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Soil-transmitted helminthiasis and undernutrition among schoolchildren in Mettu town, Southwest Ethiopia

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Soil-transmitted helminthiasis (STHs) and undernutrition are common health problems in developing countries. Several reports showed that STH and undernutrition are often associated. The main aim of this study was to determine the association of STH and undernutrition among schoolchildren in Mettu town, Southwest Ethiopia. A cross-sectional study design was employed. To collect socio-demographic data, semi-structured questionnaire and physical observation were used. Kato-Katz technique and Anthropometric measurements were also considered to see STH infection and determine the nutritional statuses of the study participants respectively. Then, the data generated from the study was managed using Chi-square test and logistic regression analysis to determine the association of demographic variables with infections of helminthes and assess the risk factors for nutritional status of the study participants respectively. As a result, among the 392 study schoolchildren, 331 (84.4%) children were positive for different species of STH and undernutrition accounted 32.6%. *Ascaris lumbricoides* (39.0%), *Trichuris trichiura* (32.9%) and hookworm (28.1%) are the predominant STH identified from the study participants. Age, maternal educational and occupation status, and fingernail status of children were found significantly associated ($p < 0.05$) with the risk of getting STH. Bivariate logistic regression analysis showed that, age (AOR 2.18, 95% CI 1.53, 6.59), maternal illiteracy (AOR 0.13, 95% CI 0.91, 0.34) and maternal occupation (AOR 1.67, 95% CI 1.08, 5.91) were major co-founding factors for the prevalence of STH among study participants. In addition, children with *T. trichiura* infection were more likely ($P < 0.01$) to suffer from undernutrition (AOR 0.52, 95% CI 0.31, 0.83). Thus, the findings revealed the high prevalence of STH and it has significant association with undernutrition among school age children in the study area. Anti-helminthic mass drug administration and maternal health education should be anticipated to curve the tragedy.

Abbreviations

| | |
|-----|-------------------------------|
| AOR | Adjusted odds ratio |
| BAZ | Body-mass-index-for-age |
| BMI | Body mass index |
| CI | Confidence interval |
| DHS | Demographic and Health Survey |
| EPG | Eggs per gram of faeces |
| HAZ | Height-for-age |
| Hb | Haemoglobin |
| HAZ | Height for age |
| IDA | Iron deficiency anemia |
| PEM | Protein-energy malnutrition |
| SD | Standard deviation |
| STH | Soil-transmitted helminths |
| WAZ | Weight-for-age |

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STH is among the most common infectious diseases worldwide and affects the poorest and most deprived communities. *A. lumbricoides*, *T. trichiura*, and Hookworm (*Necator americanus* and *Ancylostoma duodenale*) are the three major STH that are prevalent in developing countries and characterized by having low socioeconomic status such as poor housing and sanitation conditions, unsafe water supplies, inefficient or no health care, poor education, and low remunerations^{1,2}.

STH infections have been found in several studies to be associated with malnutrition and anemia^{3,4}. Malnutrition and STH infections often coexist in the same geographical locations with the same individuals experiencing both conditions. Protein-energy malnutrition (PEM) and iron deficiency anemia (IDA) has been recognized as the most common forms of malnutrition in developing countries⁵.

Child undernutrition (mainly involving stunting, wasting and underweight) is a serious global public health problem in developing world including Ethiopia⁶. Although, the magnitude of childhood undernutrition has decreased from 58% in 2000 to 40% in 2014 in Ethiopia, it continues as the major public health concern causing low academic performance in primary schools^{2,7}.

In the study area, the implementation of mass deworming in line with vaccination for children began in 1998, and efforts to reach national coverage have intensified over the years (clinical records of the town, 2017). Despite these efforts, the prevalence of STH infections remains high in the town according to the clinical data generated from the health offices of the town. In the area, infection by *A. lumbricoides*, hookworm, and *T. trichiura* are the common STHs among school aged children. However, there is still a scarcity of adequate information on the prevalence and association of STH with undernutrition. Therefore, the present study attempted to determine the prevalence of STH and its association with undernutrition among schoolchildren attending Mettu town primary schools, Southwest Ethiopia.

Materials and methods

Study design. This study utilized a cross-sectional study design.

Study setting and study area. Mettu is a capital town for the district and Ilu Aba Bore zone. The town lies between 8°18' N 35°35' E and an altitude of 1605 m above sea level. The weather condition of the study area was characterized by an average temperature of 17 °C and 92% Humidity. According to the 2013 population projection report, the number of inhabitants was estimated to be 54,792 (22,857 males and 31,935 females). Agriculture, government employee, and small-scale trading are means by which the local people earn their living costs. In the town, eight primary schools are found and an estimated 5,000 school children were attending their education.

Study population. All school children attending primary schools of Mettu town in the academic year 2018 were the source population. Children aged 5–16 years old, who were not terminally ill, having no any other disease conditions, not on anti-helminthic chemotherapy for the past 3 months and with no iron supplementation were included in the study.

Sample size and sampling technique. The sample size for the study was determined using single population proportion formula; $n = z^2 p(1 - p) / d^2$ at 95% confidence of interval (CI) where, $z = 1.96$, $p = 0.5$ and $d = 5\%$ precision (0.05). The prevalence of STH and undernutrition was not known among school age children in the study area. Thus, to calculate sample size of the study participants, 50% prevalence of STH and undernutrition was assumed and the sample size estimated to be 384 children. Five percent of the total estimated sample size for withdraws or missed data were added and the final sample size was 404. Four schools equivalently admitted near to 50% of the total school children attended the primary education in the town was selected purposively from the list of schools and systematic random sampling technique was employed to select the sampling unit by using class attendance sheet. Finally, to ensure that data include independent observations, only a child was selected from a family.

Nutritional status determination. Duplicate body weight and height data were taken by trained data collectors to evaluate the nutritional status of study participants. Height and weight measurements were recorded to the nearest to 0.1 cm and 0.1 kg respectively. School children wore light clothes and were bare footed during measurements. Weight for age (WAZ), height for age (HAZ), and body mass index (BMI) for age were compared with WHO child growth reference standards. The body mass index (BMI) for age is the index of choice for determining nutritional status for children above 5 years⁸. Study participants with Z-score values of $< -2SD$ for height for age and weight for height were classified as stunted and wasted respectively. Likewise, children with a Z-score value of $< -2SD$ for weight for age were also classified as underweight.

Parasitological examination. Stool samples were collected from study participants at the health post of the schools using labeled, sterile screw-capped plastic containers and transported to Mettu University parasitology laboratory within half an hour. Standard Kato-Katz technique (thick smear 41.7 mg) was employed to examine stool specimens for the presence of *A. lumbricoides*, *T. trichiura* and hookworm eggs. Microscopic examination was done within 1 h of Kato smear preparation for hookworms and after 2 h for *A. lumbricoides* and *T. trichiura*. The mean intensity of infection was expressed as the number of eggs per gram stool (EPG) and classified according to World Health Organization (WHO) criteria⁹. Double Kato-Katz slides were prepared from each stool specimen and examined twice by two different laboratory experts.

| Variables | Category | Frequency (n) | Percentage (%) |
|-------------------------|-------------|---------------|----------------|
| Age | 5–10 | 192 | 48.9 |
| | 11–16 | 200 | 51.1 |
| Sex | Male | 181 | 46.2 |
| | Female | 211 | 53.8 |
| Maternal literacy | Literate | 146 | 37.2 |
| | Illiterate | 246 | 62.8 |
| Paternal literacy | Literate | 177 | 45.2 |
| | Illiterate | 215 | 54.8 |
| Maternal occupation | Employed | 93 | 23.7 |
| | Unemployed | 299 | 76.3 |
| Paternal occupation | Employed | 104 | 26.5 |
| | Unemployed | 188 | 47.5 |
| Dirty fingernail | Yes | 311 | 79.3 |
| | No | 81 | 20.7 |
| Open filed defecation | Yes | 289 | 73.7 |
| | No | 103 | 26.3 |
| Undernutrition | Yes | 128 | 32.6 |
| | No | 264 | 67.4 |
| Types of undernutrition | Stunting | 63 | 16.1 |
| | Wasting | 20 | 5.1 |
| | Underweight | 45 | 11.4 |

Table 1. Socio-demographic characteristics of schoolchildren in Mettu town, Southwest Ethiopia, 2018 (n = 392).

Socio-demographic assessments. Semi-structured questionnaire and physical observation were used to collect information related with socio-demographic characteristics of study participants and associated factors.

Data analysis. Data were double entered, cleaned in Microsoft Office 2010 and analysis done using Stata 11 statistical software (Stata Corporation, College Station, Texas, USA). The Chi-square test was employed to see the association of socio-demographic variable with the prevalence of STH infection. Logistic regression analysis was also conducted to assess the risk factors for nutritional status indices. At first, the effect of each exposure variable on the outcome was evaluated using bivariate logistic regression analysis. Then, variables with a significant association at 0.2 and less level of significance were considered for the final multivariate analysis using a backward stepwise model. Z-score for undernutrition were calculated using WHO 2007 AnthroPlus software¹⁰. P < 0.05 was considered statistically significant.

Ethics approval and consent to participate. The study was carried out after having an ethical clearance endorsement from Mettu University Research Technical and Ethical Review Committee and all methods were carried out in accordance with relevant guidelines and regulations. In addition, informed written consent was obtained from guardian of study participants. Positive children for STH and other intestinal parasitosis got free treatment using standard dose of the respective drugs prescribed by a physician.

Results

Socio-demographic characteristics. Four hundred four schoolchildren aged from 5 to 16 years old were recruited for this study at the beginning. However, 12 (3%) children were excluded from the study because of missing stool specimens and labeling errors. The mean average age of study participants was 9.5 years (SD: ± 2.4 years) and 211 (53.8%) were female. Maternal literacy was found to be 37.2% and 45.2% for fathers. Families of the majority of study participants 289 (73.7%) had a latrine and 183 (46.7%) of the study participants were using tap water. One hundred twenty eight (32.6%) children were identified for undernutrition (Table 1).

STH infection among school-aged children. A total of 331 (84.4%) study participants were found positive for one or more STH infections. The most prevalent parasite identified was *A. lumbricoides* (39.0%) followed by *T. trichiura* (32.9%) and hookworm (28.1%). *S. mansoni* (2.3%), *H. nana* (1.8%), *Taenia* species (1.3%), and *E. vermicularis* (0.7%) infections were also detected among the study participants. According to the data presented in Table 2, a statistically significant (p < 0.05) association between STH with age groups, maternal literacy, fingernail status, and maternal education was observed. However, gender and habit of shoe wearing, paternal education and occupation, source of drinking water, and availability of latrine did not have any significant association with the presence of STH infections among study children (Table 2).

| Variables | Categories | STH infection status n (%) | | |
|----------------------|------------|----------------------------|---------------------|---------------|
| | | <i>A. lumbricoides</i> | <i>T. trichiura</i> | Hookworm |
| Age | 5–10 | 83 (36.6) | 67 (29.5) | 39 (17.2) |
| | 11–16 | 46 (27.9) | 42 (25.5) | 54 (32.7) |
| | X^2 (P) | 5.91 (0.02)* | 2.64 (0.06)* | 0.82 (0.36) |
| Sex | Male | 52 (28.7) | 48 (26.5) | 39 (21.5) |
| | Female | 77 (36.5) | 61 (28.9) | 54 (25.6) |
| | X^2 (P) | 2.72 (0.09) | 0.83 (0.35) | 4.85 (0.12) |
| Maternal literacy | Literate | 37 (25.3) | 28 (19.2) | 27 (18.5) |
| | Illiterate | 92 (37.4) | 81 (32.9) | 66 (26.8) |
| | X^2 (P) | 9.21 (0.01)* | 7.54 (0.00)** | 17.6 (0.00)** |
| Paternal literacy | Literate | 53 (29.9) | 44 (24.8) | 37 (20.9) |
| | Illiterate | 76 (35.3) | 65 (30.2) | 56 (26.1) |
| | X^2 (P) | 2.23 (0.14) | 0.12 (0.07) | 3.63 (0.06) |
| Maternal occupation | Employed | 43 (46.23) | 34 (36.5) | 24 (38.1) |
| | Unemployed | 86 (28.7) | 75 (25.1) | 69 (23.1) |
| | X^2 (P) | 2.46 (0.12)* | 1.63 (0.21) | 0.13 (0.79) |
| Paternal occupation | Employed | 54 (28.7) | 48 (25.5) | 50 (26.6) |
| | Unemployed | 75 (36.7) | 61 (29.9) | 43 (21.1) |
| | X^2 (P) | 0.22 (0.71) | 0.51 (0.45) | 0.23 (0.98) |
| Dirty fingernail | Yes | 103 (33.1) | 88 (28.3) | 68 (21.9) |
| | No | 26 (32.1) | 21 (25.9) | 25 (30.9) |
| | X^2 (P) | 9.26 (0.001)* | 4.82 (0.03)* | 3.31 (0.04)* |
| Shoe wearing | Yes | 101 (32.6) | 82 (26.4) | 65 (20.9) |
| | No | 28 (34.1) | 27 (32.9) | 28 (34.1) |
| | X^2 (P) | 0.41 (0.52) | 0.32 (0.59) | 1.21 (0.28) |
| Water source | Tap water | 55 (30.1) | 53 (28.9) | 46 (25.1) |
| | Others | 74 (35.4) | 56 (26.8) | 47 (22.5) |
| | X^2 (P) | 0.32 (0.55) | 0.12 (0.91) | 1.61 (0.22) |
| Latrine availability | Yes | 93 (32.2) | 76 (26.3) | 59 (20.4) |
| | No | 36 (34.9) | 33 (32.1) | 34 (33.1) |
| | X^2 (P) | 7.14 (0.08) | 3.72 (0.09) | 0.91 (0.41) |

Table 2. Factors associated with soil transmitted helminthes infections among school children in Mettu town, Southwest Ethiopia, 2018 (n = 392). **Statistically significant at $P < 0.01$. *Statistically significant at $P < 0.05$.

Factors associated with STH infection and under nutrition. Bivariate logistic regression analysis showed that infection of STH was at higher risk for undernutrition than non-infected. *T. trichiura* infection was associated with significant increased risk of undernutrition (AOR 0.49, 95% CI 0.31, 0.83). Whereas, infection of *A. lumbricoides* and hookworm didn't show any significant ($P > 0.05$) association with undernutrition although a higher prevalence of undernutrition was also seen among children being infected. Undernutrition was also found significantly associated with age (AOR 2.18, 95% CI 1.53, 6.59), maternal literacy (AOR 0.13, 95% CI 0.01, 0.34), and maternal occupation (AOR 1.67, 95% CI 1.08, 5.91). Children in the ages between 5 and 10 years were also about 3 times (95% CI 1.53, 6.59) more likely to be undernourished than children in the ages 11 to 16 years. Controlling for other variables, the final model retained having an illiterate mother (AOR 0.13, 95% CI 0.04, 0.35) ($p < 0.001$) as the major factor associated with undernutrition (Table 3).

Discussion

STH infections and malnutrition are among the most common public health problems, primarily affecting children living in rural and semi-urban areas of developing countries^{1,2}. Given this, the present study attempted to determine the prevalence of STH infections and undernutrition among schoolchildren in Mettu town, Southwest Ethiopia. The results then revealed the high prevalence of STH infections (84.4%) which is higher than the findings from “Butajira”¹¹ and “Jimma”, Ethiopia¹². However, the result of this study was comparable with the reports from Nigeria (83.3%)¹³ and the Philippines (82.8%)¹⁴. In contrast, it was much higher than the study conducted in the west-central border area of Thailand (15.6%)¹⁵. These differences could be explained by variations in altitude, hygienic conditions, awareness level towards STH and playing habits and facilities of children in and outside the school¹¹.

The socioeconomic status of the parents did not measured directly as many of them could not give accurate information about their income. However, the occupation and educational background of the parents and physical observation of the fingernail status of children enrolled could help as an indicator of their socioeconomic

| Variable | Nutritional status (n) | | COR (95% CI) | AOR (95% CI) |
|--------------------------------|------------------------|--------|--------------------|--------------------|
| | Undernutrition | Normal | | |
| Age | | | | |
| 5–10 | 78 | 114 | 3.21 (1.53–6.59)** | 2.18 (1.02–4.83)* |
| 11–16 (ref.) | 50 | 150 | 1 | |
| Sex | | | | |
| Male | 76 | 105 | 1.09 (0.82–2.81) | 0.88 (0.16–1.91) |
| Female (ref.) | 52 | 159 | 1 | |
| Maternal literacy | | | | |
| Literate | 38 | 108 | 0.26 (0.91–0.34)** | 0.13 (0.04–0.35)** |
| Illiterate (ref.) | 90 | 156 | 1 | |
| Paternal literacy | | | | |
| Literate | 55 | 122 | 2.14 (1.01–3.72) | 1.27 (0.93–2.48) |
| Illiterate (ref.) | 73 | 142 | 1 | |
| Maternal occupation | | | | |
| Employed | 19 | 74 | 2.53 (1.08–5.91)** | 1.67 (0.81–3.05) |
| Unemployed (ref.) | 109 | 190 | 1 | |
| Paternal occupation | | | | |
| Employed | 58 | 130 | 1.04 (0.72–2.68) | 0.78 (0.38–1.61) |
| Unemployed (ref.) | 70 | 134 | 1 | |
| Dirty finger nail | | | | |
| Yes | 99 | 212 | 2.53 (1.18–4.13) | 1.12 (0.06–2.17) |
| No (ref.) | 29 | 52 | 1 | |
| Drinking water sources | | | | |
| Tap water (ref.) | 71 | 112 | 1 | 2.18 (1.22–3.16) |
| Others (well, spring, river) | 57 | 152 | 2.07 (1.45–2.71) | |
| Shoe wearing habit | | | | |
| Yes | 97 | 213 | 1.36 (0.97–1.62) | 1.15 (1.02–1.99) |
| No (ref.) | 31 | 51 | 1 | |
| Availability of latrine | | | | |
| Yes | 94 | 195 | 1.25 (1.01–2.03) | 1.44 (1.07–2.09) |
| No (ref.) | 34 | 69 | 1 | |
| <i>A. lumbricoides</i> | | | | |
| Yes | 68 | 61 | 1.09 (0.87–2.91) | 0.87 (0.42–1.79) |
| No (ref.) | 60 | 203 | 1 | |
| <i>T. trichiura</i> | | | | |
| Yes | 70 | 39 | 0.49 (0.31–0.83)** | 0.52 (0.30–0.91)* |
| No (ref.) | 58 | 225 | 1 | |
| Hookworm | | | | |
| Yes | 54 | 39 | 2.01 (1.37–2.67) | 2.06 (1.18–3.09) |
| No (ref.) | 74 | 225 | 1 | |

Table 3. Results of bivariate and multivariate Logistic regression analysis for undernutrition among school children in Mettu town, Southwest Ethiopia, 2018 (n = 392). COR crude odd ratio, AOR adjusted odd ratio. **Statistically significant P < 0.01. *Statistically significant P < 0.05.

status¹¹. As a result, *A. lumbricoides* infection was found significantly associated with age groups, maternal literacy, and fingernail status, while, *T. trichiura* and Hookworm infection was associated with maternal literacy, maternal occupation and fingernail status of children. This reflects the low socioeconomic status and unhygienic living conditions which lead to STH infectious agents flourished in the study area. The other point is paternal literacy status does not show any association with STH infections and the justification could be implicated to the different in roles fathers and mothers play in the management of the family and mothers play a crucial role on hygiene and feeding activities.

The prevalence of *A. lumbricoides* (39.0%), *T. trichiura* (32.9%), and Hookworm (28.1% %) shown in this study were very much higher than the national prevalence of STH infection report and the findings of other similar studies^{11,12,16}. *A. lumbricoides* infections were found to be significantly higher in children of ages 5 to 10 years than children of ages 11 to 16 years (P = 0.02, $\chi^2 = 5.91$). It shows children in the age groups of 5–10 years are more exposed to the infection. This could be justified as children below the age of 10 years playing in the contaminated outdoor environment and experience frequent contact with soil. It is because when age increases, the prevalence of STH infection decreases possibly due to improved personal hygiene and reduced contact with soil.

Reports from Nigeria^{13,17} also showed the highest prevalence of infections among the younger age groups. However, in contrary to this result, *A. lumbricoides* infection was found to be higher among children aged > 10 years reported from the Philippines¹⁴. The other justification for the higher prevalence of *A. lumbricoides* in the study area is could possibly be the humid climatic condition and clay nature of the soil which is favorable for the ova to survive longer¹⁸.

In the present findings, the prevalence of stunting, underweight, and wasting was found to be (16.1%), (5.1%), and (11.4%) respectively among the study participants. It was considerably lower than the report of the Ethiopian Demographic Health Survey (EDHS) which was (51.3%), (35.7%), and (9.7%) respectively⁹. A similar study from Mongolia¹⁹ showed a lower rate of undernutrition (29.3%), while a report from Nigeria; similar figures with the present finding were determined¹⁷. These different findings could be attributed to the difference in agro-ecology, socioeconomic status of the study participants, and the type of staple food the community depends on (vegetable, fruits and roots of some plant species which are rich in fiber proteins and vitamins).

Infection of *T. trichiura* was found significantly associated with the prevalence of undernutrition. Medium and heavy intensity infections of *T. trichiura* have contributed to its association with undernutrition because adult worm of the parasite is known to play a significant role through gastrointestinal blood loss and immunological disturbances²⁰. Thus, the finding is consistent with the work of Shang et al., who reported that moderate to heavy intensity of *T. trichiura* infection identified as factors for the occurrence of high stunting among school children in China²¹.

The prevalence of undernutrition was significantly higher among children aged 5–10 years compared to those aged 11–16 years. A similar previous study also documented the same result with the present study¹⁴. The high nutritional requirement associated with rapid growth and developments in young children affects their nutritional status and normal growth. In this study, children born from mothers who didn't have formal education were more likely to be undernourished than their counterparts (AOR 0.13, 95% CI 0.04, 0.35) ($p = 0.015$). This was in line with the findings from India²² and Bolivia²³ which revealed that uneducated mothers were likely to have malnourished children than those of the educated. This could be expected that educated mothers might have good knowledge on health, hygiene, and feeding practice of their children than uneducated.

Conclusion

The result of the present study showed the high prevalence of STH and undernutrition. Risk of STH was increased with maternal illiteracy, maternal unemployment, under ten years of age and dirty fingernail of the study participants. Undernutrition was also found significantly associated with STH. The study warrant the need of integrated control programs including mass deworming campaign, synchronized nutritional rehabilitation, and maternal health education to curve the problem.

Limitation of the study

The present study used only anthropomorphic measurements to collect nutritional status and did not assess the micronutrient parameters of study participants. Hence, this finding should be interpreted by taking into account these limitations.

Data availability

The datasets used during the current study are available from the corresponding author on reasonable request.

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Author contributions

The study was carried out in collaboration with all authors. SY and TB conceived the study, carried out the field and laboratory work. HD, EA and MT took analysis of the data. SY, TB and ZT wrote the draft manuscript. All authors critically read, revised and gave the final approval of the version to be published and agreed to be accountable for all aspects of the work.

Competing interests

The authors declare no competing interests.

Additional information

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