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Prevalence and associated risk factors of soil-transmitted helminth infections among schoolchildren in Mekan Eyesus town, northwestern Ethiopia

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ABSTRACT

Background: Little attention has been paid to determining the prevalence and associated factors of soil-transmitted helminth (STH) infections in some developing countries. This study was, therefore, carried out to determine the prevalence and associated factors of STH infections among schoolchildren attending three primary schools in Mekane Eyesus town, northwestern Ethiopia.
Methods: A school-based cross-sectional study was conducted from March to June 2023 in Mekane Eyesus town. Stool samples were collected from 401 children from three primary schools in the town. Wet-mount and formol ether concentration techniques were used to diagnose stool samples, and a structured questionnaire was used to collect data on socio-demographic characteristics and risk factors for STH infections.
Results: The overall prevalence of STH infection in this study was 18.2 % (73/401). The most common helminth species detected was *Ascaris lumbricoides* (*A. lumbricoides*) (7.5 % (30/401)). Not trimming fingernails regularly (adjusted odds ratio (AOR) = 3.75, 95 % CI = 1.87–7.50), having illiterate fathers (AOR = 2.29, 95 % CI = 1.18–4.44), and being aged 15–17 years (AOR = 2.37, 95 % CI = 1.06–5.30) were associated with increased odds of STH infection. Children who wash their hands after defecation (AOR = 0.43, 95 % CI = 0.21–0.88) and those whose mothers were housewives (AOR = 0.22, 95 % CI = 0.08–0.58) had lower odds of STH infection.
Conclusion: This study found a high prevalence of STH infection among schoolchildren in Mekane Eyesus town. Thus, STH infection preventive measures, including deworming of schoolchildren, should be implemented in the study area. Moreover, giving health-related knowledge about STH infection prevention strategies, such as regular fingernail trimming and hand washing after defecating, is vital for reducing the prevalence of STH infections in the study area.

1. Background

Soil-transmitted helminth (STH) infections are a public health problem in the world (Organization WH, 2010). About 1.5 billion people worldwide have been reported to be infected with STHs (**World Health Organization, 2020**). The most prevalent STH in the world, *Ascaris lumbericoides* (*A.lumbricoides*), is estimated to infect more than 1.2 billion people (Parija et al., 2017). Hookworms (*Necator americanus* (*N.americanus*) and *Ancylostoma duodenale* (*A.duodenale*)) and *Trichuris trichiura* (*T. trichiura*) are also common

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STHs, infecting 740 and 795 million people globally, respectively (Parija et al., 2017). Socioeconomic status, low standard of living, and poor personal and environmental hygiene have been linked to an increased risk of STH infections (Aemiro et al., 2024).

STH infections are most prevalent in children, and can affect their intellectual development, growth, and immunity to diseases (Raj et al., 1997). About 260 and 654 million preschool and school-aged children live in areas where STHs are intensely transmitted, respectively (World Health Organization Expert Committee, 2002). The severity of STH infections has been reported to be higher in children than adults (Tefra et al., 2017). The high prevalence and severity of STH infections in children are primarily due to their frequent contact with STH-contaminated soil and less developed immune systems (Tefra et al., 2017).

STH infections are a major cause of morbidity and mortality among children in sub-Saharan Africa (SSA), including Ethiopia (Farrant et al., 2020). There have been initiatives in SSA to prevent and control STH infection among children though its burden is still increasing in many countries in the region (Farrant et al., 2020). In Ethiopia, a plan was developed to reduce STH infections to the point where they are no longer a public health problem by 2020, and efforts have been made to put this plan into action in the country, including the Amhara region (*Ethiopia FMoHo. of National Neglected Tropical Diseases Master Plan*, 2016). This plan comprised strategies such as annual school-based deworming integrated with ongoing deworming efforts for preschool-aged children, adults, and adolescents (*Ethiopia FMoHo. of National Neglected Tropical Diseases Master Plan*, 2016). The plan also integrated strategies such as improving access to and utilization of sanitation services and safe water, as well as promoting social behavior change (*Ethiopia FMoHo. of National Neglected Tropical Diseases Master Plan*, 2016). The strategies have been implemented through various delivery channels, including school-based mass drug administration (MDA) and primary health care centers (*Ethiopia FMoHo. of National Neglected Tropical Diseases Master Plan*, 2016). Despite previous control efforts, the prevalence of STH infection among children is increasing in different parts of the country (Farrant et al., 2020; WHO, 2015). The prevalence and severity of STH infections in Ethiopia also vary by region and community (Farrant et al., 2020; Alelign et al., 2015).

The Amhara region is one of the regions in Ethiopia with a moderate to high prevalence of STH infections among schoolchildren (Alemu et al., 2018; Afework Bitew et al., 2016). Despite this, the majority of studies undertaken in this region to assess the burden of STH infections did not focus on schoolchildren, and those that did only targeted a few schools in the area (Farrant et al., 2020). Mekane Eyesus town is one of the towns in the Amhara region with a paucity of data on the burden of STH infections among schoolchildren. However, assessing the prevalence of STH infections has been reported to aid policymakers in developing effective preventative and control strategies (Tchuem Tchuenté, 2011; Mascarini-Serra, 2011). There was also a lack of recent data on the prevalence of STH in different parts of Amhara region. However, close follow-up and periodic STHs infection studies are crucial for updating and understanding the prevalence of infection, as well as the efficacy of control measures implemented (Eyayu et al., 2022). This study was, therefore, conducted to determine the prevalence and associated risk factors of STH infection among schoolchildren in Mekane Eyesus, northwestern Ethiopia.

2. Methods

2.1. Study area and design

A school-based cross-sectional study was conducted from March to June 2023 to explore the prevalence of STH infection and related risk factors among children enrolled in three primary schools (Mabie, Mekan Eyesus, and Gafat) in Mekan Eyesus, South Gondar Zone, Northwest Ethiopia. Mekan Eyesus is in the Amhara region in northwest Ethiopia. The town lies 114 km from Bahir Dar, the capitol of the Amhara Region, and 678 km from Addis Ababa, the capital of Ethiopia. According to 2017 data from the Central Statistical Agency of Ethiopia, the population of this town is estimated to be 20,601, with 10, 719 males and 204,631 women (Ababa, 2014). Mekan Eyesus town is located at 11°37′60″N and 38°4′0″E, with an elevation of 2616 m above sea level. The average annual rainfall in the district is 1307 mm, with a maximum of 1500 mm (Alelign et al., 2024).

2.2. Study population and eligibility criteria

The study population included schoolchildren who attended the three selected primary schools in Mekane Eyesus during the study period. During the 2023 academic year, 1642 children (817 males and 825 females) attended the three schools. Schoolchildren who gave their consent through their parents or caregivers to participate in the study were included. The study excluded schoolchildren who had used anti-helminthic drugs within the last three months of data collection.

2.3. Sample size determination and sampling

The sample size was estimated using the formula $n = (z\alpha/2)^2 p(1-p)/d^2$ at 95 % confidence interval (95% CI), 50 % prevalence/proportion, 5 % non-response rate, and 5 % marginal error (Naing et al., 2006). The sample size was established to be 403, and 401 children with complete data were included in the study. 50 % prevalence was used since the prevalence of STH infection in schoolchildren in the study area was unknown. The study participants were selected using systematic random sampling.

The sampling process involves multiple steps. All five schools in the study area were first listed, and three primary schools were chosen at random using the lottery method. The percentages of male (48 %) and female (52 %) students in the three selected primary schools were then determined. The number of respondents, both male and female, from each of the three schools that would be included in the study was then determined by multiplying the percentage of male students in the three schools by the sample size. The same method was used to determine the number of female respondents. Thus, 192 male (401*48/100) and 209 female (401*52/100) students were included in the study from the three schools.

The total number of students from each school who would participate in the study was then calculated by multiplying the total number of students in each school by the sample size and then dividing by the total number of students in the three schools. Thus, 176 (721*401/1642), 138 (565*401/1642), and 87 (356*401/1642) students were selected from Mekane Eyesus, Mabie, and Gafat schools, respectively.

Following this, the proportion of male and female students who would participate in the study from each school was determined as follows: (number of male students in one of the schools) x (total number of male students that would be included in the study) ÷ (total number of male students in the three schools).The same method was used for female students. Thus, the study included 80 male (330*192/788) and 96 female (391*209/854) students from Mekane Eyesus School. The same procedure was used to select male and female respondents for Mabie (male: 245*192/788 = 60; female: 320*209/854 = 78) and Gafat (male: 175*192/788 = 43; female: 181*209/854 = 44) schools. A quota was allocated for each grade level based on the number of students in each grade. After determining the proportion of students who would participate in the study, a lottery was employed to select them; that is, each student was assigned a number, and the numbers were drawn at random.

2.4. Questionnaire survey

A pretested structured questionnaire was used to collect data on the study participants' socio-demographic characteristics. The study participants were schoolchildren, and a questionnaire was presented to them to collect data on socio-demographic and potential risk factors. Parents or guardians assisted children who were unable to provide some of the questions on socio-demographic and potential risk factors. Some of the socio-demographic data collected from study participants included age, gender, residence, and education status. Data on potential risk factors for STH infection, such as access to a latrine, washing hands after defecation, and eating unwashed vegetables, were also collected. The questionnaire was initially written in English and then translated into Amharic, the local language. The questionnaire was pretested with 5 % of the study's overall sample size.

2.5. Stool sample collection

The study participants were given a clean plastic stool collection cup with an applicator stick and instructed to provide approximately 5 g of their stool. The stool collecting cups were labeled with the sample collection date and the study participant's names or ID number. Each participant's stool sample was examined with a direct smear within 30 min of collection at a field or temporary laboratory set up at the study sites. Fresh stool specimens were put in tubes labeled with the sample collection date and the study participant's name or ID number, mixed with 10 % formalin, and transported to Este Primary Hospital for the formol-ether stool concentration technique. Two qualified laboratory technicians worked independently to examine the stool samples. Before collecting and analyzing samples, all reagents and supplies were quality checked.

2.6. Wet-mount

A direct wet mount was prepared and examined after macroscopically examining the stool specimens for consistency, color, blood, mucus, and adult parasites. Briefly, two grams of stool were emulsified with normal saline (0.85 % sodium chloride (NaCl) solution), and a drop of the resulting sample was placed onto a clean, microscopic glass slide. On the opposite side of the slide, an iodine mount was prepared. Both wet mounts were covered with coverslips positioned at a 45° angle. Lastly, the samples were examined for parasites using a light microscope with 10× and 40× objective lenses.

2.7. Formol-ether concentration

The formol-ether concentration technique was used to examine a part of the 5 g stool sample collected from each study participant. Using an applicator stick, roughly 1–2 g of stool sample were added to a clean 15 ml conical tube that held 7 ml of 10 % formalin. The applicator stick was used to completely mix the suspended sample. The resultant suspensions were put through a cotton gauze screen into a beaker, and the filtrate was then poured into the same tube. The mixture was manually shaken and then centrifuged for three minutes at 2000 rpm using 3 ml of diethyl ether. From the sediments, an iodine stain was prepared for each sample. Using 10× and 40× objective lenses, the entire region under the coverslip was finally examined. The specimens were considered positive if the helminth eggs, larvae, or cysts were found by wet mount or formol-ether concentration techniques.

2.8. Data analysis

The statistical package for social sciences (SPSS) software, version 25, was used to enter and analyze the data (Armonk, NY: IBM Corp.). Using logistic regression, the crude odds ratio (COR) and adjusted odds ratio (AOR) were calculated to examine the association between socio-demographic characteristics, STH risk factors, and STH infection. Multivariable logistic regression includes variables with $p < 0.25$ from univariable logistic regression. *P*-values ≤ 0.05 were considered statistically significant.

3. Results

3.1. Socio demographic characteristics

A total of 401 schoolchildren (52.10 % female) were enrolled in the study. The majority (36.91 %) of the children's mothers were farmers, followed by housewives (29.93 %), merchants (24.94 %), and government employees (8.23 %). 54.9 % of the children lived in urban areas, with the rest living in rural areas. Most of the children's mothers (53.87 %) and fathers (53.62 %) were illiterate. 56.61 % and 43.39 % of the children were in grades 1–4 and 5–8, respectively. 21.70 %, 34.41 %, and 43.89 % of the children attended Gaft, Mabi, and Mekaneyesus primary schools, respectively (Table 1).

3.2. Prevalence of soil-transmitted helminth infections

The overall prevalence of STH infection among schoolchildren was 18.2 %. The most common STH found among schoolchildren was *A. lumbricoides* (7.48 %), followed by hookworm (3.24 %), *Enterobius vermicularis* (*E. vermicularis*) (3.74 %), *Taenia* species (2.00 %), and Trichuris *trichiura* (*T. trichiura*) (1.00 %). While *A. lumbricoid* and hookworm species co-infection was found in 0.50 % of the schoolchildren, 0.25 % of them were co-infected with *A. lumbricode* and *E. vermiculaties* (Table 2).

3.3. Factors associated with soil-transmitted helminth infections

Children aged 15–17 years were 2.37 times more likely to be infected with STH than those aged 6–10 (AOR = 2.37, 95 % CI = 1.06–5.30). There was a higher odds of STH infection in children who did not trim their fingernails than in those who did (AOR = 3.75, 95 % CI = 1.87–7.50). Children with illiterate fathers were more likely to have STH infection than those with literate fathers (AOR = 2.29, 95 % CI = 1.18–4.44). In comparison to children in households with latrine, children in households without latrine had higher odds of STH infection (AOR = 2.90, 95 % CI = 1.37–6.13). The odds of STH infection was lower in children with housewife mothers than in those whose mothers were farmers (AOR = 0.22, 95 % CI = 0.08–0.58). Children who wash their hands after defecation were 0.43 times less likely to be infected with STH than those who do not (AOR = 0.43, 95 % CI = 0.21–0.88) (Table 3).

4. Discussion

Assessing the burden of STH infections and associated risk factors in a community is important for evaluating previous preventive strategies or designing a new one (Ribado Meñe et al., 2023). This study assessed the prevalence and associated risk factors of STH infection among schoolchildren in Mekane Eyesus town in northwest Ethiopia. The overall prevalence of STH infections among the schoolchildren in this study was 18.2 %, with *A. lumbricoides* being the most common STH identified among the participants. The majority of the participants had farming mothers (36.9 %), did not have a habit of trimming fingernails regularly (56.9 %) and washing hands after defecation (56.9 %), were in grades 1–4 (56.6 %), and were between the ages of 6 and 10 (47.6 %).

This study found a higher overall prevalence of STH infections among schoolchildren in agreement with studies elsewhere (Okoyo

Table 1
General characteristics of the schoolchildren in Mekane Eyesus, northwestern Ethiopia (N = 401).

Characteristics	Category	Schools						Total	
		Mekane Eyesus		Mabi		Gaft			
		Number	%	Number	%	Number	%	Number	%
Age in years	15–17	29	7.23	23	5.74	19	4.74	71	17.71
	11–14	50	12.47	52	12.97	37	9.23	139	34.66
	6–10	97	24.19	63	15.71	31	7.73	191	47.63
Gender	Male	86	21.45	76	18.95	47	11.72	192	47.88
	Female	90	22.44	62	15.46	40	9.98	209	52.12
Education	Grade 5–8	64	15.96	78	19.45	32	7.98	174	43.39
	Grade 1–4	112	27.93	60	14.96	55	13.72	227	56.61
Residence	Urban	75	18.70	85	21.20	60	14.96	220	54.86
	Rural	101	25.19	53	13.22	27	6.73	181	45.14
Mother's education	Literate	61	15.21	75	18.70	49	12.22	185	46.13
	Illiterate	115	28.68	63	15.71	38	9.48	216	53.87
Mother's occupation	Government employee	10	2.49	9	2.24	14	3.49	33	8.23
	Merchant	28	6.98	42	10.47	30	7.48	100	24.94
	Housewife	73	18.20	32	7.98	15	3.74	120	29.93
	Farmer	65	16.21	55	13.72	28	6.98	148	36.91
Father's education	Literate	77	19.20	63	15.71	46	11.47	186	46.38
	Illiterate	99	24.69	75	18.70	41	10.22	215	53.62
Father's occupation	Government employee	12	2.99	27	6.73	13	3.24	52	12.97
	Merchant	34	8.48	15	3.74	26	6.48	75	18.70
	Farmers	46	11.47	40	9.98	13	3.24	175	43.64
	Other	84	20.95	56	13.97	35	8.73	99	24.69

Table 2
Soil-transmitted helminth infections among schoolchildren in Mekane Eyesus, northwestern Ethiopia (N = 401).

Single and double helminth infections	Schools						Total	
	Mekane Eyesus		Mabi		Gaft			
	Number	%	Number	%	Number	%	Number	%
A. lumbricoides	17	4.24	10	2.49	3	0.75	30	7.48
E. vermicularis	6	1.50	6	1.50	3	0.75	15	3.74
Hookworm	7	1.75	4	1.00	2	0.50	13	3.24
Taenia species	5	1.25	2	0.50	1	0.25	8	2.00
T. trichiura	1	0.25	3	0.75	3	0.75	4	1.00
A.lumbricoid & Hookworm	2	0.50	0	0	0	0	2	0.50
A.Lubricode & E.vermicularies	1	0.25	0	0	0	0	1	0.25

et al., 2020; Akenten et al., 2022). Several factors, such as poor environmental hygiene, low awareness of STH, and low socio-economic status, have been reported to increase the prevalence of STH, and these factors are said to vary by district (World Health Organization Expert Committee, 2002; Vandemark et al., 2010; Östan et al., 2007; Alelign et al., 2024). Thus, the differences in the prevalence of STH infection between this study and other studies in Ethiopia and other African countries could be attributed to variations in the aforementioned factors.

The high prevalence of STH infection in this study suggests the importance of effective prevention and control measures in the study area. According to the World Health Organization, effective STH infections prevention and control entails the use of integrated strategies such as periodic anthelminthic therapy, health and hygiene education for parents and children, and sanitation provision, among other things (WHO, 2011). Thus, implementing integrated STH preventative and control measures in the study area may help reduce the prevalence of STH infections.

In tropical and subtropical countries, including Ethiopia, *A. lumbricoides* is often the most prevalent intestinal helminth (Ruth et al., 2021; Ayele et al., 2021; Kiiti et al., 2020; Terefe et al., 2011). Similarly, this study found *A. lumbricoides* to be the most prevalent STH. Studies in India and China also found *A. lumbricoides* to be the most prevalent STH among schoolchildren (Wang et al., 2012; Pasaribu et al., 2019). According to the Ministry of Health of Ethiopia, parasitic diseases are frequent in Ethiopia due to largely poor personal hygiene caused by limited availability of clean, inadequate water supply, and a lack public knowledge of the role of personal hygiene in parasite infection (Ababa, 2003). Thus, poor personal hygiene practices in the study area may contribute to a high frequency of *A. lumbricoides*.

This study's finding that children of illiterate fathers were more likely than those of literate fathers to have a STH infection is in line with that of Shakya et al. (Shakya et al., 2012), who found that children of fathers with only a basic education and no literacy were frequently more parasite-infected than those of literate fathers. Nematian et al., (Nematian et al., 2004) and Wamani et al., (Shakya et al., 2012) similarly found that the more educated the parents, the lower the prevalence of parasitic diseases in children. It has been suggested that the more educated parents are, the better their awareness of diseases and the more likely they are to protect their children from disease exposure, which may explain the higher prevalence of STH in children of illiterate fathers in this and previous studies (Eyamo et al., 2019).

The higher odds of STH infection in children aged 15–17 years compared to those aged 6–10 years in this study is consistent with other studies (Shumbej et al., 2015; Sowemimo and Asaolu, 2011). The prevalence of STH among school-aged children in the Amhara region was reported to be 36.4 % in 2011–2015 (Nute et al., 2018). Ethiopia launched MDA in four rounds in multiple regions of the country, including Amhara region (WHO Regional Office for Africa, 2024). In the first MDA, one million school-aged children were dewormed in 2007, and similar treatments were given to 6.8 million and 7.8 million children in 2013 and 2014, respectively (WHO Regional Office for Africa, 2024). The fourth round of deworming took place in 2015 (WHO Regional Office for Africa, 2024).The MDA has been shown to be effective in reducing the prevalence of STH among schoolchildren in the region (Meleko et al., 2023). For instance, a study conducted in Debre Tabor, Amhara region, reported a lower prevalence (13.2 %) of STH among primary school children in 2019 (Workineh et al., 2020a). The MDA in Amhara region may explain the lower odds of STH among children aged 6–10 years in this study.

The finding that children who did not have latrine were more likely to contract STH than those who did have latrine is consistent with studies conducted in Ethiopia and other parts of the world (Yarinbab and Darcha, 2019; Workineh et al., 2020b; Suen et al., 2019). Two studies in Ethiopia (Yarinbab and Darcha, 2019; Workineh et al., 2020b) and one in Nigeria (Suen et al., 2019) reported that children who did not have latrines in their backyards had threefold higher odds of STH infection than children who did. In Ethiopia, poor sanitary facilities such as toilets and latrines are a major concern (Ministry of Water, Irrigation and Energy, 2019; United Nations Development Programme, 2020); the rate of improved toilet use (not shared) is only 6 % (Demographic, 2016). 8.7 % of urban and 37.5 % of rural individuals in Ethiopia engaged in open defecation (Beyene et al., 2015). Open defecation has been reported to contaminate soil and water sources (Ministry of Water, Irrigation and Energy, 2019; United Nations Development Programme, 2020; Demographic, 2016). Thus, children in this study who did not have access to a latrine may have practiced open defecation in their surroundings and contracted STH while playing on contaminated soil at home.

Schoolchildren who did not trim their fingernails regularly had higher odds of STH infection than those who did, which is consistent with other studies in Ethiopia (Hussein et al., 2022; Genet et al., 2021; Getaneh et al., 2022; Tadege et al., 2022). Some STH eggs were detected under the fingernails of schoolchildren (Beyene et al., 2015; Tadege et al., 2022). A study in Jimma, Ethiopia, found

Table 3
Factors associated with soil-transmitted helminths infections in Mekane Eyesus in Este district, south Gondar zone, northwest Ethiopia ($N = 401$).

Categories		STH Infection		COR (95 % CI), *P* value	AOR (95 % CI), P value
		Positive (%)	Negative (%)		
Age	6–10	40(20.92)	151(79.05)	1	1
	11–14	27(19.42)	112(80.58)	0.91 (0.52–1.57),0.73	0.89 (0.27–2.94),0 0.85
	15–17	6(8.45)	65(91.55)	0.35(0.14–0.86), 0.02	2.37(1.06–5.30), 0.03*
Gender	Male	149(77.60)	43(22.40)	1	1
	Female	179(85.65)	30(14.65)	1.72(1.03–2.88),0.03	1.23(0.65–2.32), 0.51
Residence	Urban	190(86.36)	30(13.64)	1	1
	Rural	138(76.24)	43(23.76)	1.97 (1.17–3.30)0.01	1.75(0.92–3.32), 0.08
Father's education	Literate	163(75.81)	52(24.19)	1	1
	Illiterate	165(88.71)	21(11.29)	2.50(1.44–4.34), 0.001	2.29(1.18–4.44),0 0.01*
Mother's education	Literate	168(77.78)	48(22.22)	1	1
	Illiterate	160(86.49)	25(13.51)	1.82(1.07–3.10),0.02	1.14(0.57–2.24),0 0.70
Father's occupation	Farmers	135(77.14)	40(22.86)	1	1
	Merchant	67(89.33)	8 (10.67)	0.28(0.09–0.82),0.02	0.31(0.09–1.07),0 0.06
	Government employee	48(92.31)	4(7.69)	0.40(0.17–0.90),0.03	0.53(0.21–1.36), 0.19
	Other	78(78.79)	21(21.21)	0.90(0.90–0.50),0.75	0.91(0.44–1.88),0 0.81
Mother's occupation	Farmers	35(23.65)	113(76.35)	1	1
	Merchant	9(9.00)	91(91.00)	0.32(0.09–1.12), 0.075	0.20(0.04–1.06),0 0.05
	Housewife	26(21.67)	94(78.33)	0.31(0.14–0 0.69), 0.004	0.22(0.08–0.58), 0.002*
	Government employee	3(9.09)	30(90.91)	0.89(0.50–1.58),0 0.70	0.64(0.31–1.30),0 0.22
Grade	1–4	175(77.09)	52(22.91)	1	1
	5–8	153(87.93)	21(12.07)	2.16(1.24–3.75), 0.006	2.78(1.25–6.20),0 0.01*
Fingernail trimming	Yes	174(76.32)	54(23.68)	1	1
	No	154(89.02)	19(10.98)	2.51 (1.42–4.43), 0.001	3.75(1.87–7.50), <0.01*
Hand washing before food	No	201(78.52)	55(21.48)	1	1
	Yes	127(87.59)	18(12.41)	1.93(1.08–3.43),0.02	1.64(0.81–3.31),0 0.16
Hands washing after defecation	No	199(87.28)	29(12.72)	1	1
	Yes	129(74.57)	44(25.43)	0.427 (0.254–0.718),0.001	0.43(0.21–0.88),0 0.02*
Shoe wearing	No	20(95.24)	1(4.76)	1	
	Yes	308(81.05)	72(18.95)	0.21(0.02–1.62), 0. 35	NA
Type of shoe	Have no shose	20(95.24)	1(4.76)	1	1
	Coverd	166(78.30)	46(21.70)	5.54(0.72–42.39),0.09	0.60(0.33–1.09),0 0.09
	Open	142(84.52)	26(15.48)	3.66(0.47–28.48),0.21	0.83(0.44–1.58),0 0.58
Playing with soil	Yes	180(80.54)	28(13.46)	1	1
	No	148(76.68)	45(23.32)	0.512 (0.304–0.86),0.01	0.83(0.44–1.58),0 0.58
Clean water availability	No	17(89.47)	2(10.53)	1	
	Yes	311(81.41)	71(18.59)	0.51(0.11–2.21),0.38	NA
Latrine availability	Yes	46(65.71)	24(34.29)	1	1
	No	282(85.20)	49(14.80)	3.003(1.68–5.35),<0.01	2.90(1.37–6.13),0 0.005*
Type of latrine	Open field	66(88.00)	9(12.00)	1	
	Privates	255(80.19)	63(19.81)	1.72(0.81–3.66),0.5	NA
	Public toilet	10(90.91)	1(9.09)	0.70(0.08–6.13),0.74	NA
Floor type	Soil	284(80.23)	70(19.77)	1	
	Cement	44(93.62)	3(6.38)	3.61(1.09–11.96),0.03	1.82(0.45–7.29),0 0.39
Source of water	Unprotected spring	31(64.58)	17(35.42)	1	1
	Protected spring	297(84.14)	56(15.86)	2.90(1.50–5.60), 0.001	1.88(0.77–4.56), 0.15
Vegetable use	Unwashed	187(77.92)	53(22.08)	1	1
	Washed	141(87.58)	20(12.42)	1.99(1.143–3.494),0.01	1.87(0.96–3.65),0 0.06
Food storing for later use	No	128(76.19)	40(23.81)	1	1
	Yes	200(85.84)	33(14.16)	0.528(0.31–0.88),0.01	1.04(0.52–2.07),0 0.89

AOR; adjusted odds ratio, COR; crude odds ratio; STH; soil-transmitted healminth, NA; not applicable, * significant difference.

eggs of *A. lumbricoides*, *T. trichiura*, *Taenia* spp., and *E. vermicularis* under the nails of schoolchildren (Tadege et al., 2022). Schoolchildren in Nigeria (Hosea et al., 2019), Pakistan (Ghani et al., 2016), and Iraq (Jameel et al., 2017) have also been shown to have STHs eggs under their nails. In Nigeria, hookworm eggs have also been found under the fingernails of schoolchildren (Alo et al., 2013). Thus, the absence of a habit of trimming fingernails among the children in this study may have resulted in helminth eggs under their nails, potentially leading to STH infection.

This study's finding that not washing hands after defecation is associated with STH infection among children is consistent with findings from prior studies conducted in Ethiopia and elsewhere (Hussein et al., 2022; Genet et al., 2021; Imalele et al., 2023). Poor personal hygiene has been linked to parasite spread (Suen et al., 2019), which could explain this finding. Moreover, this study found that children whose mothers were housewives had lower odds of STH infection than those whose mothers were farmers. It has been reported that the more time mothers spend at home, the better children receive care, resulting in less child exposure to STHs (Quihui et al., 2006). This could explain the low odds of STH infection in children whose mothers were housewives.

The increased odds of STH in children who did not have latrine in this study emphasize the need of improving latrine availability in the study area. This may be achieved by encouraging households by community leaders, and government representatives to install latrines and assisting neighbors with latrine construction. Households with limited resources in the study area may also need financial assistance from the government, non-governmental organizations, and community members to construct latrines. There should also be an effort to enhance hand hygiene after defection among schoolchildren in the study area by educating them and their caretakers about the importance of hand hygiene in STH prevention, as well as providing convenient access to hand washing products. Schoolchildren and their caregivers should also be aware of the importance of fingernail trimming in STH prevention.

This study has some limitations. First, because it used students as study subjects, its findings may not be representative of the prevalence of STH in the general population. Second, this study did not take into account all of the potential determinants or risk factors of STH in the study area, emphasizing the need for future similar studies in the area that include more determinants or risk factors.

5. Conclusion

STH infection is a public health problem among schoolchildren in Mekane Eyesus town, northwestern Ethiopia. Some of the factors associated with increased odds of STH infections among children in the study area included not washing hands after defecation, not trimming fingernails, and having illiterate fathers. Deworming school-aged children and providing health education to children and parents about STH, such as the importance of washing hands after defecation and regularly trimming fingernails in STH prevention, may help to reduce the burden of STH in the study area.

Ethical approval

The project obtained ethical approval from the University of Gondar, College of Natural and Computational Sciences, ethical committee. Permissions to conduct the study were secured from the Estie Primary Schools and the Educational Office of the Estie District Administration. The objectives and protocol were also discussed with the Estie Primary Schools and the Educational Office of the Estie District Administration for clarification. The children voluntarily participated in the study after being informed about its purpose and providing their assent. Parents and guardians gave consent for their children to participate in the study. Children who tested positive for STH were referred to Mekan Eyesus Primary Hospital for treatment.

CRediT authorship contribution statement

Yohannes Andargie: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Amir Alelign:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Zinaye Tekeste:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no conflict of interests.

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