



Soil-Transmitted Helminthiasis and Associated Risk Factors among School Children in Molale Town of Menz-mama District, Northern Ethiopia

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Abstract

Soil-transmitted helminths (STH) pose a significant public health challenge in Ethiopia. This research aimed to assess the prevalence of soil-transmitted helminth infections (STHI) and their associated risk factors among schoolchildren in Molale town, a topic not previously explored. A sample of 183 students from grades 1 to 8 was randomly chosen for participation, with data on sociodemographic and environmental factors collected using pre-tested questionnaires. Stool samples from each child were examined through direct wet mount techniques. Statistical analysis, including descriptive statistics, chi-square tests, and logistic regression was conducted using SPSS version 23. The study revealed an overall STHI prevalence of 33.8% (62 cases) among the 183 participants. The primary parasite identified was *Ascaris lumbricoides* (50%), followed by hookworm species (35.4%), *Enterobius vermicularis* (11.2%), and *Hymenolepis nana* (3.2%). Risk factors for STHI included open-field defecation, the use of running water for drinking, lack of shoe-wearing, rural residency, being female, and being in the age group of 10-14 years. The odds of STHI were 3.6 times higher for children using running water compared to those using piped or tap water (AOR=3.68; CI: 1.47, 2.28). Children not wearing shoes were 2.6 times more likely to be exposed to STHI than their counterparts who wore shoes regularly (AOR=2.6; CI: 1.1, 2.7). In conclusion, promoting health education regarding handwashing before eating, the use of clean drinking water, and the consistent wearing of shoes could play a crucial role in preventing STH in the study area.

Keywords: Ethiopia, Molale town, Schoolchildren, Soil-transmitted helminths

1. Introduction

Soil-transmitted helminths (STH) represent a significant public health concern in Ethiopia. Helminths are organisms characterized by multiple cells including nematodes (roundworms), cestodes (tapeworms), and trematodes (flatworms), which commonly inhabit the human gastrointestinal tract. Geohelminths, specifically *Ascaris lumbricoides* (roundworm), *Trichiuris trichiura* (whipworm), *Ancylostoma duodenale*, and *Necator americanus* (hookworms), are particularly prevalent in tropical and subtropical regions where there is a lack of sufficient water and sanitation infrastructure. Estimates indicate that *A. lumbricoides* can infect more than a billion people, while *T. trichiura* and hookworms affect 795 million and 740 million individuals, respectively. According to the World Health Organization (WHO) [1], approximately 1,472 million people are affected

by roundworm infection, 1,289 million by hookworm infection, and 1,049 million by whipworm infection. These STH species are commonly grouped because they require similar diagnostic procedures and respond to the same medications [2].

Infections caused by *Trichiuris trichiura*, *Ascaris lumbricoides*, and *Necator americanus* can lead to stunting, wasting, diarrhea, nutritional deficiencies, physical and mental growth retardation, organ failure, and in rare cases, death [3]. Additionally, intestinal helminth infections can impede educational achievement and hinder economic development. The extent of harm inflicted by STH on individual health varies based on factors such as the parasite species, infection intensity, interactions between different parasite species (and concurrent infections), the host's immunological status, and overall health. In tropical regions, the elevated prevalence of intestinal parasites

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is largely attributed to factors like socioeconomic status, lack of access to safe drinking water, poor sanitation conditions, and inadequate medical care. However, quantifying the impact of intestinal parasitic infections is challenging due to the asymptomatic nature of many cases, leading them to go undetected [4].

The spread of STH is influenced by various environmental factors including soil type and climate, which affect parasite survival. Transmission is also influenced by the degree of contamination in the environment with infectious eggs or larvae and the level of contact between susceptible hosts and contaminated soil [5]. WHO categorizes areas with STH prevalence as high transmission (prevalence >50%), moderate transmission (prevalence between 20%-50%), and low transmission (prevalence <20%) [2]. In East African countries, the prevalence of intestinal parasitic infections is reported to be 50%, and notably, all diagnosed infected children were asymptomatic [6]. There is an observed upward trend in STH infections in developing nations with STH parasites contributing to mortality, particularly in developing countries [7].

In Ethiopia, STH infection poses a significant public health challenge [8]. The country is heavily burdened by STH infection, attributed to factors such as poor personal and environmental hygiene, inadequate water quality, and insufficient toilet coverage and usage. In certain regions of Ethiopia, the prevalence of STH infection has been reported to reach 83.3% [9]. Similarly, residents in and around Molale district face challenges such as low socio-economic status, substandard personal and environmental hygiene (including environmental contamination due to human excreta and limited toilet coverage), and a lack of access to safe water. Additionally, the district lacks well-organized health centers and trained health personnel to raise awareness about STH. Notably, there has been no scientifically reported study on the prevalence of STH in this particular area. Hence, this study aimed to assess the prevalence of soil-transmitted helminthiasis and identify associated risk factors among children attending Molale Elementary School.

2. Materials and Methods

2.1. Description of the study area

Molale town is situated in the Menz mama district of the North Shewa Zone, Amhara region, approximately 124 km away from Debere Berhan town and 256 km from Addis Ababa. The district encompasses three ecological zones, namely "Woinadega" (40%), "Dega" (35%), and "Kola" (25%). The primary livelihood of the district's residents revolves around agriculture with livestock breeding being another significant activity.

The major food crops cultivated in the area include barley, wheat, teff, and beans. The district is served by one hospital, four health centers, and twenty health extension service centers.

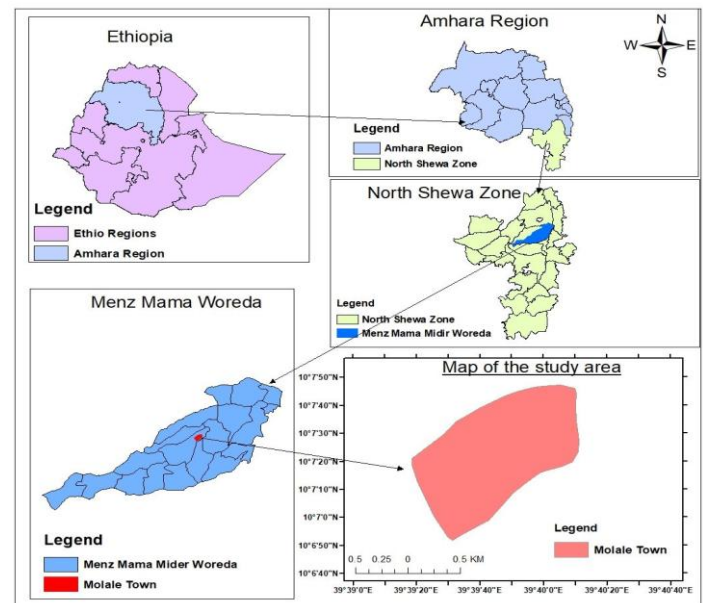


Figure 1. Map of Ethiopia showing Molale town (Source: Ethio-GIS, 2021).

2.2. Research design and Study population

A cross-sectional study was carried out at Molale Primary School from December 2021 to March 2022, involving children attending grades 1 to 8 during that period. The total student enrollment for the academic year 2021 in grades 1 to 8 was 1489, with 677 being male and 812 females. Only children who voluntarily agreed to participate and whose parents or guardians provided signed consent were included in the study.

2.3. Sample size determination and sampling techniques

The sample size (n) was determined using Daniel's statistical formula from 1999, as cited in [10]. The formula employed for this study was $n = Z^2 * P * (1 - P) / d^2$, where n represents the total sample size, Z is 1.96 at a 95% confidence level, d is the margin of error set at 5% (d= 0.05), and p is the assumed probability of STH prevalence. Given that the prevalence of STH parasites was unknown in the study area, it was conservatively assumed to be 50% (p=0.05). Consequently, the total required sample size was calculated as 403, including a 5% addition to account for potential errors arising from non-respondents.

The selection of students from Molale Elementary School was carried out through a simple random sampling technique. The registration lists for each grade and section were compiled from the school, and the necessary number of children was randomly chosen, with the sample size proportionally allocated to each educational level and section (grades 1-8).

2.4. Data collection methods

Data collection tools included both questionnaires and stool examination methods. Pre-tested questionnaires were utilized to gather information on socio-demographic characteristics, environmental factors, hygiene and sanitation practices, water sources, toilet facilities, and habits related to consuming unwashed fruits and vegetables. The questionnaires were initially developed in English, but translated into Amharic, and then back-translated into English. Participants independently provided stool samples, and laboratory examinations were conducted using the direct wet mount (direct fecal smear) techniques at Molale Health Center. Data collection was facilitated by Molale primary school teachers who were familiar with the school children and their families (parents and guardians). The quality of reagents and instruments used for data collection was assessed by experienced laboratory technicians before the commencement of data collection.

2.5. Data analysis

The data underwent a thorough completeness check and were analyzed utilizing SPSS software version 23. Descriptive statistics including frequency and percentages were employed along with association tests such as the chi-square test and logistic regression analysis. Statistical significance between variables was determined by a p -value < 0.05 .

3. Results

3.1. Prevalence of helminthiasis in Molale Elementary Schoolchildren

Out of the 403 individuals targeted for the study, 183 students actively participated. Among them, 63 (34.4%) were males, and 120 (65.5%) were females. The overall prevalence of soil-transmitted helminthiasis among the study participants was 33.8%, with a total of 62 cases identified. The stool examination revealed the presence of four species of STH parasites, with *Ascaris lumbricoides* being the most prevalent, accounting for 50% of helminth infections. Following this, hookworm species constituted 35.4%, *Enterobius vermicularis* was present in 11.2%, and *Hymenolepis nana* accounted for 3.2% (Figure 2).

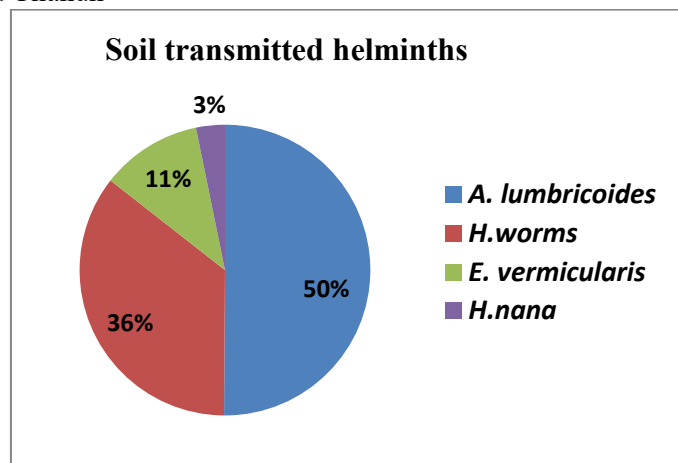


Figure 2. Soil-transmitted parasitic helminths identified in the study area.

3.2. Helminthiasis concerning demographic features

Among the 183 students surveyed, 103 (56.2%) resided in rural areas, while 80 (43.8%) lived in urban locations. Of the 103 students in rural residences, 71.1% were found to be infected with at least one of the identified soil-transmitted helminth infections (STHI). A higher prevalence of STHI was observed in females (67.7%) compared to males (32.3%). The age group of 10 to 14 years exhibited the highest prevalence of soil-transmitted helminthiasis at 80.6%, in contrast to the 5 to 9 age group, which had a prevalence of 19.4%. Additionally, the prevalence of *Ascaris lumbricoides* and hookworm infections was higher in the 10 to 14 age group compared to the 5 to 9 age group (Table 1).

3.3. Risk factors associated with helminthiasis

In this study, several factors were identified as risk factors for soil-transmitted helminthiasis, including toilet conditions, water sources, shoe-wearing habits, family dwelling practices, sex, and age. The odds of STHI were found to be 2.21 times higher in children who practiced open-field defecation compared to those using private toilets (AOR=2.21; CI: 0.47, 0.58; $p < 0.05$). Individuals predominantly using running water had approximately 3.6 times higher odds of STHI than those relying on piped or tap water (AOR=3.68; CI: 1.47, 2.28; $p < 0.05$). Children who did not wear shoes were 2.6 times more prone to STHI than those who wore shoes regularly (AOR=2.6; CI: 1.1, 2.7; $p < 0.05$). Those residing in rural areas were 2.8 times more affected by STHI compared to their urban counterparts (AOR=2.8; CI: 1.4, 1.9; $p < 0.05$).

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Females exhibited 2.2 times higher likelihood of STHI than males (AOR= 2.2; CI: 1.7, 4.2; $p < 0.05$). Furthermore, the age group of 10 to 14 years was identified as a higher-risk group for STH compared to the 4 to 9 age group (AOR =2.4; CI: 1.05, 1.75; $p < 0.05$) (Table 2).

Table 1. Prevalence of STHI among children in Molale Elementary School

Variables	Categories	Number examined	<i>A. lumbricoides</i> Positive (n, %)	<i>E. vermicularis</i> Positive (n, %)	<i>H. nana</i> Positive (n, %)	<i>H. worms</i> Positive (n, %)	Total
Age	5 – 9	23	4(6.4)	2(3.2)	1(1.61)	5(8.06)	12(13.4%)
	10 – 14	160	27(43.5)	5(8.06)	1(1.61)	17(27.4)	50(80.6%)
	X ² (P)		0.82(0.01)	0.44 (0.93)	1.24(0.74)	0.16(0.08)	
Sex	Male	63	5(8.06)	3(4.8)	0(0)	12(19.3)	20(32.3%)
	Female	120	26(41.9)	4(6.44)	2(3.2)	10(16.1)	42(67.7)
	X ² (P)		3.69(0.06)	0.36(0.94)	0.94(0.81)	5.01(0.17)	
Resident	Rural	103	28(45.1)	4(6.4)	1(1.61)	16(25.8)	49(79.1%)
	Urban	80	3(4.8)	3(4.8)	1(1.61)	6(9.6)	13(20.9%)
	X ² (P)		2.38(0.04)	2.03(0.56)	0.66(0.88)	0.45(0.03)	

Table 2. Socio-demographic factors associated with STHI among schoolchildren of Molale primary school, Molale town, from September 2021-October 2021. AOR- Adjusted odds ratio; 1- Reference variable; * = $p < 0.05$

Variables	Categories	Helminths infection		AOR (95% CI)	P - value
		Yes	No		
Toilet condition	Private	33	81	1	
	Open field	22	17	2.21(0.47, 0.58) *	0.02
	Common	7	23	4.35 (-1.8, 0.25)	0.06
Source of water	Pipe water	11	76	1	
	Spring water	42	25	0.08(-0.044, 0.065)	0.08
	Running water	9	20	3.68 (1.47, 2.28) *	0.001
Cut their nail when it grows	Yes	39	89	1	
	No	23	32	0.60 (- 1.1, 0.095)	0.136
Washed their hand after toilet with soap	Yes	52	113	1	
	No	10	8	0.36 (-2.1, 0.07)	0.06
Use soap to wash dinning utensils	Yes	47	98	1	
	No	15	23	0.73 (-1.031, 0.43)	0.91
Washed fruits and vegetables	Yes	44	99	1	
	No	18	22	0.53 (-1.32, 0.052)	0.59
Shoe wearing habit	Yes	16	14	1	
	No	46	107	2.6 (1.1, 2.7) *	0.008
Family job	Government	21	34	1	
	Private	41	87	1.2 (- 0.46, 0.82)	0.417
Family education	literate	19	45	1	
	Illiterate	43	76	0.74 (-0.943, 0.341)	0.386
Family dwelling areas	Urban	13	10	1	
	Rural	49	111	2.8 (1.14, 1.9) *	0.005
Drinking water	With treatment	36	65	1	
	Without treatment	26	56	1.1(- 0.55, 0.70)	0.577

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Get information about hygiene	Yes	15	39	1	0.65 (-1.09, 0.23)	0.265
	No	47	82			
Sex	Male	20	3	1	2.2 (1.7, 4.2) *	0.05
	Female	42	118			
Age	4 – 9	12	11	1	2.4 (1.05, 1.75) *	0.01

4. Discussion

The overall prevalence of STHI was 33.8%, affecting 62 children out of the 183 study participants. This prevalence was comparatively lower than STH studies conducted in various regions of Ethiopia, such as Durbete town (54.9%) [11], Adwa town (69%) [12], and North Gondar (66.7%) [13]. Conversely, the prevalence of STH in our study was higher than that reported in other Ethiopian studies, including Were-abay (12.22%) [14], Babile town (13.8%) [15], and Medebay Zana district of North Western Tigray (12.7%) [16]. These variations in STH prevalence among different study areas could be attributed to factors such as topography, sample size, study site selection, and seasonal variations. However, it underscores the significant burden of STH particularly among the poorest communities worldwide and its widespread occurrence in Ethiopia.

In this study, the predominant parasite identified was *Ascaris lumbricoides* accounting for 50%, followed by hookworm species at 35.4%, *Enterobius vermicularis* at 11.2% (7 cases), and *Hymenolepis nana* at 3.2% (2 cases). A similar study reported that *A. lumbricoides* (25.7%) was the most prevalent infection, followed by *T. trichiura* (10.3%), hookworms (5.1%), and *S. stercoralis* (1.5%) in Dadin Kowa school [17]. The higher prevalence of *A. lumbricoides* is often associated with favorable environmental conditions and the high reproductive capacity of their eggs in contaminated soil [18]. Climatic conditions may also contribute to the prevalence of hookworm infections [19].

STHI are transmitted through eggs present in human feces, contaminating the soil and developing into infective stages (eggs/larvae) in areas with poor sanitation. The current study reveals that females were more susceptible to STHI than males. Children residing in rural areas were significantly more affected by STH than their urban counterparts, possibly due to the lack of preventive measures such as wearing shoes, poor sanitation, and limited utilization of latrines. This finding aligns with a study conducted by Tolera and Dufera [20] in Sekela town, which reported a higher infection rate (17.7%, 68 cases) in surrounding rural/village areas compared to urban settings (8.1%, 31 cases). This disparity may be attributed to the increased exposure

of schoolchildren in rural areas to STH transmission factors, including contact with fecal-contaminated soil, lack of sanitation, and inadequate shoe-wearing practices [18].

In this study, a significant number of individuals engage in open-field defecation. The odds ratio strongly suggests a robust association between open defecation and STHI. The prevalence of STHI was notably higher among those who reported practicing open-field defecation compared to those who did not engage in this practice [21]. Improving latrine coverage and utilization emerges as a crucial initiative in the study area, and it could be effectively facilitated through health extension program packages [22].

Study limitation: The primary constraint encountered during the study was the disruption of the data collection process due to the COVID-19 pandemic.

5. Conclusion and recommendations

STH posed a significant public health concern among schoolchildren in Molale town, with *A. lumbricoides* being the most prevalent in the study area. Implementing community-based health education to promote the habits of wearing shoes, discouraging open defecation practices, and advocating the use of clean drinking water (after boiling running water) would be crucial to minimize STHI. Additionally, prioritizing environmental sanitation, personal hygiene practices, and incorporating deworming would be essential components for controlling and preventing STHI.

Ethical consideration

Approval to conduct the research was granted by the Biology Department of Debre Berhan University. Before data collection, signed assent was obtained from each child's parent or guardian. Children who tested positive for STH received treatment with anti-helminthic drugs (Albendazole and Mebendazole).

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