infected in Ethiopia with hookworm, *A. lumbricoides*, and *T. trichiura* were 11 million, 26 million, and 21 million, respectively.[12] A low prevalence of STH was reported in Debre Tabor (11.8%), where the prevalence of *A. lumbricoides*, hookworms, and *T. trichiura* was 7, 3.2, and 1.2%, respectively.[14] However, the prevalence of STH was moderate in Hawassa (52.4%) with

A. lumbricoides (44.4%), which was the predominant parasite, followed by *T. trichiura* (11.1%) and hookworm (7.7%).[15] In another study conducted in Mizan Aman, the prevalence of STH was high (70.3%).[16]

Risk factors associated with STH infections include walking barefoot, overcrowding, and poor health or nutritional status.[17] Furthermore, family education level, unsafe human waste disposal systems, lack of safe water supplies, low socioeconomic status, poor personal hygiene, and poor environmental sanitation, as well as frequent outdoor exposure, favor transmission.[18] According to the WHO, periodic deworming to eliminate infecting worms, health education to prevent reinfection, and improved sanitation to reduce soil contamination with infective eggs are vital for controlling STH infections.[7] The main drugs for the control of STH infections are albendazole and mebendazole. Strategic drug administration based in the community is more important for the control of STH and other intestinal parasitic infections than school- and hospital-based drug administration. Epidemiological evaluations and reports in communities are needed as guides for choosing and instituting treatments.[19]

Soil-transmitted helminth infection is highly distributed in tropical and sub-tropical countries those with lack of adequate sanitary facilities, inappropriate waste disposal systems, lack of safe water supply, and low socio-economic status. School-age children are mainly at high risk of STH infections, especially in developing countries like Ethiopia. Many investigations have been carried out among these risk groups in different parts of Ethiopia to determine the prevalence of STH and its predictors; it is unknown in this study area. Hence, this study was aimed to assess the prevalence and associated risk factors of STH infection among children in three government elementary schools in Dembecha town, Ethiopia.

Materials and Methods

Study area

The study was conducted in Dembecha town, in the West Gojjam zone of the Amhara Regional State. Dembecha is located 349 kilometers north of Addis Ababa and 205 kilometers in the western direction of Bahir Dar, the regional capital city.[61] It is situated at a latitude and longitude of 10°33′N 37°29′E/10.550°N 37.483°E and an elevation of 2083 meters above sea level.[20] The town has 1 hospital, 2 health centers, 3 health posts, 1 family guidance association clinic, and 4 private clinics. According to the 2007 Central Statistical Agency of Ethiopia (CSA),[21] Dembecha town has a population of 15 735 (7040 males and 8695 females). The research was carried out among systematically selected children from three government elementary schools in Dembecha town. There were an adequate number of latrine and pipe water supplies for schoolchildren to use in the schools (Figure 1).

Study design

A school-based cross sectional study was conducted from November 21, 2019 to March 7, 2020, among three elementary school children, such as Siso Mesk, Dembecha Junior, and Addis Amba.

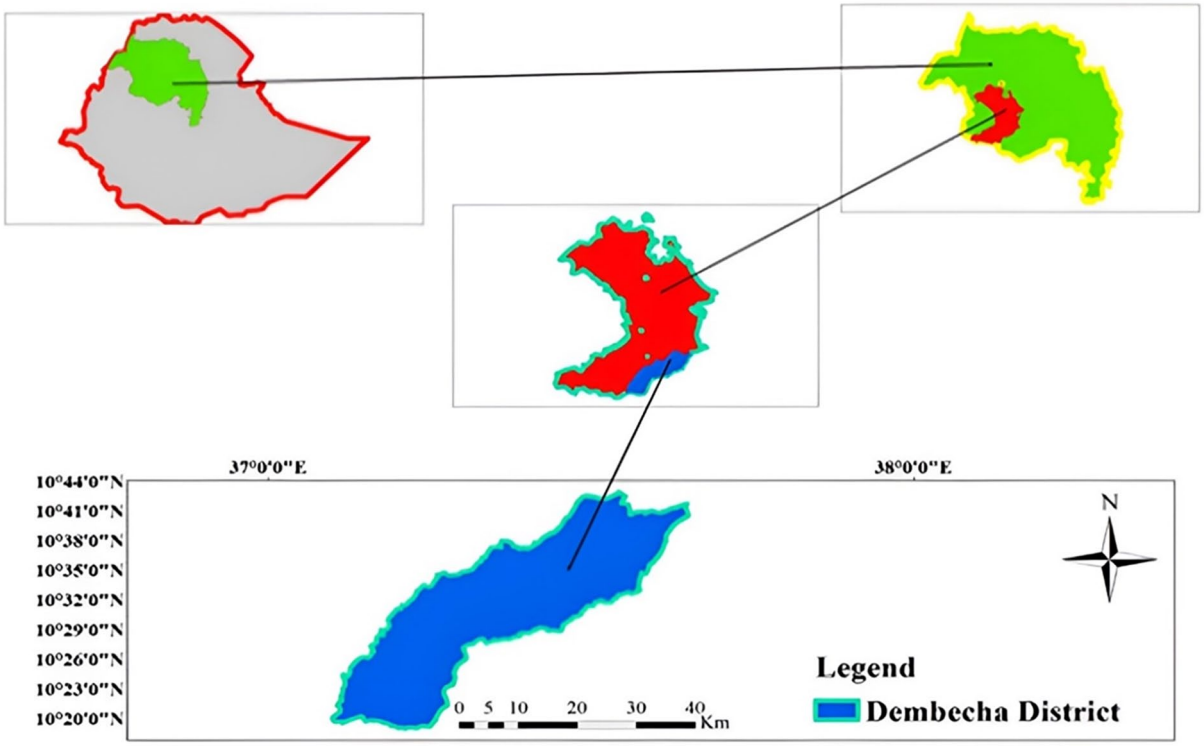

Figure 1. Location map of Dembecha district (adopted from Addis & Mengesha, 2020) with permission.[61]

Study population

All schoolchildren enrolled in three elementary schools were considered to constitute the study population for this research.

Criteria for inclusion and exclusion

Schoolchildren who were willing to participate, provided sufficient stool samples, and provided informed consent and consent from their parents or legal guardians were included, while schoolchildren who were unwilling to participate and had taken helminth chemotherapy within 3 months before data collection were excluded.

Sample size determination

The sample size was calculated using the single population proportion formula. There have been no studies on the prevalence of STH infections in the study area. As a result, we used a 50% prevalence rate of soil-transmitted infections. The required sample size (n) was determined using the following statistical formula[22]:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where, n = sample size
d= margin of error (0.05)
Z = 1.96 at the 95% confidence level
P = prevalence rate of 50% = 0.5

Finally, 384 schoolchildren were consecutively enrolled in three schools, where participants were assigned proportionally from all schools.

Sampling technique

There are 6 clusters in the town of Dembecha. Using the random sampling technique, 3 clusters were selected. Each cluster contained 2 schools, and from the 3 clusters, 3 schools were randomly selected. The schoolchildren were then stratified according to their educational level (grades 1-8). Schoolchildren's allocation to schools, grade levels, and sections was performed proportionally to the number of schoolchildren in each school, grade, and section. A systematic sampling technique was used in each study to select participants, in which thousands of children were randomly selected from readily available school lists based on unique identification codes.

Questionnaire survey

A structured questionnaire based on known risk factors was developed in English and translated into the local language (Amharic). For each schoolchild, a structured questionnaire was completed to collect demographic and associated risk factors for STH infections.

Stool sample collection and examination procedures

Each study participant provided a clean, waterproof, labeled plastic stool cup and applicator sticks to bring about 2 g of fresh stool sample. The samples collected were preserved in 10% formalin and transported to Dembecha Health Center for examination.[1] The resulting suspension was filtered through a sieve into another conical tube. After 3 to 4 mL of diethyl ether was added to the formalin solution, the mixture was centrifuged at 2000 rpm for 2 minutes.[23] The supernatant was discarded, and a thick smear was prepared from the sediment and examined under a microscope with a magnification of 400 times (40× objective and 10x ocular). Laboratory technicians examined the slides to observe the eggs and larvae of STH.

Variables

The study focused on independent variables (sociodemographic data such as age and sex); socioeconomic data such as paternal and maternal income levels; environmental factors such as latrine availability and garbage storage; types of water sources; and behavioral factors such as wearing shoes, hand washing habits after toilet, and parental education. The dependent variable was the prevalence of soil-transmitted helminth infections in the study area.

Data analysis

Statistical analysis was performed using the SPSS version 20.0 statistical package. Chi-square and univariate analyses were used to assess the associations between independent and dependent variables. The strength of the association between STH infections and associated risk factors was measured as the odds ratio (OR) using logistic regression. After univariate analysis, for which $P < .25$, a multivariate logistic regression model was used for further analysis of potential risk factors. According to our multivariate logistic regression, the associations between variables were considered to be statistically significant only if the P value was $< .05$ at the 95% confidence level. The results are presented in the text and tables.

Quality control

Before actual data collection began, experienced laboratory technologists pretested the questionnaire and other materials, such as the microscope, centrifuge, and chemicals used during data collection. The specimens were also checked for serial number, quality, and collection procedures. The stool samples were examined by 2 laboratory technicians, in order to avoid

observer bias. For quality control, randomly selected stool samples were examined by a third person, who was blinded to previous test results.

Ethical consideration

Ethical approval was obtained from the Ethics Committee of the College of Science at Bahir Dar University. A letter describing the objective of the research was sent to the Dembecha town educational office and to the schools where the research was conducted. School authorities, teachers, parents/legal guardians, and participants were informed about the objectives, procedures, and benefits of the study. Written consent was obtained from school officials and the parents or legal guardians of the children. Informed consent was also obtained from the children at the time of specimen collection.

Results

Characteristics of the study participants

Out of the 384 participants, 316 (82.3%) were interviewed, and stool samples were submitted for the use of the formol-ether concentration technique. Of the 316 study participants, 121 were from Dembecha Junior, 107 from Addis Amba, and 88 from Siso Mesk government elementary schools. There were 169 (53.5%) female and 147 (46.5%) male schoolchildren. A total of 185 (58.5%) children aged > 10-15 years were included. 162 (51.3%) of the schoolchildren were from grades 1 to 4. About 156 (49.4%) schoolchildren fathers whose education level was secondary school and above. About 177 (56.0%) study participants had a father's income level above 3000, whereas 155 (49.1%) of schoolchildren had their mother's income level below 1000 Ethiopian Birr (ETB) (Table 1).

The majority of the study participants (178; 56.3%) had a family size of 4 to 6. According to the study, 229 (72.5%) schoolchildren used the toilet. Around 216 (68.4%) schoolchildren regularly cut their fingers, and 175 (55.4%) schoolchildren always wash their hands before meals. A total of 253 (80.0%) study participants had garbage storage in their locality (Table 2).

Prevalence of STH infections and associated risk factors

The overall prevalence of STH infection in the study area was 21.5% (68/316). Among these, 27.6% (51/185) of those participants were in the 10 to 15-year-olds and had STH, while those in the 5 to 9-years-olds had parasitic infection (13%, 17/131). Among the 3 kebeles, study participants from Kebele 2 account for 32.7% (32/98) of STH infections. According to this study, 38.4% (38/99) of the respondents had STH infections from illiterate mothers. About 34.6% (53/155) of the schoolchildren were positive for STH infections that came from mothers with an income level less than 1000 ETB, and 28.2% (22/78) of the respondents were positive for STH infections that came from their fathers with an income level of 1000 to 3000 ETB. The prevalence of STH infections in schoolchildren from family sizes 4 to 6 was 28.7% (51/178). Schoolchildren who had no practice of washing hands before meals were infected with STH infections, with a prevalence of 23.5% (8/34). About 51.6% (163/316) of schoolchildren had practiced eating raw and unwashed fruits and vegetables, and 25.8% (42/163) of them were positive for STH parasitic infections (Table 3).

Table 1. Sociodemographic and socioeconomic characteristics of the study participants, including schoolchildren, Dembecha town, Ethiopia November 2019 to March 2020.

VARIABLES	CATEGORIES	FREQUENCY (%)
Sex	Male	147 (46.5)
	Female	169 (53.5)
Age in year	5-9	131 (41.5)
	10-15	185 (58.5)
Grade	1-4	162 (51.3)
	5-8	154 (48.7)
Kebele	1	102 (32.3)
	2	98 (31.0)
	3	116 (36.7)
Mother's education level	Illiterate	100 (31.7)
	Primary school	118 (37.3)
	Secondary school and above	98 (31.0)
Mother's income level	Below 1000	155 (49.1)
	1000-3000	96 (30.3)
	Above 3000	65 (20.6)
Father's education level	Illiterate	57 (18.0)
	Primary school	103 (32.6)
	Secondary school and above	156 (49.4)
Father's income level	Below 1000	61 (19.3)
	1000-3000	78 (24.7)
	Above 3000	177 (56.0)

Major STH species identified in schoolchildren

A species-specific analysis revealed that 6 species were identified. The most dominant STH was *A. lumbricoides,* followed by hookworm, *T. trichiura*, and *S. stercoralis*, with prevalence rates of 11.4% (36/316), 7.3% (23/316), 1.9% (6/316), and 0.9%

Table 2. Environmental and behavioral characteristics of the study participants, Dembecha town, Ethiopia, November 2019 to March 2020.

VARIABLES	CATEGORIES	FREQUENCY (N)
Family size	1-3	86 (27.2)
	4-6	178 (56.3)
	Above 7	52 (16.5)
Shoe wearing habit	Always	145 (45.9)
	Sometimes	117 (37.0)
	No	54 (17.1)
Eating raw and unwashed fruit and vegetables	Yes	163 (51.6)
	No	153 (48.4)
Latrine usage	In toilet room	229 (72.5)
	Open field	87 (27.5)
Hand washing before meal	Always	175 (55.4)
	Sometimes	107 (33.9)
	No	34 (10.8)
Regular finger nail trimming	Yes	216 (68.4)
	No	100 (31.6)
Habit of playing with soil	Yes	148 (46.8)
	No	168 (53.2)
Garbage storage	Yes	253 (80.0)
	No	63 (20.0)

(3/316), respectively. The distribution of STH infections among the primary school survey participants showed that the highest infection rate was recorded in the children of Dembecha Junior (44.1%), followed by Addis Ama and Siso Mesk, with prevalence rates of 30.9% and 25.0% (Table 4).

Risk factors associated with infections caused by STH

In the present study, age, residence (Kebele), maternal education level, and family size were identified as potential risk factors. The analysis revealed that individuals aged 10 to 15 years was 3 times more likely to be infected with STH infection than those aged 5 to 9 years (AOR = 3.109 (95% CI: 1.033, 9.350); additionally, participants whose residence in Kebele 2 were almost 3 folds more likely to have an infection (AOR = 2.990; 95% CI: 1.082, 8.264); and respondents who came from illiterate mothers were 4.7 (95% CI: 1.410, 15.59) times greater chance to have STH infections than educated mothers. Children with a family size of 4-6 were 3.3 (95% CI: 1.299, 8.313) times more affected than children from a family size of 1-3 (Table 5).

Risk factors associated with Asacris lumbricoides, Hookworm, and Trichuris trichiura infections

A. lumbricoides infection was significantly associated with the schoolchildren from Kebele 2 with an AOR of 8.3 (95% CI: 2.317, 29.934). Study subjects from illiterate mothers were 7 (95% CI: 1.357, 34.808) times more likely to develop *A. lumbricoides* infection than literates. Respondents with a family size of 4 to 6 and a family size greater than 7 were 9 (95% CI: 1.724, 48.426) and 8 (95% CI: 1.245, 49.210) folds more likely to catch *A. lumbricoides* infection, respectively. Furthermore, *T. trichiura* was significantly associated with respondents who practiced open field defection, with an AOR 15 (95% CI: 2.054, 161.638) times greater than that of respondents who used latrine. During the study period, hookworm and *S. stercoralis* were not significantly associated with any of the potential risk factors (Table 6).

Discussion

The burden of intestinal parasites, particularly STH infections, is often very high in schoolchildren and pregnant women.[24] Parasite infections caused by STH have been the most common infection among people living in resource-depleted developing countries. Although the deworming program has progressed in most Ethiopian primary schools since 2003 in rural areas and 2009 in urban areas,[25] the burden of STH infection is still a public health problem, as revealed in this study.

The prevalence of STH infection was 21.5%. The result is similar to those of Butajira Town, south-central Ethiopia (23.3%),[26] Gamo Gofa, southern Ethiopia (23.5%)[14] and Cameroon (24.1%).[27] However, the prevalence of STH was greater than the result in Nigeria (8.3%).[28] As compared with the current finding of STH infection, the result of STH infection in Rwanda was higher, with a prevalence rate of 65.8%.[29] This variation could be due to differences in topography and study period, during which the communities improved their living standards and personal and environmental hygiene over time.

A. lumbricoides was the most prevalent STH infection, with a prevalence rate of 11.4%, which was consistent with previous studies conducted in the Libo Kem Kem district (11.0%),[30] Durbete Town (13.9%),[31] Zegie Peninsula (12.7%)[32] and southwestern China (10.0%).[33] The result is greater than those findings in Jawi town (0.73%).[34] On the other hand, the prevalence of *A. lumbricoides* in the present study was lower than that in Gara Riketa (38.0%) (southern Ethiopia)[35] and Maytsbri/Tigray (24.9%).[36] The relatively high prevalence of *A. lumbricoides* observed in the present study may be due to the high environmental contamination resulting from the large number of infected people, the durability of *A. lumbricoides* eggs under varying environmental conditions, the high fertility,[37] and the sticky nature of the shell of *A. lumbricoides* eggs,[38] which aid in their attachment to human hands, fruits and vegetables.

Table 3. Prevalence of STH infections and associated risk factors among three school children in Dembecha town, Ethiopia, November 2019 to March 2020.

VARIABLES	CATEGORIES	NUMBER OF EXAMINED (%)	NEGATIVE FOR STH (%)	POSITIVE FOR STH (%)	CHI-SQUARE	*P* VALUE
Sex	Male	147 (46.5)	117 (79.6)	30 (20.4)		
	Female	169 (53.5)	131 (77.5)	38 (22.5)	0.201	.654
Age in year	5-9	131 (41.5)	114 (87.0)	17 (13.0)		
	10-15	185 (58.5)	134 (72.4)	51 (27.6)	9.667	.002
Grade	1-4	162 (51.3)	134 (82.7)	28 (17.3)		
	5-8	154 (48.7)	114 (74.0)	40 (26.0)	3.530	.060
Kebele	1	102 (32.3)	79 (77.5)	23 (22.5)		
	2	98 (31.0)	66 (67.3)	32 (32.7)	9.476	.050
	3	116 (36.7)	85 (73.3)	13 (26.7)		
Mother's education level	Illiterate	99 (31.3)	61(61.6)	38 (38.4)	29.197	.000
	Primary school	118 (37.3)	95 (80.2)	23 (19.8)		
	Secondary school & above	99 (31.3)	92 (93.0)	7 (7.0)		
Mother's income level	Below 1000	155 (49.1)	102 (65.4)	53 (34.6)	29.074	.000
	1000-3000	96 (30.3)	88 (90.5)	8 (9.5)		
	Above 3000	65 (20.6)	58 (93.6)	7 (6.4)		
Father's education level	Illiterate	57 (18.0)	42 (73.7)	15 (26.3)	1.763	.414
	Primary school	103 (32.6)	79 (76.7)	24 (23.3)		
	Secondary school & above	156 (49.4)	127 (81.4)	29 (18.6)		
Father's income level	Below 1000	61 (19.3)	44 (72.1)	17 (27.9)	6.284	.043
	1000-3000	78 (24.7)	56 (71.8)	22 (28.2)		
	Above 3000	177 (56.0)	148 (83.6)	29 (16.4)		
Family size	1-3	86 (27.2)	78 (90.7)	8 (9.3)		
	4-6	178 (56.3)	127 (71.3)	51 (28.7)	13.508	.001
	Above 7	52 (16.5)	43 (82.7)	9 (17.3)		
Shoe wearing habit	Always	145 (45.9)	119 (83.1)	26 (17.9)		
	Sometimes	117 (37.0)	88 (75.2)	29 (24.8)		
	No	54 (17.1)	41 (75.9)	13 (24.1)	2.054	.358
Eating raw and unwashed fruit and vegetables	Yes	163 (51.6)	121 (74.2)	42 (25.8)	3.597	.058
	No	153 (48.4)	127 (83)	26 (17.0)		
Latrine usage	In toilet room	229 (72.5)	185 (80.8)	44 (19.2)		
	Open	87 (27.5)	63 (72.4)	24 (27.6)	2.617	.106
Hand washing before meal	Always	175 (55.4)	147 (84.0)	28 (16.0)		
	Sometimes	107 (33.9)	75 (70.0)	32 (30.0)		
	No	34 (10.8)	26 (76.5)	8 (23.5)	7.695	.021

(Continued)

Table 3. (Continued)

VARIABLES	CATEGORIES	NUMBER OF EXAMINED (%)	NEGATIVE FOR STH (%)	POSITIVE FOR STH (%)	CHI-SQUARE	*P* VALUE
Habit of playing with soil	Yes	148 (46.8)	113 (76.4)	35 (23.6)	0.748	.387
	No	168 (53.2)	135 (80.4)	33 (19.6)		
Garbage storage	Yes	253 (80.0)	204 (80.6)	49 (19.4)		
	No	63 (20.0)	44 (69.8)	19 (30.2)	3.478	.062
Total		316 (100)	248 (78.5)	68 (21.5)		

Table 4. Identification of the main species of STH parasite among three government elementary school children in Dembecha town, Ethiopia, from November 2019 to March 2020.

STH TYPE	ADDIS AMBA (N = 121)	DEMBECHA JUNIOR (N = 107)	SISO MESK (N = 88)	TOTAL (OVERALL PREVALENCE)
A .lumbricoides	8 (22.2)	22 (61.1)	6 (16.7)	36 (11.4)
Hookworm	10 (43.5)	4 (17.4)	9 (39.1)	23 (7.3)
T. trichiura	-	4 (66.7)	2 (33.3)	6 (1.9)
S. stercoralis	3 (100)	-	-	3 (0.9)
Total	21 (30.9)	30 (44.1)	17 (25.0)	68 (21.5)

In the present study, the prevalence of hookworms was 7.3%. This result was comparable with that of a study conducted in Lake Hawassa (7.7%)[15] and in Birbir (5.4%).[39] However, the finding was greater than those of the Gamo Gofa zone in southern Ethiopia (3.1%)[14] and Ambo in western Ethiopia (2.8%).[40] The result of this study was much lower than the studies in Arbaminch Zuria district (14.5%),[41] Yirgacheffee, South Ethiopia (16.7%)[42] and among schoolchildren in Mettu town, southwest Ethiopia (28.1%).[43] This variation might be due to differences in altitude and environmental, socioeconomic, and behavioral conditions among the residents.

The prevalence of *T. trichiura* infection was 1.9%, which was similar to the previous studies carried out in the Libo Kem district and Ambo City elementary school children, in which the prevalences were 1.6%[30] and 2.2%[40], respectively. The present result was slightly greater than those obtained in the Guragie zone (0.5%)[44] and in Medebay Zana wereda, northwestern Tigray (0.5%).[45] However, the prevalence of *T. trichiura* was lower than the report in the southwestern part of Ethiopia (Zemika kebele) (66.8%),[16] South Asia (14%),[46] and Nigeria (31.9%).[47] This could be due to differences in environmental conditions and the study period. People living in tropical and subtropical areas of the world are at the highest risk of infection by *T. trichiura*. In addition, populations without reliable access to safe water and sanitation were at increased risk for this infection.[48]

Among the STH infections, the prevalence of *S. stercoralis* was 0.9%. This finding is in agreement with previous results from the Ilie, Osun State, southwest, Nigeria[18] and Zegie Peninsula (0.7%).[32] Nevertheless, the prevalence of this infection was lower than the result in Mecha district, Northwest Ethiopia (6.4%)[49] and the finding in Nigeria (3.4%).[47] The low prevalence of *S. stercoralis* may be due to its peculiar characteristics, which require different diagnostic methods than other STH infections. For this reason, this species is often not identified,[7] and the incidence of strongyloidiasis is greater in HIV-positive individuals than in HIV-negative individuals.[50] Moreover, environmental factors may contribute to the lower prevalence of *S. stercoralis* in the study area.

Age, residence (kebele), mother education level, and family size were identified as risk factors for STH infections among schoolchildren in Dembecha Town. Children in the age group of 10 to 15 were 3 times (95% CI: 1.033, 9.350) more likely to be infected with STH infections than those 5 to 9 years old. This is perhaps because children in these age groups are more engaged in outdoor activities such as farming; as a result, they have more exposure to STH infections. However, other study reported that children under the age of 6 years were more harbor STH infections than children older than 6 years.[44] Similarly, a report from Mizan-Aman Town showed that younger children were more infected with STH infections.[51] This variation might be due to environmental factors such as the frequent exposure of an individual to soil, the probability of contact with fecal materials, a lack of a safe water supply, and poverty.

With regard to residence, the odds of developing STH infections were 3 times higher among study participants who reside in Kebele 2 (95% CI: 1.082, 8.264) than those who reside in other Kebeles. Similar findings were reported in

Table 5. Univariate and multivariate logistic regression analyses of factors associated with STH infections among schoolchildren in Dembecha town, Ethiopia, November 2019 to March 2020.

VARIABLES	CATEGORIES	STH-POSITIVE CASE (%)	COR (95% CI)	*P* VALUE	AOR (95% CI)	*P* VALUE
Age	5-9	17 (13.0)	1		1	
	10-15	51 (27.6)	2.552 (1.396, 4.665)	.002*	3.109 (1.033, 9.350)	.044*
Grade	1-4	28 (17.3)	1		1	
	5-8	40 (26.0)	1.679 (.975, 2.892)	.062	0. 747 (0. 252, 2.220)	.600
Kebele	1	23 (22.5)	1		1	
	2	32 (32.7)	2.860 (1.218, 6.716)	.059	2.990 (1.082, 8.264)	.035*
	3	13 (26.7)	1.408 (.565, 3.509)		1.814 (0.594, 5.545)	.296
Mothers' education level	Illiterate	38 (38.4)	8.187 (3.435, 19.517)	.000*	4.689 (1.410, 15.59)	.012*
	Primary school	23 (19.8)	3.182 (1.302, 7.774)		1.701 (0.531, 5.453)	.371
	Secondary school & above	7 (7.0)	1		1	
Mother s' income level	Below1000	53 (34.6)	4.305 (1.837, 10.089)	.000*	2.548 (0.751, 8.642)	.133
	1000-3000	8 (9.5)	.753 (.259, 2.190)			
	Above 3000	7 (6.4)	1		1	
Father s' education level	Illiterate	15 (26.3)	1.241 (.548, 2.813)		0.558 (0.248, 1.254)	.158
	Primary school	24 (23.3)	1.766 (.935, 3.335)	.214		
	Secondary school & above	29 (18.6)	1		1	
Fathers' income level	Below 1000	17 (27.9)	1.972 (.992, 3.919)		1.404 (0.574, 3.433)	.457
	1000-3000	22 (28.2)	2.005 (1.064, 3.779)	.046*	0.768 (0.340, 1.738)	.527
	Above 3000	29 (16.4)	1			
Family size	1-3	8 (9.3)	1		1	
	4-6	51 (28.7)	3.915 (1.765, 8.687)	.002*	3.286 (1.299, 8.313)	.012*
	Above 7	9 (17.3)	2.041 (.734, 5.674)		2.965 (0.926, 9.497)	.067
Eating raw & unwashed fruit and vegetables	Yes	42 (25.8)	1.695 (.979, 2.935)	.059	1.563 (0.791, 3.091)	.199
	No	26 (17.0)	1		1	
Latrine usage	In toilet room	44 (19.2)	1		1	
	Open	24 (27.6)	1.602 (.902, 2.843)	.108	0.776 (0.370, 1.624)	.500
Hand washing habit before meal	Always	28 (16.0)	1		1	
	Sometimes	32 (30.0)	2.240 (1.256, 3.994)	.023*	1.957 (0.957, 4.002)	.066
	No	8 (23.5)	1.615 (.664, 3.932)		1.468 (0.444, 4.848)	.529
Garbage storage	Yes	49 (19.4)	1		1	
	No	19 (30.2)	.556 (.299, 1.036)	.065	1. 109 (0.504, 2.439)	.798

Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio.
*Statistically significant at $P < .05$; 1 = reference value.

Sekela Primary School, Western Ethiopia[52] and Brazil[53] and they agree that rural people were more affected than people who lived in urban residences. This may be due to the fact that, though the area is part of Dembecha town, the people who live there have less access to water, a lack of environmental sanitation, poverty, and poor personal hygiene.

Table 6. Univariate and multivariate logistic regression analysis of possible risk factors associated with *A. lumbricoides*, hookworm, and *T. trichiura* infection among schoolchildren in Dembecha town, Ethiopia, November 2019 to March 2020.

VARIABLES	CATEGORIES	NUMBER OF POSITIVE CASES (%)	COR (95% CI)	*P* VALUE	AOR (95% CI)	*P* VALUE
A. lumbricoides						
Age	5-9	17 (13.0)	1		1	
	10-15	51 (27.6)	2.316 (1.051, 5.107)	.037*	1.426 (0.548, 3.713)	.467
Kebele	1	23 (22.5)	1		1	.001*
	2	32 (32.7)	5.037 (1.742, 14564)	.000*	8.328 (2.317, 29.934)	.516
	3	13 (26.7)	0.950 (0.261, 3.456)		1.696 (0.344, 8.356	
Mothers' education level	Illiterate	38 (38.4)	10.240 (2.970, 35.302)	.000*	6.873 (1.357. 34.808)	.020*
	Primary school	23 (19.8)	2.642 (0.695, 10.042)		2.192 (0.468, 10.271)	.319
	Secondary school & above	7 (7.0)	1		1	
Mothers' income level	Below1000	53 (34.6)	3.362 (1.129, 10. 012)	.003*	1.498 (0.329, 6.825)	.602
	1000-3000	8 (9.5)	0.663 (0.160, 2.752)		0.524 (0.095, 2.895)	.459
	Above 3000	7 (6.4)	1		1	
Fathers' education level	Illiterate	15 (26.3)	2.553 (1.037, 6.289)	.102	1.386 (0.432, 4.447)	.583
	Primary school	24 (23.3)	1.888 (0.835, 4.265)		0.717 (0.246, 2.093)	.543
	Secondary school & above	29 (18.6)	1		1	
Fathers' income level	Below 1000	17 (27.9)	3.724 (1.595, 8.694)	.009*	2.933 (0.968, 8.727)	.053
	1000-3000	22 (28.2)	2.257 (0.950, 5.367)		0.781 (0.249, 2.451)	.672
	Above 3000	29 (16.4)	1		1	
Family size	1-3	8 (9.3)	1			
	4-6	51 (28.7)	7.840 (1.822, 33.732)	.020*	9.137 (1.724, 48.426)	.009*
	Above 7	9 (17.3)	5.478 (1.062, 28.247)		7.828 (1.245, 49.210)	.028*
Garbage storage	Yes	49 (19.4)	1		1	
	No	19 (30.2)	2.245 (1.054, 4.784)	.036*	1.643 (0.621,4.345)	.317

(Continued)

Table 6. (Continued)

VARIABLES	CATEGORIES	NUMBER OF POSITIVE CASES (%)	COR (95% CI)	*P* VALUE	AOR (95% CI)	*P* VALUE
Hookworm						
Age	5-9	17 (13.0)	1			
	10-15	51 (27.6)	2.246 (0.866, 5.821)	.096	2.269 (0.851, 6.050)	.102
Mothers' income level	Below1000	53 (34.6)	2.715 (0.771, 9.559)	.120	2.291 (0.634, 8.279)	.206
	1000-3000	8 (9.5)	0.667 (0.130, 3.410)	.626	0.598 (0.115, 3.099)	.540
	Above 3000	7 (6.4)	1			
Eating raw & unwashed fruit and vegetable	Yes	42 (25.8)	1.973 (0.819, 4752	.130	1.798 (0.718, 4.500)	.210
	No	26 (17.0)	1			
Hand washing before meal	Always	28 (16.0)	1		1	
	Sometimes	32 (30.0)	2.330 (0.947, 5.732)	.181	2.065 (0.805, 5.294)	.131
	No	8 (23.5)	1.785 (0.457, 6.967)		1.683 (0.408, 6.938)	.471
T. trichiura						
Grade	1-4	28 (17.3)	1			
	5-8	40 (26.0)	5.403 (0.624, 46.780)	.126	7.971 (0.892, 71.229)	.063
Latrine usage	In toilet room	229 (72.5)	1			.009*
	Open	87 (27.5)	13.902 (1.600, 120.769)	.017*	15.220 (2.054, 161.638)	

Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio.
*Statistically significant at $P < .05$; 1 = reference value.

The odds of developing STH infections were 4.7 (95% CI: 1.410, 15.59) times higher among respondents who came from illiterate mothers as compared to their counterparts. This finding is in harmony with the results of Mecha town[49], Kenya[54] and Mexico.[55] This might be due to educated mothers who know their children to practice personal hygiene, not allow playing with soil, and hand washing practices before meals and after defecation.

Among the study participants, family size 4 to 6 was significantly associated with STH infections, with an AOR of 3.3 (95% CI = 1.299, 8.313). The report is in accordance with the results conducted in Dona Ber[50], Bahir Dar[51] and outside of Ethiopia in Brazil.[53] This could be due to overcrowding or communal living conditions, which are risk factors for the transmission of some intestinal helminths.[39] In addition, people with a larger family may be unable to fulfill necessary commodities, including hygienic materials and quality food for their families. Hence, family size, along with other risk factors, plays a significant role in the transmission of STH infections.

Schoolchildren who practiced open field defection were 15 times (95% CI: 2.054, 161.638) more likely to develop *T. trichiura* infections than those who used latrine. This result is in line with the study done in Jimma[56] and the central American report.[57] This finding was also in agreement with the findings in Indonesia,[58] and Cameroon.[59] At the same time, a study conducted in Bangladesh reported that nonhygienic disposal of human stool was significantly associated with *T. trichuris* infection.[60] This may be due to the fact that open field defecation increases contamination in society, which in turn decreases environmental and personal hygiene and hence increases *T. trichuris* infection among schoolchildren because of the existing improper defecation system.

Conclusion and Recommendations

Soil-transmitted helminth infections are the main public health problem among the three selected government elementary schoolchildren. *A. lumbricoides*, hookworm *T. trichuris*, and *S. stercoralis* were identified as the most prevalent STH parasitic species among schoolchildren. In the present study, age, residence, education level of the mother, and family size were identified as risk factors significantly associated with STH infections. Therefore, we recommend community-based strategic drug administration rather than school-based drug administration. We also recommend that improved personal and environmental sanitation, health education, and good handling of affected individuals are very important for the control of STH infections.

Author Contributions

Material preparation was performed by AA and AG; Data collection and analysis were performed by AA, SM, and AG; writing the paper was done by AA, SM, and AG. All authors reviewed and approved the manuscript.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author (Abayeneh Girma), upon reasonable request.

Ethical Approval

The study was approved by the ethical committee of the College of Science of Bahir Dar University (BDU). Date 21/11/2019, Ref no. PGRCSVD/100/2019.

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