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MEKELLE UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICINE, DIVISION OF BIOMEDICAL SCIENCES

DEPARTMENT OF MEDICAL PARASITOLOGY AND ENTOMOLOGY

SOIL-TRANSMITTED HELMINTH INFECTIONS AND NUTRITIONAL STATUS OF SCHOOL AGE CHILDREN, IN MEKHONI TOWN, TIGRAY, ETHIOPIA, 2025: SCHOOL BASED CROSS SECTIONAL STUDY.

BY: ABEL DERES (BSc)

A THESIS SUBMITTED TO THE DEPARTMENT OF MEDICAL PARASITOLOGY AND ENTOMOLOGY, COLLEGE OF HEALTH SCIENCES, MEKELLE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS IN MEDICAL PARASITOLOGY

MARCH, 2025

MEKELLE, ETHIOPIA

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BY: ABEL DERES TEKA

ID No**: CHS/RMP/001/13**

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MARCH, 2025

MEKELLE, ETHIOPIA

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Advisor's Approval Sheet

This is to certify that the thesis entitled "Soil-transmitted helminth infections and nutritional status of school-age children, in Mekhoni town, Tigray, Ethiopia, 2025" is submitted in partial fulfillment of the requirements for the degree of MSc with specialization in "Medical Parasitology" to the Graduate Program of the College of Health sciences of Mekelle University. The thesis research has been carried out by Abel Deres Teka ID No: CHS/RMP/001/13 under our supervision. Therefore, we the undersigned advisors recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

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Name of Co advisor	Signature	Date

Mekelle University

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Examiners' Approval Sheet

We, the undersigned, members of the Board of Examiners of the final open defense by "**ABEL DERES TEKA**" have read and evaluated his thesis "Soil-Transmitted Helminth Infections and Nutritional Status of School age Children, in Mekhoni town, Tigray, Northern Ethiopia" and evaluated the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the Masters of Degree in Medical Parasitology.

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Declaration/Assurance of Principal Investigator

I the undersigned declare that no portion of the work referred to in the dissertation thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Date_____

MEKELLE UNIVERSITY

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MASTER'S THESIS SUBMISSION FORM

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FULL TITLE OF THESIS	SOIL-TRANSMITTED HELMINTH INFECTIONS AND NUTRITIONAL STATUS OF SCHOOL AGE CHILDREN, IN MEKHONI TOWN, TIGRAY, ETHIOPIA, 2025: SCHOOL BASED CROSS SECTIONAL STUDY.
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List of Abbreviations and Acronyms

BAZ	Body mass index for age Z score
DALY	Disability adjusted life year
EPG	Eggs per gram
GIT	Gastrointestinal tract
HAZ	Height for age Z score
MDA	Mass drug administration
NTD	Neglected tropical disease
PSC	Preschool children
SAC	School age children
SPSS	Statistical Package for social sciences statistical software
STH	Soil-transmitted helminths
TRHB	Tigray regional health bureau
WASH	Water, sanitation and hygiene
WAZ	Weight-for age Z score
WHO	World Health Organization

Abstract

Background: Soil-transmitted helminths (STH) are public health challenges among school-age children in developing countries like Ethiopia. Approximately 2 billion individuals worldwide carry at least one type of soil-transmitted helminth infection. Malnutrition and Soil-transmitted helminths frequently occur together in the same area, affecting the same individuals simultaneously and perpetuate each other. Therefore, this study aimed to determine the prevalence of soil transmitted helminths, associated factors and nutritional status of school-age children in Mekhoni town, Tigray, Ethiopia, 2025.

Methods: School based cross-sectional study design was conducted among 277 schoolchildren in Mekhoni town, Tigray, Ethiopia from June_2024 to July_2024. Structured questionnaire was used to collect data on demographic characteristics of study participants, and stool sample were collected and processed using direct wet mount and Kato-Katz techniques. Anthropometric measurements were taken and anthropometric indices were generated using the WHO AnthroPlus software to determine the nutritional status of schoolchildren. Data were analyzed using SPSS 27 software. Descriptive statistics was applied to present the data using frequency, tables, figures and bar graph. Bivariate logistic regressions was employed to show the correlation of the dependent variable with the individual independent variable, and multivariate logistic regressions was computed to identify the independent effect of the main explanatory variable on the outcomes of interest, and P-value < 0.05 was considered as statistically significant

Results: The overall prevalence of soil-transmitted helminth infections was 16.2%, with *Ascaris lumbricoides* being the most identified parasite (10.1%), followed by *Trichuris trichiura* (6.1%) and Hookworms (2.9%). From the infected children 31(18.7 %) were males and 14 (12.6 %) were females. The number of infections is also higher among schoolchildren with in age group of 5-10, 22(18.4%) than 11-14 years old, 23(14.65%). Statistically significant associations were observed between soil-transmitted helminth infections and family size (AOR= 2.56, 95% CI: 1.18-5.55, P=0.017), fingernail cleanness (AOR=2.63, 95% CI: 1.14-6.03, P=0.022), trimmed fingernails (AOR=2.25, 95% CI: 1.006-5.03, P=0.002) and hand washing practice after using toilet (AOR= 0.29, 95% CI: 0.13-0.63, P=0.002). The overall prevalence of undernutrition was 37.5%, with 22.2% being under-weight (N=117), 27.8% stunted and 11.19% wasted. There were no statistically significant association between soil-transmitted helminth infection and nutritional status among study subjects.

Conclusion: The prevalence of soil-transmitted helminth infections was 16.2%. The most common species identified were *Ascaris lumbricoides*. The study also revealed a high prevalence of undernutrition among school-age children. Ensuring access to clean toilet and hand washing facilities in the schools, emphasizing hand washing and nail care may support to reduce the burden of soil-transmitted helminths. Furthermore, introducing a school health and nutrition program may enhance the nutritional status of schoolchildren in the study area.

Key-words: Ethiopia, nutritional status, school-age, soil-transmitted helminths, Tigray

1. INTRODUCTION

1.1 Background

Ascaris lumbercoides, *Trichuris trichiura* and Hookworms are the three main parasitic worms that cause soil transmitted helminthic infections (STH) [1]. These parasitic infections continue to pose significant public health challenges, particularly among school-age children (SAC) in developing nations with limited resource [2,3]. Approximately 2 billion individuals worldwide carry at least one type of STH infection (with *A. lumbericoides*, 1 billion, *T. trichuria*, 800 million, and hookworm, 740 million). Besides, around 4 billion people are susceptible to contracting STH infections globally [4,5]. South Asia, Southeast Asia, and Sub-Saharan Africa are the regions with the highest burden [6]. Low income, inadequate personal hygiene, poor environmental sanitation, restricted availability of clean water, and tropical climate are the factors linked with infection of STH [7]. Most infections of STHs typically occur due to contact with water, soil, or food that has been contaminated with feces [8]. Eggs excreted in the feces of infected individuals contaminate soil and water making their prevalence as indirect indicator of inadequate sanitation and poor personal hygiene. *A. lumbercoides* and *T. trichiura* are transmitted through the fecal-oral route, where individuals become infected by ingesting eggs from contaminated water, surfaces, hands, or food. Hookworm infections are spread through the skin by contact with soil contaminated with infective larvae [9], ingestion of larvae [6], or through transmammary route [10]. Due to the necessity of fecal contamination of soil for the life cycle of STH, the prevalence of their infection is elevated in developing nations where access to sanitary facilities is limited and hygiene practices are inadequate [11]. Climate and seasonal variation significantly influence the prevalence of STH by affecting transmission dynamic, with adequate moisture and warm temperature being crucial for the development of eggs in the soil [12].

Moreover, morbidity and transmission rate of STH are directly linked to infection intensity, which refer to the quantity of worms hosted by an individual. The primary epidemiological measure for characterizing STH infection is the intensity, determined by the number of eggs per gram of feces. Higher egg counts indicate a greater worm burden, leading to increased morbidity and a higher risk of transmission within the community. Monitoring infection intensity is essential for effective public health interventions and controlling STH spread [2].

On the other hand, a well-balanced diet and favorable nutritional condition are crucial factors in preserving optimal human health. Inadequacies or imbalance in nutrient consumption can increase the risk of mortality, particularly leading to conditions such as stunted growth, wasting, and underweight particularly in children. Malnutrition was approximated to have accounted for 54% of child mortality in developing nations [13]. Malnutrition and STH frequently occur together in the same area, affecting the same individuals simultaneously and perpetuate each other in which one predisposes the other. Inadequate nutrient intake raises the risk of parasitic infection [14]. Mild infections of STH often show no symptoms. Nevertheless, heavier infections lead to a range of symptom [15]. Studies have revealed that children with STH infections usually suffer from malnutrition, which includes stunting, wasting, and nutritional deficits [16]. Chronic STH infection can impede nutrient absorption, resulting in lower intake and use of key elements such proteins, vitamins, and minerals [17]. This impairment of nutrient absorption and utilization can have far-reaching consequences, inhibiting the growth and development of infected children. The depletion of critical nutrients can also increase susceptibility to other illnesses, further exacerbating the burden of malnutrition [18]. Indications of malnutrition are often evident in terms of anemia, micronutrient deficiencies (iron, folic acid, riboflavin, vitamin A and B12) and anthropometric measurements [19]. Critical approaches to treat the twin burden of STH infections and malnutrition among school-aged children, thereby improving their overall health and well-being.

Several studies was carried out among these risk groups in different parts of Ethiopia to determine the prevalence of soil transmitted helminthic infection, associated factors [15,20,21] and the relationship with nutritional status [11,22,23]. However, it is not well documented in Tigray region. Hence, this study aimed to determine the prevalence of soil transmitted helminths, associated factors and nutritional status among school age children in Mekhoni town, Tigray, Ethiopia.

1.2 Statement of the problem

Soil-transmitted helminth infections are still a serious health concern for many children around the world, especially those living in areas with poor sanitation and limited access to clean water [28]. These might be linked to the reality that children often encounter contaminated soil while playing, walking barefoot, ingesting soil, and lacking proper personal hygiene [32]. Pre-school and school-age children are most at risk of heavy infection and of developing severe morbidity [29, 30]. The morbidity they experience includes malnutrition, stunted growth, anemia, as well as cognitive and educational impairments [31]. STH infections exacerbate poverty by diminishing children's cognitive abilities and growth, while also decreasing the work capacity and productivity of adults [33]. These infections caused by parasites worms such as, hookworms (*Necator americanus* and *Ancylostoma duodenale*), *A. lumbercoides*, and *T. trichiura*, create a significant health challenge globally [24]**.** Nearly one-fourth of the world's population is affected by STHs [25], and 90% of the population residing in Sub-Saharan Africa [26]. STH causing an approximate 4.98 million years of disability adjusted life years (DALYs) [27].

Despite the introduction of deworming initiatives and enhancements in water, sanitation, and hygiene (WASH) practices in the region, the prevalence of STH infections among school-age children in Tigray remains elevated [38]. The continued existence of these infections indicates that the root causes, such as poor sanitation, lack of access to clean water, and limited health education, have not been sufficiently addressed. Furthermore, in regions like Tigray, where there are internally displaced people due to war, managing infectious diseases becomes exceedingly complex and challenging [39].

On the other hand undernutrition remains a major contributor to increased vulnerability to disease, , morbidity, and mortality among SAC, particularly in resource limited countries, and is responsible for nearly half of the deaths in the age group worldwide [34, 40].

The recent destructive war in the Tigray region of Ethiopia has probably worsened the challenges associated with STH infections and malnutrition among SAC in the study area. The interruption of essential services, displacement of communities, and breakdown of health care and sanitation infrastructure in the Tigray region could have heightened the prevalence and seriousness of these public health concerns. Undertaking this research in the post-conflict context of the Tigray region

will produce vital evidence to steer the implementation of the recovery and rehabilitation endeavors, guaranteeing that the health and nutritional requirements of the vulnerable school-age population are adequately met. Moreover, STH infections persist as a pressing public health issue in the Tigray region, with high prevalence rates among the school-age population. Understanding the current burden of STH infections and their accompanying risk factor is essential for formulating targeted intervention strategies. Additionally, malnutrition, encompassing stunting, underweight, and wasting poses a significant concern in Tigray, potentially affecting the long-term physical and cognitive development of affected children.

While there is some data available regarding the extent of STH infections [35,36,42] and high level of malnutrition [41,43,] there is paucity of data regarding the synergistic relationship between STH infections and malnutrition in this population which underscores the importance of this research study.

1.3 Significance and beneficiary of the study

Children in the Tigray region of Ethiopia face numerous challenges that threaten their health and development. Among them parasitic infection and undernutrition remain closely linked and often overlooked. SAC in particular are at a vulnerable stage of growth, and when exposed to soil-transmitted helminths in environments with poor sanitation and limited access to clean water, their ability to thrive can be severely compromised.

Examining the synergistic effects of STH infection and malnutrition will offer valuable insights into the intricate interaction between these two public health challenges. Hence this study aims to fill this gap by investigating the prevalence of STH infections, identifying key risk factors, and examining the association between STH infections and the nutritional status of school-age children in the Tigray region of Ethiopia, holds considerable importance in the post-conflict context, facilitating the development of more comprehensive and efficient interventions to address the dual burden of STH infections and malnutrition and enhance the overall health and well-being of this vulnerable population. While deworming campaigns and nutrition programs exist, their effectiveness depends on having accurate, local data to guide decisions

The primary beneficiary of this project is the school-age children of Mekhoni town but all children of Tigray are indirectly benefited from this project.

2. LITERATURE REVIEW

2.1. Classifications of soil-transmitted helminths

According to the world health organizations (WHO), infection with STH fall under the category of neglected tropical disease (NTD) [44, 46, 51]. The three prevailing species of STHs globally are *A. lumbricoides*, *T. trichiura* and Hookworms (*N. americanus or A. duodnale*) [45].

2.2. Transmission and lifecycle

Ascariasis and *Trichuriasis* infections are acquired when individuals ingest parasitic eggs that have been released into the environment through the feces of infected individuals. This can happen through contact with contaminated hands or by consuming undercooked vegetables or fruit. Additionally, hookworm eggs mature and hatch in the soil, developing into larvae that penetrate human skin when people walk barefoot in contaminated areas [47, 48]. STH reside in the human intestine, and their eggs are excreted in the faces of infected individuals, ending up in the soil [48].

2.3. Global distribution

STH infections pose a significant global public health concern, impacting approximately 1.5 billion individuals worldwide, primarily in low and middle-income nations [49, 51], the presence of these parasitic worms, such *A. lumbricoides*, *T. trichiura*, and hookworms (*N. americanus* and *A. duodenale*), are strongly associated with factors like poverty, inadequate sanitation, and restricted access to clean water [50].

A study from Cameroon focusing on SAC, revealed a prevalence of 2.2% for STH [19]. Another study conducted in Katsina state, Nigeria, 59.1% of the children was infected with at least one species of STHs. *A.lumbricoides* was detected in approximately 44.7% of the infected children, hookworm was found in 29.1%, and *T.trichuria* was present in 2.5% of the children [52]. Similar study conducted in Western Kenya among PSC revealed that prevalence for STH infection was 17.0% with 12.9% for *T. trichiura*, 8.3% for *A. lumbricoides* and 1.2% for hookworms [53]. Several studies conducted in Ethiopia on the prevalence of STHs among school children have indicated a high burden of STH infection. School-based cross-sectional study conducted among SAC in Jimma indicated that 55% of them found to be infected with STH. *T.trichiura* was the most prevalent parasite, found in 34.9% of the SAC, while *A.lumbricoides* and hookworm were

identified in 28.5% and 11.4% of the children respectively [11]. Another study conducted in Gurage zone showed that the overall prevalence of STHs among SAC was 9.5%. Hookworm was the highest STH infection (4.2%) followed by *A. lumbricoide* (3%). While *T.trichiura* was 0.5 [21]. According to study reported from Ambo, Prevalence of any STHs infection was 12.6%. The prevalence rates for the major STHs were *Ascaris* (7.8%), Hookworm (2.8%) and *Trichuris* (2.2%) [15]. Similar study carried out in Hawassa revealed that the overall prevalence of STHs was 23.1%. *A. lumbricoides* was the most common infection (11.2%) followed by *T. trichiura* (4.5%), and hookworm (2.7%) [54]. A school-based cross-sectional study was conducted in Dembecha town with 316 participants. The overall prevalence of STH infection was 21.5%. *A. lumbricoides* had the highest prevalence at 11.4%, followed by hookworms at 7.3% and 1.9% *T. trichiura* [20]. Research conducted in other parts of Ethiopia such as Mettu [22], Yirgachefe [23], Adola town [55], Durebte town [4], Dara mallo and Uba Debretsehay districts [56], Fogera district [57] Enderta [35], Wera-baye [36] and Medebay zana [42] showed that the prevalence of STH was 84.4%, 54%, 16.1%, 63.1%, 33.2%, 30.30%, 6.5%, 6.6% and 6.3% respectively.

2.4. Malnutrition and STH

Malnutrition, continues to be a major global issue, more than 200 million SAC are stunted and underweight [58]. STH reside in gastrointestinal tract (GIT), where they interfere with the digestion and absorption of nutrients, leading to malnutrition through various mechanisms [59]. They consume carbohydrate and proteins before these nutrients can be absorbed by the body. Additionally, they can cause damage to the intestinal wall, disrupting its function [60]. SAC are especially vulnerable, as they are in a critical phase of growth and development, and the burden of STH infections and malnutrition can have long-lasting impacts on their health and well-being. In Jimma stunting was primarily associated with *T.trichiura* infection among the SAC, while the overall prevalence rates for stunting and wasting stood at 21.0% and 6.9%, respectively [11]. Similar study in Yirgachefe showed that the prevalence of undernutrition was 54.0%, with underweight being the most prevalent form at 12.9%. However there were no significant associations found between STH infections and undernutrition [23]. Another study from Mettu [22], revealed that the prevalence of stunting, underweight, and wasting was found to be (16.1%), (5.1%), and (11.4%) respectively. Infection of *T. trichiura* was found significantly associated with the prevalence of undernutrition. A study conducted in Chencha [14] disclosed, an overall

prevalence of malnutrition, stunting and under-weight among SAC to be 12.3%, 8.9% and 4.2% respectively. Although neither stunting nor under-weight significantly associated with STH re-infection. The study conducted in Debremarkos [61] found that the overall prevalence of stunting, underweight and wasting were 27.5%, 20.4% and 8.7% respectively. In Mulo district [62] prevalence of stunting among SAC was 42.4%. Similar study in Addis Ababa [63] showed that, 31% were undernourished (19.6% stunted, 15.9% under-weight). Further study conducted in Arbaminch unveiled that the prevalence of stunting and wasting were 41.9% and 8% respectively [58].Another study conducted in Agulae [41] depicted that, stunting, wasting and underweight were 25.5%, 44% and 55% respectively. A study conducted in Hawzen [64], found that 32.2% and 33.2% of school adolescent girls were underweight and stunted respectively

2.5. **Risk factors contributing to STH**

The risk of contracting STH infection doesn't stem from a single factor [65]. Risk factor for STH infection includes having a caregiver who is illiterate, belonging to a lower socioeconomic status, and living in a more crowded household [66]. Furthermore SAC with poor personal hygiene, failure to wash hands after using toilet, swimming locations, shoe wearing habit, not washing hands after soil contact, and not washing fruits and vegetables before consumption are high-risk behaviors for STH**.** According to a study in Lurambi, Kenya children who wash their hands with water only are more likely to be infected with STH than with water and soap [67]. A meta-analysis study from Ethiopia revealed that nail trimming and cleanness as significant predictor of STH infections [3]. Study conducted in Jimma showed, children who had habit of open-field defecation had significantly higher risk of acquiring STH infections, and children who reported to walk barefoot had higher risk of being infected with the hookworms [11]. In Dembecha maternal education level and family size were identified as potential risk factors [20]. Similar study in Ambo and Hawassa indicated that family size is a key risk factor of STH infections. [15, 54]

2.6. Prevention and control of soil-transmitted helminths

Chemotherapy and enhancing water, sanitation, and hygiene (WASH) practices are acknowledged methods to combat soil-transmitted helminths (STHs) (68). WHO has issued guidelines for widespread preventive chemotherapy, utilizing mass drug administration (MDA) of albendazole or mebendazole. These guidelines target reducing morbidity caused by soil-transmitted helminth(STH) infections in preschool age children(pre-SAC) and SAC, aiming to decrease the prevalence of moderate to heavy infections to below 1% in SAC (47).

Conceptual framework

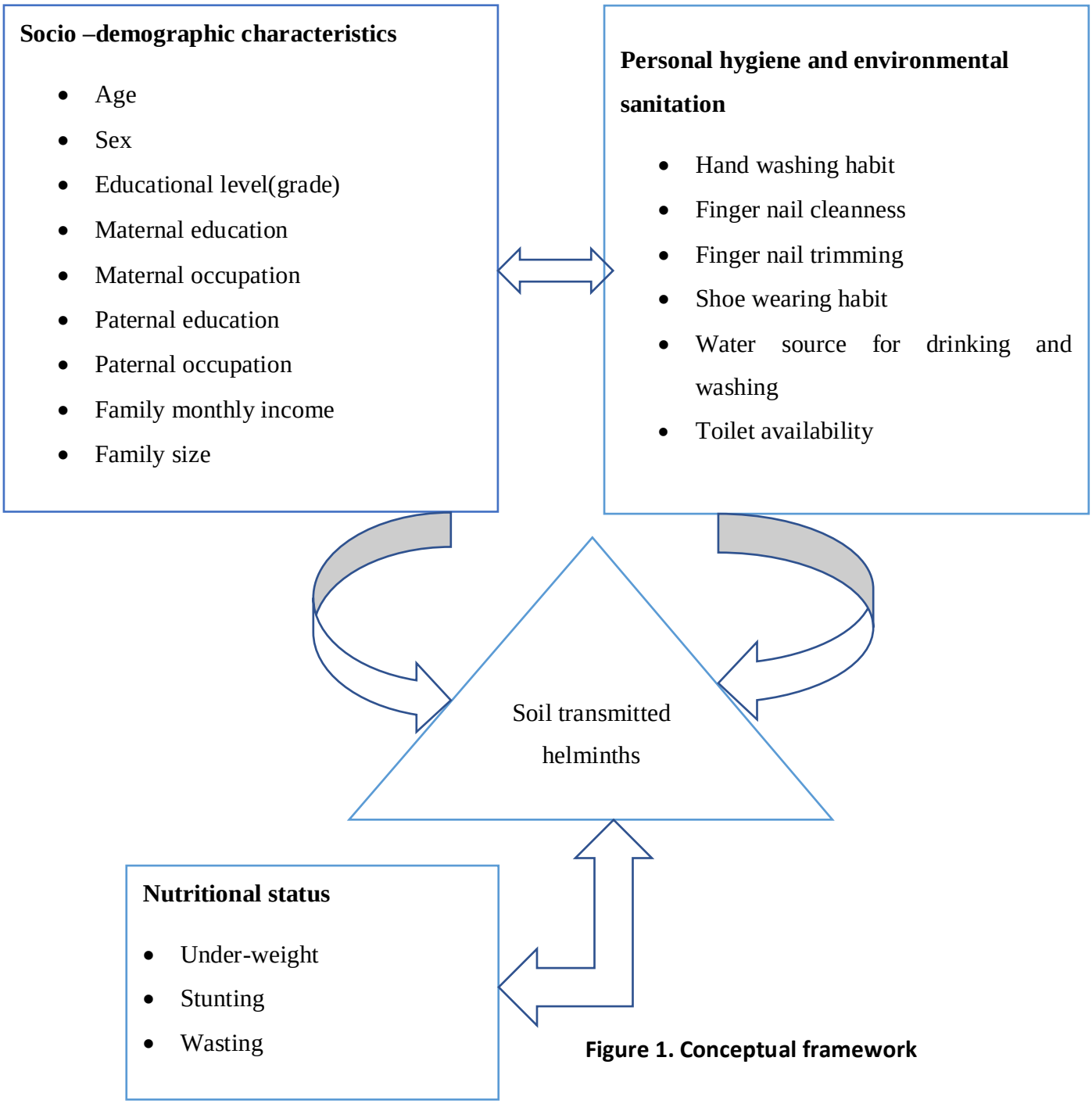


Figure 1. Conceptual framework

3. OBJECTIVES

3.1. General objective

- To determine the prevalence of soil transmitted helminths, associated factors and nutritional status among school-age children in Mekhoni town, Tigray, Ethiopia, 2025

3.2. Specific objectives

- To determine the prevalence of soil transmitted helminths among school-age children in Mekhoni town, Tigray, Ethiopia, 2025
- To identify factors associated with soil transmitted helminths among school-age children in Mekhoni town, Tigray, Ethiopia, 2025
- To assess the nutritional status of school-age children in Mekhoni town, Tigray, Ethiopia, 2025

4. MATERIALS AND METHODS

4.1. Study design, period, area

This school based cross-sectional study was conducted among SAC in Mekhoni town, Tigray, Ethiopia from May_2024 to March_2025. The town is situated 657 kilometers north of Addis Ababa, the capital city of Ethiopia, 126 kilometers south of Mekelle, the capital city of the Tigray National Regional State. It is positioned at coordinates $12^0$48.17'N and 39^0 38.754'E with an elevation of around 1773 meters above sea level. According to central statistical agency (CSA) report of 2007 census the town had a total population of 9,419. The economy of the population is heavily dependent on agricultural activities, which serve as the primary source of livelihood for the majority of its population. The regions fertile lands support the cultivation of crops such as teff and millet, while livestock farming also play important role in local economy. The town has one primary hospital, provides in and outpatient medical services to residents of Mekhoni town and Raya Azebo wereda. The town has four elementary schools, all of which have suffered significant damage to their sanitation and water facilities as a result of the recent devastating war.

4.2. Source of population

All school-age children of Mekhoni town with the age of 5-14 years

4.3. Study population

All school-age children enrolled in two selected elementary schools who were available during the study period

4.4. Study unit

All randomly selected school age children enrolled in the two selected elementary schools who were available during the study period

4.5. Eligibility criteria

4.5.1. Inclusion criteria

School-age children who were willing to participate, provided stool samples, and obtained consent from their parents or legal guardians were included.

4.5.2. Exclusion criteria

School-age children who had taken helminths chemotherapy within 3 months before data collection were excluded.

4.6. Sample size and sampling technique

4.6.1. Sample size determination

A sample size of 285 was determined using single population proportion statistical formula by the following assumptions: 95% level of confidence, 5% margin of error and P (proportion) of 0.215(20).

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

Where

n = Sample size

α = level of significance

z = at 95% confidence interval Z value (α= 0.05) =>Z α/2=1.96

p = Proportion of occurrence of the event estimated 0.215

d = Margin of error at (5%) (0.05)

4.6.2. Sampling technique

Two elementary schools were chosen from the four available in Mekhoni town using simple random sampling. Once the schools were selected, students were stratified by their educational levels (grades 1-8). The allocation of schoolchildren to schools and grade levels was done proportionally based on the number of students in each school and grade. Sections within the schools were selected using a lottery method. A roster containing the list of students was compiled as the sampling frame. To select study participants for each grade level, systematic random sampling was employed, following proportional allocation. The sampling interval (K) was calculated by dividing the total number of units in the population (N) by the desired sample size (n), resulting in a sampling interval of 11 (K=11) across the two schools.

The first student was randomly selected from the Kth interval, and subsequent participants were chosen at every Kth interval thereafter.

Proportional allocation of samples

The formula for proportionate allocation is as follows:

$n_j = n \times N_j / N$ (55)

Where

nj = sample size of the each school

Nj =population size of the each institution

n = n1 + n2 + ...+ nk is the total sample size

N = N1 + N2 + ...+ Nk is the total population size

Using the above formula samples were calculated as follows.

Sample from Degol primary school

Nj= 1946

n= 285

N= 3046

Calculation: 285×1946÷3046=172,

Sampling interval: K=N/n=1946÷172=11

Sample from Hayelom Araya primary school

Nj= 1100

n= 285

N= 3046

Calculation: 285×1100÷3046=103,

Sampling interval: K=N/n=1100÷103=11 both schools had a consistent sampling interval of 11, ensuring systematic selection from the respective populations.

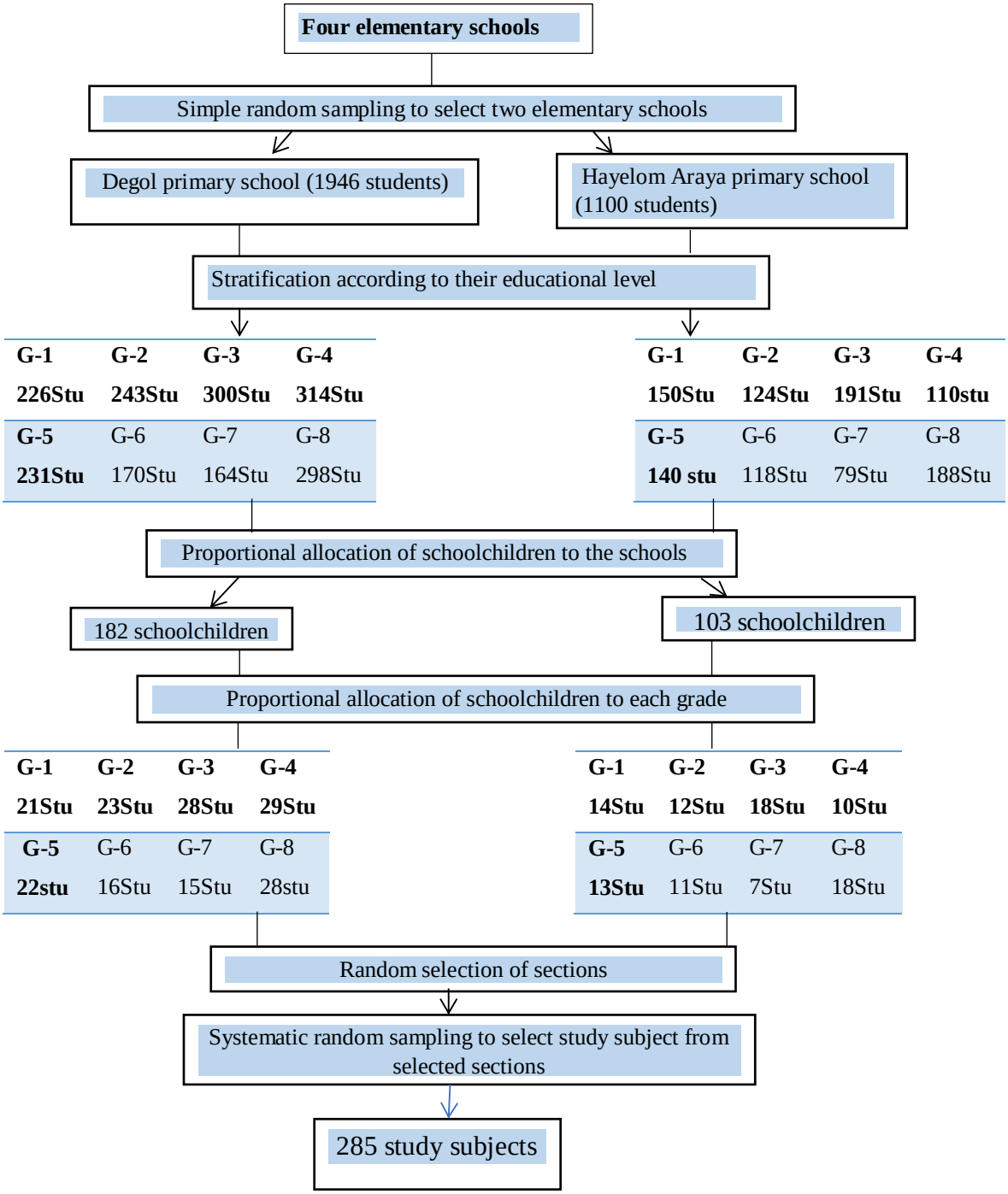


Figure 2. Schematic representation of sampling procedure

4.7. Study variables

4.7.1. Dependent variable

- Prevalence of soil transmitted helminths

4.7.2. Independent variables

✓ **Socio-demographic characteristics**

- Age
- Sex
- Educational level
- Parental educational level
- Family income
- Family size

✓ **Hygiene and sanitation**

- Hand washing habit
- Finger nail cleanness
- Finger nail trimming
- Shoe wearing habit
- Toilet availability
- Water source for drinking and washing
- Waste disposal habit

✓ **Nutritional status**

- Under-weight
- Stunting
- Wasting

4.8. Data collection technique and tools

4.8.1. Questionnaire

Data on demographic characteristics, hygiene and sanitation of study participants were collected using structured and pre-tested questionnaire. The questionnaire was developed in English based on previous research works and translated into local language (Tigrigna). The face-to-face interview was conducted by trained data collectors (Annex-3).

4.8.2. Anthropometric measurement

Using standardized anthropometric measurements, weight and height were taken for all study participants. For weight measurement, children were asked to remove their shoes, wear light clothes and remove accessories. Then, trained data collectors measured children's weight on a calibrated portable digital scale (FAZZINI S759) and record the value to the nearest 0.1 kilograms. For height measurement, children were instructed to stand upright with their shoulders aligned, arms at their sides, thighs and heels touching comfortably together, the buttocks, scapulae, and

head were positioned against the vertical backboard with a sliding head bar. The height was then recorded to the nearest 0.1 centimeter (58).

Stool examination

Labeled stool containers with tight covers bearing serial numbers of the subjects were supplied for the study participants. Fecal specimens were processed by wet mount and Kato-Katz techniques

4.8.2.1. Direct wet mount method

Fresh stool samples (approximately 2 mg of stool) were put on a slide with the wooden applicator and emulsified with a drop of physiological saline (0.85%). The preparation was then covered with a cover slide and examined at 10× and 40× microscopic objectives(69) The detailed procedure is provided in (annex-4)

4.8.2.2. Kato- Katz method

Kato thick smear was prepared using the Kato-Katz template which delivers 41.7 mg of stool and the smears was transported to Mekhoni primary hospital for further analysis. The slides were examined by experienced laboratory technologist under 10-x and 40-x objective lenses for presence of eggs of STH **(**annex-5). Hook worm ova detection was performed by examination of the Kato-Katz slide within one hour of stool collection and its preparation. Furthermore, all eggs of STHs was counted under a microscope and reported as the number of eggs per gram of stool(EPG) by multiplying with appropriate factor of 24 (70). The intensity of the infection was estimated based on the cut-off value for the classification of infection intensity (71). As light, moderate and heavy infection. 1–4999 epg, 5000–49999 epg, and >50000 epg, respectively for *A.lumbericoides* for *T.trichuira,* 1–999 epg, 1000–9999 epg, and >10000 epg, and for hookworm, 1–1999 epg, 2000–3999 epg , >4000 epg according to WHO cut-off values (72)

4.9. Operational definitions

Anthropometric measurements: are systematic measurements of the variation of physical dimensions and composition of the human body.

School-age children: children who attend primary school (one to eight grade) and are in the age group of 5 to 14 years.

Disability-adjusted life year (DALY): is a measure of overall disease burden, expressed as the number of years lost due to ill health, disability or early death.

Nutritional status: is the child's state of the body which is determined by anthropometric measurement indices as normal, stunted, wasted, or under-weight based on the WHO standard reference 2007

Undernutrition: is a poor nutritional status of primary schoolchildren which is expressed in anthropometric indices when the Z-scores for the WHO standards of 2007 are less than minus two (Z-scores < -2SD)

Under-weight: weight-for-age z-scores below -2SD

Severe under-weight: weight-for-age z-scores below -3SD

Stunting: height-for-age z-scores below -2SD

Severe stunted: height-for-age z-score below -3SD

Wasting: BMI(body mass index)-for-age z-scores below -2SD

Severe wasted: BMI-for-age z-scores below -3SD

4.10. Data quality assurance

The Questionnaire was pre-tested in Baro elementary school before actual data collection. The collected data were checked for consistency and accuracy on a daily basis. All the laboratory procedures were conducted as per the Standard Operating Procedures (annex-8). Two slides were prepared from each sample and were independently examined by two Medical Laboratory Technologists independently. Additionally, 10% of the samples were randomly chosen and re-checked by senior medical Laboratory Technologists.

4.11. Data analysis and interpretation

All data was recorded by hard copy. After checking for completeness, data were coded and entered, using SPSS (Statistical Package for social sciences statistical software) version 27. Then Descriptive statistics was applied to present the data using frequency, tables, figures and bar graph. Binary logistic regression was employed to show the correlation of the dependent variable with the individual independent variable. Multivariate analysis was done to identify the independent effect of the main explanatory variable on the outcomes of interest after adjusting for several other confounding variables. P-value of <0.05 was considered indicative of a statistically significant difference. The results of the logistic regression indicated that the chosen model was a good fit, as evidenced by the Hosmer-Lemshow goodness-of-fit test, which yielded a P-value of 0.08. WHO AnthroPlus 2009 (v 1.0.4) was used to calculate weight-for-age z-scores (WAZ), height-for-age z-scores(HAZ), and BMI(body mass index)-for-age z-scores ((BAZ). Children <-2SD were classified as Under-weight (WAZ<-2SD), Stunted (HAZ<-2SD), and Wasted (BAZ<-2SD) (11). (Annex-6)

4.12. Ethical clearance

Ethical clearance was obtained from Mekelle University, College of Health Sciences Ethical Review Committee. Furthermore, permission letter was obtained from Tigray Regional Health Bureau and Mekhoni Wereda Health office. Besides, further permission was obtained from the selected school's administrator. Moreover, consent was obtained from families and/or guardians. Each data was kept confidential. Results showing positive for STH were communicated with participant's families and they were linked with the closest health facilities for treatment.

4.13. Result dissemination

The findings of this investigation will be submitted and presented to Mekelle University, Health Sciences College, Institute of Biomedical Sciences, Department of Medical Parasitology and Entomology. This submission will serve as a valuable resource within the university's library, for students, faculty, and researchers. A copy of this result will also be shared to Tigray Regional Health Bureau (TRHB). Finally, for wider dissemination to the scientific community. The findings will be prepared as manuscripts for publication in peer reviewed reputable journals.

5. RESULTS

5.1. Socio-demographic characteristics of study participant

A total of 277 study participants were enrolled with a response rate of 97.2%. Of the participants, 176 were from Degol, while 101 were from Hayelom Araya elementary Schools. Majority (59.9%) of the participants were males, and 56.7% participants were aged 11-14 years, with a median age of 12years and an inter-quartile range [IQR] of 4 years. Additionally, approximately half of the children (50.5%) lived in households with a family size of more than five (Table 1).

Table 3: Socio-demographic characteristics of school age children, Mekhoni town, Tigray, Ethiopia May_ 2024 to March_2025 (N=277).

Variables	Category	Frequency (%)
School	Degol	176(63.5)
	Hayelom Araya	101(36.5)
Sex	Male	166(59.9)
	Female	111(40.1)
Age in years	5-10	120(43.3)
	11-14	157(56.7)
Religion	Orthodox	234(84.5)
	Muslim	43(15.5)
Grade	1-4	150(54.2)
	5-8	127(45.8)
Family monthly income (ETB)	<1000	39(14.1)
	1000-2000	25(9)
	>2000	213(76.9)
Family size	≤5	137(49.5)
	>5	140(50.5)
Mother's educational status	No formal education	97(35)
	1-8	97(35)

	≥9	83(30)
Mother's occupation	Merchant	124(44.8)
	Civil servant	65(23.5)
	House wife	61(22)
	Daily labourer	27(9.7)
Father's educational status	No formal education	103(37.2)
	1-8	90(32.5)
	≥9	84(30.3)
Fathers occupation	Merchant	102(36.8)
	Farmer	58(20.9)
	Civil servant	68(24.5)
	Daily labourer	49(17.7)

5.2. Hygienic and environmental factors of study participants

Among the 277 study subjects, majority, 82.3% reported that they always wash their hands before meals. In contrast, 11.2% participants indicated that they wash their hands sometimes, while, 6.5% reported that they do not wash their hands before meals at all. Furthermore, 78.3% of the participant stated that they always wash their hands after using the toilet. Proper hand washing with water and soap was practiced by 64.6% participants following toilet visits. Additionally, it was observed that 72.9% participants cleaned their fingers and 63.2% trimmed their fingers properly.

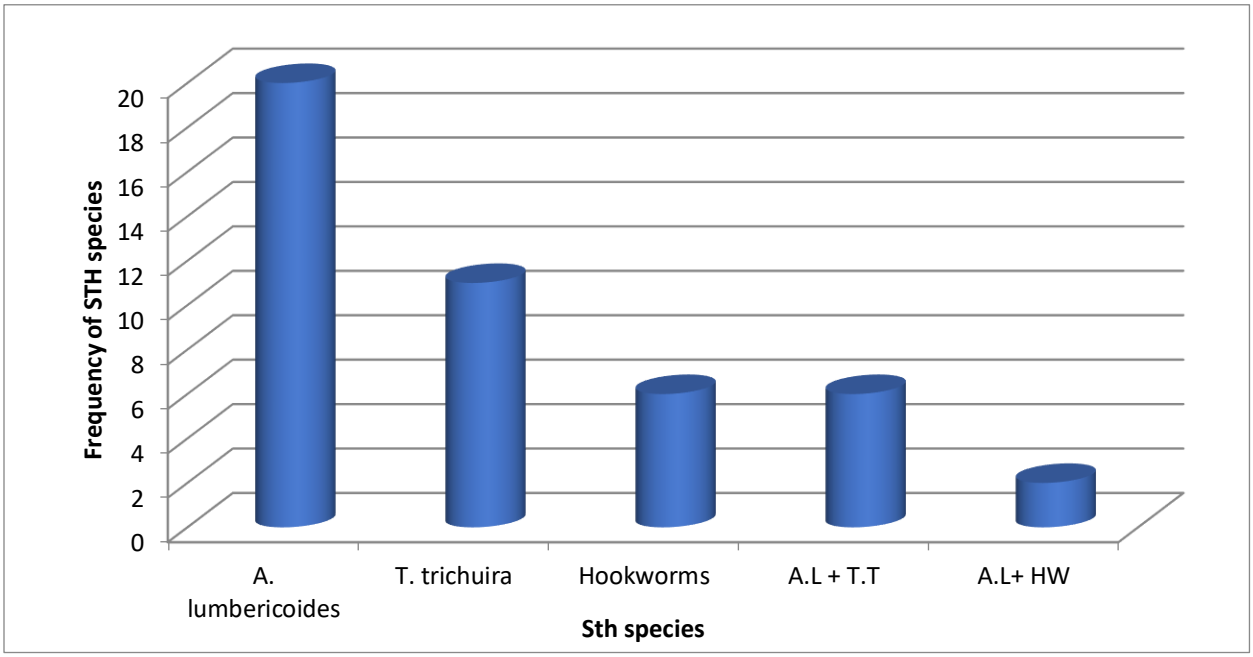
Of the participants, 72.2 % reported to have access to tap water for drinking, washing clothes, and bathing. 80.9% participants indicated that they disposed of their solid waste using house-to-house garbage collection services provided by the municipality. Besides, 92.4% participants had access to toilets (Table 2).

Table 4: Hygienic and environmental factors of school age children in Mekhoni town, Tigray, Ethiopia May_2024 to March_ 2025 (N=277).

Variable	Category	Frequency (%)
Wash hands before meal	Yes	259(93.5)
	No	18(6.5)
Frequency of washing hand before meal	Always	228(82.3
	Sometimes	31(11.2)
Wash hands after toilet	Yes	271(97.8)
	No	6(2.2)
Frequency of washing hands after toilet	Always	217(78.3)
	Sometimes	54(19.5)
Using water and/or soap after toilet	Using water only	92(33.2)
	Using water and soap	179(64.6)
Fingernail cleanness	Clean	202(72.9)
	Not clean	75(27.1)
Trimmed fingernails	Trimmed	175(63.2)
	Not trimmed	102(36.8)
Shoe wearing habit	Always	275(99.3)
	Sometimes	2(0.7)
Habit of eating unwashed / undercooked vegetables	Yes	31(11.2)
	No	246(88.8)
Availability of toilet	Yes	256(92.4)
	No	21(7.6)
Type of toilet	Traditional pit latrine	138(49.8)
	Ventilated improved	118(42.6)
Solid waste disposal habit	Burry underground	17(6.1)
	Open field	19(6.9)
	Incinerate	17(6.1)
	By municipality	224(80.9)

5.3. Prevalence of Soil-transmitted Helminths

A total of 45(16.2 %) study participants were found positive for one or more STH infections. Moreover, *A. lumbricoides* represented the most dominant STH parasite affecting 10.1 % (n=28) of the study participants. *T. trichiura* and hookworm were detected in 6.1% (n=17) and 2.9% (n=8) of the schoolchildren respectively. From the infected children 31(18.7 %) were males and 14 (12.6 %) were females



STH co-infections and infection intensity

The prevalence of single STH infection was 82.2 % (37/45). A single infection by *A. lumbricoides* was the most predominant parasite constituting 54 % (20/37) of the infections. Furthermore, 17.8 % (8/45) of the cases harbored dual infections. Co-infection by *A. lumbricoides* and *T.trichiura* were 75% (6/8) whereas *A. lumbricoides* and hookworm co-infections were 25 % (2/8). The proportions of light infections for, *A. lumbricoides* and Hookworm were 100 %; only 2 cases of *T.trichuira* were with moderate infection intensity. Heavy infections were not observed in all STH infections.

Table 3: Intensity of infection in schoolchildren with STH in Mekhoni town, Tigray, Ethiopia May_2024 to March_2025 (N=277).

Type of STH infection	Mean (EPG)	Class of infection intensity			
		Light (%)	Moderate (%)	Heavy (%)	Total (%)
Ascariasis	1122	28(100)	0	0	28(100)
Trichiurasis	598	15(88.2%)	2(11.8)	0	17(100)
Hookworms	561	8(100)	0	0	8(100)

Epg=eggs per gram of stool

5.4. Nutritional status of school-age children

Both weight and height of schoolchildren in Mekhoni town were not normally distributed with the corresponding median and interquartile range (IQR) of 29.5 kilogram (kg) (IQR=13.5) and 136 Centimeter (Cm) (IQR=23). The anthropometric assessment of study participants revealed that the overall prevalence of under-nutrition was 37.5% (N=104). Besides, 26 (22.2%) children aged 5–10 years were under-weight, 77 (27.8%) of the children were stunted and 31 (11.19%) of the children were wasted. The prevalence of a severe form of under-weight among children aged 5-10 years (WAZ < -3SD), severe stunting (HAZ,-3SD), and wasting (BAZ<-3SD) were 5 (4.3%), 6.9% and 3.2% respectively.

Table 4: Nutritional status of Schoolchildren in Mekhoni town, Tigray, Ethiopia, May_ 2024 to March_2025 (N=277).

Variable	N	%	Median(IQR)
Under-nutrition	104	37.5%	
WAZ(n=117*)			-1.44(1.36)
Below -2SD underweight	26	22.2	
Below -3SD severe underweight	5	4.3	
HAZ			-1.38(1.20)
Below -2SD stunted	77	27.8%	
Below -3SD (severe stunted)	19	6.9	
BAZ			-0.69(1.33)
Below -2SD wasted	31	11.9	
Below -3SD (severe wasted)	9	3.2	

Height-for-age Z-score (HAZ), Weight-for-age Z-score (WAZ), Body-mass-index-for-age Z-score (BAZ)

*For WAZ (an indicator of underweight), only calculated for individual ≤ 10 years of age (age group 10 years covers up to age 120 completed months), n = 117.

5.5.1. Nutritional status and STH infection

A total of 104 (37.5%) children were found to be undernourished, with 26 (25%) of them having STH infections. Among the children infected with STH, 27.3% were underweight (n=117), 44.4% were stunted, and 20% were wasted. In comparison, the prevalence of underweight, stunting and wasting among healthy children was 20% (n=117), 24.5%, and 9.5%, respectively.

5.5. Bivariate and Multivariate logistic regression results of the study participant

The prevalence of STH infection is relatively higher among males, 31(18.7%) as compared to females 14(12.6%), although not statistically significant. Similarly, the number of infections is also higher among SAC within age group of 5-10, 22(18.4%) than 11-14 years old, 23(14.65%) but this difference is also not statistically significance. The family size of study participants, hand washing method after toilet, cleanness of fingernails and trimming of fingernails were identified as independent factors associated with STH infection at a significant level of 0.05. Family size emerged as a strong predictor of STH, with participants from households of more than five members being more likely to be infected by STH than participants having family size ≤5 (AOR= 2.56, 95% CI: 1.18-5.55, P=0.017). Participants who washed their hands with both water and soap after using the toilet were 71% less likely to be infected with STH compared to those who washed with water only(AOR= 0.29, 95 % CI: 0.13-0.63, P=0.002). Additionally, children who did not clean their fingernails were 2.63 times more likely to be infected than those who did (AOR=2.63, 95% CI: 1.14-6.03, P=0.022). Likewise, children with untrimmed fingernails had a higher likelihood of STH infection compared to those with trimmed nails (AOR=2.25, 95 % CI: 1.006-5.03, P=0.002). In bivariate logistic regression, undernutrition, stunting, and wasting were found to be statistically significant when STH infection status was considered as the outcome variable. However, these factors were no longer significant after adjusting for confounders in multivariate logistic regression.

Table 5: Risk factors for soil-transmitted helminthic infections among schoolchildren, Mekhoni, Tigray, Ethiopia May_2024 to March_2025 (N=277)

Variable	Category	STH infection		COR (95% CI)	P	AOR (95 % CI)	P
		Presence (%)	Absence (%)				
Sex	Male	31(18.7)	135(81.3)	1			
	Female	14(12.6)	97(87.4)	0.6(0.3-1.24)	0.183	1.06(0.47-2.37	0.88
Age group	5-10	22(18.33)	98(81.67)	1			
	11-14	23(14.65)	134(85.35)	0.765(0.4-1.45)	0.411		
Father's occupation	Merchant	12(11.8)	90(88.2)	1			
	Farmer	10(17.2)	48(82.7)	1.56(0.62-3.87)	0.336	1.76(0.63-4.91)	0.279
	Civil servant	13(19.1)	55(80.9)	1.77(0.75-4.16)	0.189	2.1(0.8-5.9)	0.12
	Daily labourer	10(20.4)	39(79.6)	1.92(0.76-4.82)	0.163	1.46(0.49-4.29)	0.49
Family size	≤5	14(10.2)	123(89.8)	1			
	>5	31(22.1)	109(87.9)	2.49(1.26-4.94)	0.008	2.56(1.18-5.55)	0.017*
Using water and/or soap after toilet	Using water only	27(28.7)	65(71.3)	1			
	Using water and soap	17(9.5)	162(90.5)	0.25(0.12-0.49)	0.001	0.29(0.13-0.63)	0.002*
Finger nail cleanness	Yes	21(10.4)	181(89.6)	1			
	No	24(32)	51(68)	4.05(2.09-7.87)	0.001	2.63(1.14-6.03)	0.022*
Finger nail trimmed	Yes	20(11.4)	155(88.6)	1			
	No	25(24.5)	77(75.5)	2.51(1.31-4.81)	0.005	2.25(1.006-5.03)	0.048*
Nutritional status	Normal	19(11)	154(89)	1			
	Under nutrition	26(25)	78(75)	2.7(1.40-5.18)	0.003	1.45(0.27-7.6)	0.65
Stunting	No	25(12.5)	175(87.5)	1			
	Yes	20(26)	57(74)	2.45(1.27-4.75)	0.008	1.41(0.30-6.67)	0.65
Wasting	No	36(14.6)	210(85.4)	1			
	Yes	9(29)	22(71)	2.38(1.01-5.59)	0.045	1.91(0.45-8.07)	0.37

Note: * Statistically significant at P<0.05
Abbreviations: AOR = adjusted odds ratio; COR = crude odds ratio; 1 = reference group; 95% CI = 95% confidence interval.

6. DISCUSSION

According to the WHO classification of STH infection risk category, the study population in the area showed a low prevalence of STH infection (16.2%). This rate is higher than reported rates from Wera-baye (6.6%) [36], Enderta wereda (6.5%) [35], Gurage zone(9.5%) [21] and Cameroon (2.2%) [19]. However, the prevalence in this study is lower than that observed in Fogera district (30.30%) [57], Yirgachefe (54.5%) [23], Dara mallo and Uba Debretsehay districs (33.2%) [56], Mettu (84.4%) [22], and Jimma (55%) [11]. On the other hand, it is similar to findings from studies conducted in Adola (16.1%) [55] , ambo (12.8%) [15] and Western Kenya (17.0%) [53] . Variation in socio-demographic and economic factors, as well as differences in awareness regarding STH exposure, transmission, and prevention, may explain the discrepancies in prevalence between this study area and the others.

In terms of species, *A. lumbericoides* was the most common STH infection, with a prevalence rate of 10.1%. This is higher than the findings in Medebay zana (1.71%) [42] and Gurage zone (3%) [21]. But lower than a studies from Yirgachefe (21.7%) [23] and Mettu (39%) [22]. Though, the prevalence of *A. lumbericoides* in current study is consistent with previous studies in Dembecha (11.4%) [20] and Hawassa (11.2%) [54]. *T. trichuira* and Hookworm had prevalence rates of 6.1% and 2.9% respectively, which is higher than the one observed in Wera-abaye (1.6%, 0%) [36] and Enderta wereda (0.21%, 0.42%)[35]. Moreover, the prevalence rate in this study align with research conducted in Hawassa (4.5%, 2.7%) [54]. In contrast, hookworm infection is much lower than study conducted in Durebte town (46.9%) [4]. The variation in the prevalence of specific parasites may be linked to variations in the suitability of the macro and microenvironments for the parasites across different regions, study time frame, geographical locations, urbanization, and lack of public health education, deworming practices, as well as economic, social, and cultural factors. As it has been described in literature [73]. This study found that factors such as family size, hand washing practices after using the toilet, finger nail cleanness, trimmed fingernails were significantly linked to STH infections. Similarly, studies in Dembecha [20], Hawassa [54], and Ambo [15] also identified family size as key risk factors for STH infection. In this study, children who washed their hands with both water and soap after using the toilet were 71% less likely to be infected with STH infections (AOR= 0.29, 95 CI (0.13-0.63), P=0.002). Similar with a study

conducted in Lurambi, Kenya [67]. Another report also highlighted the importance of nail trimmed and cleanness in relation to STH infection which aligns with our findings [3].

Among the schoolchildren investigated, 37.5% were found to be suffering from undernutrition, which is higher than the rates in Addis Ababa (30.9%) [63] and Yirgachefe (28.9%) [23]. But lower than rate reported from Debremarkos (56.2%) [61]. The stunting prevalence was found to be 27.8%, which is consistent with findings from studies in Agulae (25.5%) [41], and Jimma (21%) [11]. However it was higher than the prevalence reported in Chencha (8.9%) [14]. In contrast, the prevalence was lower than studies conducted in Hawzen (33.3%) [64], Arbaminch (41.9%) [58], and Mulo district (42.4%) [62]. The prevalence of wasting was 11.9%. Which is lower compared to the study conducted in Agulae (44%) [41]. In spite of that our result is higher than the rates reported in Yirgachefe (5.2%) [23] and Jimma (6.9%) [11]. The prevalence of underweight in the population being studied was found to be 22.2%, this is lower than the results reported in Agulae (55%) [41] and Hawzen (32.2%) [64]. On the other hand, it is higher than the prevalence observed in Addis Ababa (15.4%) [63], Yirgachefe (12.9%)[23], and Mettu (5.1%) [22]. The disparity in stunting, wasting and underweight prevalence's across different regions is possibly due to differences in factors such as socio-economic status, living condition, improper child feeding practices, geographic differences, variations in agricultural productivity, urbanization, and healthcare for the children.

The lack of association between nutritional status and STH infection in this study is consistent with findings from and Yirgachefe [23] and chencha [14] unlike the study conducted in Jimma [11] and Mettu [22] in which *T. trichiura* is a predictor of stunting and undernutrition respectively

7. LIMITATION

This study shares the limitation of cross-sectional study design, which does not establish a cause and effect relationship between dependent and independent variables. Additionally, the study relied solely on anthropometric measurements to assess nutritional status, without biochemical, and dietary assessment.

8. CONCLUSION

The current study found that the prevalence of STH infections is less than 20%, indicating a low risk category based on WHO classifications. The most common species of STH infections identified were *Ascaris lumbricoides*. Additionally, STH infections were linked to factors such as large family size, nail cleanness, nail trimmed, and hand washing practices after using the toilet. The study also revealed a high prevalence of undernutrition among school age children, however there was no significant difference in the nutritional status of children with or without STH infections.

9. RECOMMENDATIONS

Schools should ensure access to clean toilet and hand washing facilities. In addition, establishing sanitary clubs can help promote hygiene awareness and teach good practice, empowering students to take responsibility for their health and create a cleaner, safer school environment. Community programs should educate families, particularly those with large households, on proper hygiene. Parental involvement is crucial for reinforcing hygiene practices at home, and regular monitoring should be conducted to assess the effectiveness of these interventions in reducing STH infection.

It is essential to introduce a school health and nutrition program to enhance the nutritional status of schoolchildren in the study area, ensuring a better future for them.

Furthermore, more in-depth research studies should be conducted to examine other potential risk factors of STH infections.

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11. Annexes

Annex-1: Participant Information Sheet English and Tigrigna Version.

Participant Information Sheet English Version

Title of the project: Soil-transmitted helminths infections and nutritional status of school-age children in Mekhoni town, Tigray, Ethiopia, 2025.

Principal Investigator: Abel Deres (BSc.) Advisors: Gessessew Bugussa (MSc, Assistant professor) and Tirhas Mulubirhan(MSc).

Department: Department of Medical Parasitology and Entomology, Biomedical division, College of Health sciences, Mekelle University.

Introduction: My name is Abel Deres and I am MSc student in Medical Parasitology at Mekelle University, College of Health Sciences. I am conducting a research on soil-transmitted helminths infections and nutritional status of schoolchildren in Mekhoni town.

Purpose: The study is planned to determine the prevalence of soil transmitted helminths, associated factors, and nutritional status among school age children in Mekhoni town, Tigray, Ethiopia.

Procedure and Participation: To achieve the planned objective, a standardized questionnaire will be used to collect the socio-demographic and risk factors through interview. Then after, 5 gram of stool will be collected from each participating individuals and laboratory diagnosis will be performed using two methods includes; wet mount, Kato-Katz smear. Weight and height of the children will be taken to determine the nutritional status.

Confidentiality: All data obtained will be kept strictly confidential. Your name will not be mentioned in any report; instead, code number will be used. All of your answers and test results will keep confidential and will not be given to other institution and/ or person except for the principal investigator of this study. Your information will be used only for above-mentioned purpose

Benefits: STH result will be informed to you and give advice to inform your doctor or health provider around your area.

Risk: There will not be any risk associated during sample collection and thereafter.

Inducement, incentive and Compensation: There will be no costs and payment for you as a result of taking part in this study. You have full right to get full information about study procedures and other related issues with languages of your choice.

Results Dissemination: The study results will be discussed with all concerned bodies in the health institutions and Tigray regional health bureau. It will also be presented primarily at Mekelle University scientific community; and national and international scientific conferences. Finally, the manuscript will be sent to appropriate journal for publication. In this way, the result will not bear any information relevant to your personality.

Freedom to withdraw: Your participation is purely voluntary and has no influence on the service you seek to get. So you withdraw your participation any time

Person to contact: If you have any question, want more information and check about this project you can contact the following people:

- Mekelle University, College of Health Sciences, Institute of Biomedical Sciences Institutional Review board Office Tel= 0344-40-66-80.
- Principal Investigator Name and Address: Abel Deres (BSc) email=abelderes.wediraya@gmail.com; Mob= +251983988453.
- Advisor's Name and Address: Gessessew Bugussa (PhD fellow, Assistant professor); email=bugssag@gmail.com; Mob=0913252205, Tirhas Mulubirhan (MSc); email=tirhas.mulubirhan@mu.edu.et; Mob= +251904852219

Participant Information Sheet Tigrigna

ናይ ምርምር ፅንዓት መብራህርሂ ቅጥዒ/ትግርኛ ቅዳሕ

ናይ ምርምር ርእሲ፡-ዝርገሐ ናይ ብሓመድ ዝመሓላለፉ ናይ መዓናጡ ሓሳኩን መንቀሊኦም ምስ ስነ ኣመጋግባ ዘለዎም ርክብን ኣብ ዕድሚኦም ካብ 5-14 ዓመት ዝኾኑ ተምሃሮ ኣብ ከተማ መኾኒ.

ፅንዓት መካየዲ ሽም፡-ኣቤል ደረስ

ኣማኸርቲ፡-ገሰሰዉቡግሳ (ሓጋዚ ፕሮፌሰር) ፣ ትርሓስ ሙሉብርሃን(ማስተርስ)

ዲፓርትመንት፡-ስነ ፅግዕተኛ ሓሳኩን ነብሳትን ክፍሊ፣ጥዕና ሳይንስ ኮሌጅ፣መቐለ ዩኒቨርሲቲ

መእተዊ፡-ሽመይ ኣቤል ደረስ ይበሃል ኣብ መቐለ ዩኒቨርሲቲ ናይ ድሕረ ምረቃ ተምሃሪ እንትኾን፣ ናይ መመረቂ ፅሑፈይ "ኣብ ከተማ መኾኒ ዝርገሐ ናይ ብሓመድ ዝመሓላለፉ ናይ መዓናጡ ሓሳኩን መንቀሊኦም ምስ ስነ ኣመጋግባ ዘለዎም ርክብን ኣብ ዕድሚኦም ካብ 5-14 ዓመት ዝኾኑ ተምሃሮ'' ብዝብል ርእሲ ብክልተ ዓይነት ኣመራምራ ብምምርማር ኣብ ምክልካልን ምቁፅፃርን ፅግዕተኛ ሓሳኹ እጃመይ ንምዉፊይ እዩ።

ዕላማ ናይዙ መፅናዕቲ፡-ዝርገሐ ናይ ብሓመድ ዝመሓላለፉ ናይ መዓናጡ ሓሳኩን መንቀሊኦም ምስ ስነ ኣመጋግባ ዘለዎም ርክብን ኣብ ዕድሚኦም ካብ 5-14 ዓመት ዝኾኑ ተምሃሮ ንምፅናዕ።

ኣሰራርሓን ተሳተፍን እቲ ፅንዓት፡- ዝተዓለመሉ ሽቶ ንኽወቅዕ ብመጀመርያ ቃለምሕትት ክንገብሮሎም ኢና፡ ካብዚ ብምቅፃል ንላቦራቶሪ ምርመራ ዝኸውን ንእሽተን ፍታን ክህቡና/ባናእዮም/የን። ቐመቶምን ኽብደቶምን እውን ኽንዕቅኖም ኢና። እንገብረሎም ምርመራ ሕማም ከምፅኡ ዝኽእሉ ብሓመድ ዝመሓላለፉ ናይ መዓናጡ ፅግዕተኛ ሓሳኩ ኣብ ፍታን ምርኣይ መንቀሊኦም ምግምጋምን ምስ ስነ ኣመጋግባ ዘለዎም ርክብ ምርኣይን እዩ።

ሚስጥር ምሕላው፡ ንዝሕተቱ ሕቶታት መልሲ ኣብ ቅጥዑ ይምዝገብ። ሽሞም/ሽመን ኣብ ዝኾነ ሪፖርት ኣይግለፅን። ኣብ ክንድኡ ናይ ሚስጢር ቁፅሪ ይቕመጥ። ዝኾነ መልሲ ፤ ናይ ምርመራ ውፅኢት ብሚስጥር ይታሓዘ። ንዝምልከቶ እዙ ፅንዓት ዘካይድ ኣካል እንተዘይኾይኑን ን ዝኾነ ግለሰብ ኮነ ድርጅት ኣይወሃብን። ንዝዋሃብ መብርሂን ዝተገለፀ ምኽንያት ጥራሕ ኣገልግሎት ይውዕል።

ጥቕሚ፡ ብምስታፎም/ፈን ኣብ ፍታኖም ዝተረኽበ ዉፅኢት ንፆኦም/ን ኣድላዪ ኾይኑ እንተረኺብናዮ ፣ውን ምስ ሓካይም ክነራኽቦምን ግቡእ መድሓኒት ንክወስደ/ዲ ይግበር።

ዘስዕቦ ጉድኣት፡-ዝወሰድናሎም/ለን ናሙና እዙይ ዝባሃል ሳዕቤን/ሓደጋ የብሉን።

መበረታትዒ፡ ኣብዚ ፅንዓት ብምስታፎም/ፈን ዝዋሃበን/ኩም ወይም እትክፈልዎ/ኦ ክፍሊት የለን። ብምስታፎም/ብምስታፈን ዝኾነ ዝተፈለየ ዓይነት መበረታትዒ ኣይህሉን። ኾይኑ ግና ኣብ ዝኾነ ሰዓት ናይምርመራ ውፅኢት ንምፍላጥ ሙሉእ መሰል ኣለዎም/ወን።

ናይ ተሳታፊ ሓላፍነት፡- ንምስታፍ እንድሕር ተስማዕሚያም/አን ኣድላይ ዝበሃል ሓበሬታ ኩሉ ንዝምልከቶ ንኽህቡ/ባ ይሕተቱ/ታ እየን። ብተወሳኺ ንላቦራቶሪ ምርመራ ዝኸውን ናሙና ንምሃብ ኣድላይ ዘበለ ምትሕብባር ንክገብሩ/ራ።

ኣጠቃቅማ ውፅኢት፡ ውፅኢት ናየዚ መፅናዕቲ ንዝምልከቶም ጥዕና ትካላት ሓለፍቲ ንክልል ጥዕና ቢሮ ክንዚተየሉ ኢና። አብ መቐለ ዩኒቨርስትን ፣ሃገራውን ኣህጉራውን ሳይነሳዊ ኣኬባታት ክቀርብንን ሕትመት′ውን ክልኣኽ እዩ፡ በዚ ግዜ እዚ ግላዊ ዝኾነ ሓበሬታ ኣይወፅእን።

ክረኽብዎ ዝደልዩ፡–ሕቶ እንተሃልዩ ወይም ስለ እቲ ፅንዓት ዝበለፀ ሓበሬታ ንምርካብን ንምርግጋፅን ነዞም ዝስዕቡ አካላት ክረኽቡ ይኽእሉ፡–

- መቐለ ዩኒቨርሲቲ ጥዕና ሳይነስ ኮሌጅ ትካላዊ ግምገማ ቦርድ ጽ/ቤት፣ ስልኪ ቁፅሪ፡+251-0344-40-6680.
- ዋና ተማራማሪ ሽምን አድራሻን፡ ኣቤል ደረስ ኣድራሻ፡– abelderes.wediraya@gmail.com; ስልኪ ቁፅሪ: +251-983988453.
- ናይ አማከርቲ ሽምን አድራሻን፡–ገሰሰዉ ቡግሳ (ሓጋዚ ፕሮፌሰር)፣ ኣድራሻ፡–bugssag@gmail.com; ስልኪ ቁፅሪ፡0913252205) ፣ ትርሓስ ሙሉብርሃን ኣድራሻ፡–tirhas.mulubirhan@mu.edu.et; ስልኪ ቁፅሪ +251904852219

Annex 2: Consent form for parents/guardians (<15 years) English version.

Code number _____ Date_____

I have been informed that the objective of this study is to determine the prevalence of Soil transmitted helminths, associated factor and nutritional status among school children In Mekhoni Town, Tigray, Northern Ethiopia

The aim of the study is explained to me. I have also informed about the Confidentiality of the questionnaires. Therefore, with full understanding of the importance of the study, I agreed voluntarily to allow my child the requested samples in the above for laboratory investigation and I benefit only from the free laboratory investigation result.

I_____hereby give my consent for giving of the requested information and stool sample from my child.

Name _____ Signature: _____Date_____

Name of witness _____(Data collector, supervisor, any third person)

Signature _____ Date _____

Consent form for parents/guardians (<15 years) Tigrigna version.

ናይ ፍቓደኛ መረጋገፂ ቅጥዒ (ትሕቲ 15 ዕድመ ዘለዉ ቆልዑት) (ትግርኛ ቅዳሕ)

ናይ ሚስጢር ቁፅሪ_____ዕለት_____

ናይቲ ፅንዓት ዕላማ፣ እቲ ፍታን ንምንታይ ከምዘድልን ሚስጥር ናይቲ ቃለ መሕትት ኮነ ናይቲ ውፅኢት ከምዝሕለዉን ብዝርድኣኒ ቋንቋ ብዝግባእ ተገሊፅለይ እዩ። ኣብቲ ፅንዓት ብድልየት ከምዝሳተፍን ብዘይምስታፈይ ድማ ኣብ ዝረክቦ ኣገልግሎት ፀገም ከም ዘየምፅእ እውን ተገሊፅለይ እዩ። ስለዙ ናይቲ ፅንዓት ዕላማ ሙሉእ ብሙሉእ ተረዲአ ኣብቲ ፅንዓት ወደይ/ ጓለይን ክሳተፍ/ ንክትሳተፍ ዘድሊ ናይ ላቦራቶሪ ምርመራ ክግበረሉ/ላ፣ ውን ፍቓደኛ ምኺነይ አነ_____ብፌርማይ_____ኣረጋጊፀ ኣለኹ።

ዕለት_____

ናይ ዘፈረመ ሽም _____ክታም_____ዕለት_____

Annex 3: Questionnaire English and Tigrigna version.

Questionnaire English version.

Mekelle University, College Of Health Sciences, School Of Medicine Biomedical Division, Department Of Parasitology And Entomology.

Name of data collector_____ Date of data collection _____

School name_____

I. Participant identification

Code number----------

Socio-demographic characteristics:

1. Age in years_____
2. Sex A. Male B. Female
3. Religion A. Orthodox B. Muslim C. Protestant D. Catholic
4. Educational level

A. Grade 1 B. Grade 2 C. Grade 3 D. Grade 4

E. Grade 5 F. Grade 6 G. Grade 7 H. Grade 8

5. Fathers occupation A. Merchant B. Farmer C. Civil servant D. Daily labourer
6. Father educational level A. No formal education B. 1-8 C. ≥9
7. Mother occupation A. Merchant B. civil servant C. housewife D. Daily labourer
8. Mother educational level A. No formal education B. 1-8 C. ≥9
9. Family monthly income A. <1000 B. 1000-2000 C. > 2000
10. Family size A. 1-5 B.5 C. 6 D.>6

Hygiene practice and environmental factors

11. Do you wash your Hands before meal? A. Yes B. No
12. If your answer is yes for number 11 when? A. Sometimes B. Always
13. Do you have a Toilet? A. Yes B. No
14. If toilet is available what type of toilet is there? A. Traditional pit latrine B. Improved ventilated C.Water flush
15. Where do you defecate? A. in toilet B. open defecation

16. Do you wash your hands after visiting toilet? A. Yes B. No
17. If yes for number 16 how frequent do you wash? A. always B. sometimes
18. If yes for number 16 how do you wash. A. Using water only B. Using water and soap C. Using ash
19. Finger nail cleanness A. Clean B. Not Clean
20. Are finger nails of participant trimmed? A. Yes B. No
21. How is your shoe wearing habit? A. Sometimes B. Always
22. Is there any Habit of eating unwashed/under cooked vegetables A. Yes B. No
23. What is your Water source for drinking? A. Well water B. River C. Tap water D. Purified water (Bottled)
24. What is your Water source for washing clothes? A. Well water B. River C. Tap water D. Rain water
25. What are your Water sources for bathing? A. Well water B. River C. Tap water D. Rain water
26. How is your solid waste disposal habit A. Burry underground B. Open field C. Incinerate D. By garbage collectors from municipality

Questionnaire for interview (Tigrigna version) ትግርኛ ቅዳሕ ቃለ መሕትት

ሽም ሓታታይ_____ ዕለት_____

ሽም ቤት ትምህርቲ _____

መለለይ መንነት ተሳታፋይ

መለለይ ቁፅሪ:----------

1. ዕድመ:----------

2. ፆታ: 1.ተባዕታይ 2. ኣንስታይ

3. ሃይማኖት 1. ኦርቶዶክስ 2. ሙስሊም 3. ፕሮቲስታንት 4. ካቶሊክ

4. ደረጃ ትምህርቲ

1. 1ይ 2. 2ይ 3. 3ይ 4. 4ይ

5. 5ይ 6. 6ይ 7. 7ይ 8. 8ይ

5. ኩነታት ስራሕ ኣቦ 1.ነጋዳይ 2. ሓረስታይ 3.መንግስቲ ሰራሕተኛ 4. መዓልታዊ ሰራሕተኛ

6. ደረጃ ትምህርት ኣቦ 1. ስሩዕ ት/ቲ ዘይብሉ 2. 1-8. 3. ≥ 9

7. ኩነታት ስራሕ ኣዶ. 1. ነጋዲት. 2. ሰራሕተኛ መንግስት. 3. ናይ ገዛ ስራሕ. 4.መዓልታዊ ሰራሕተኛ

8. ደረጃ ት/ቲ ኣዶ. 1. ስሩዕ ት/ቲ ዘይብላ. 2. 1-8. 3. ≥9

9. ወርሓዊ እቶት/ብብር/ 1. ትሕቲ 1000 2. ካብ 1000-2000 3.ልዕሊ 2000

10. በዝሒ ስድራ 1. 1-5 2.5 3.6 4. ልዕሊ 6

11. ቅድሚ ምግቢ ምምጋብካ/ኪ ኢድካ/ኪ ትሕፀብ/ቢ ዶ? 1. እወ 2.ኣይፋሉን

12. መልሲ ቁፅሪ 11 እወ እንተኾይኑ መዓዝ ትሕፀብ ? 1. ሓደ ሓደ ግዜ 2. ኩሉ ግዜ ይሕፀብ

13. ሽንትቤት (ሽቓቕ) ኣለኩም ዶ? 1.እወ 2. ኣይፋሉን

14. ቁፅሪ 13 እወ እንተኾይኑ እንታይ ዓይነት ሽንትቤት (ሽቓቕ) ? 1. ናይ ጉድጌድ ሽንቲ ቤት መውፅኢ ኣየር ዘይብሉ

2. ናይ ጉድጌድ ሽንቲ መውፅኢ ኣየር ዘለዎ. 3.ተሓፃብን መውፅኢ ኣየር ዘለዎን

15. ኣብ ምንታይ ኢካ ትፍትን? 1. ኣብ ሽንትቤት 2. ኣብ ደገ

16. ድሕሪ ሽቓቕ ኢድካ/ኪ ትሕፀብ/ቢ? 1. እወ 2. ኣይፋሉን

17. ቁፅሪ 16 እወ እንተኾይኑ መዓዝ መዓዝ ትሕፀብ/ቢ? 1 .ኩሉግዜ 2. ሓደ ሓደ ግዜ

18. ቁፅሪ 16 እወ ተኾይኑ ብምንታይ/ብከመይ ትሕፀብ/ቢ

1. ብማይ 2.ብሳሙናን 3. ብሓሙክሽቲ

19. ፅሬት ፅፍሪ /ብትዕዝብቲ/ ፅሩይ ድዩ? 1. እወ 2.ኣይፋሉን

20. ፅፍሪ ኢድ ተፀፊሩ/ተስተካኪሉ/ ዶ /ብትዕዝብቲ/ 1. እወ 2.ኣይፋሉን

21. ጫማ እግሪ ኣብ ምግባር ከመይ ኢካ/ኪ? 1.ሓደ ሓደ ግዜ እየ ዝገብር 2.ኩሉ ግዜ ይገብር

22. ዘይበሰለ ወይ ዘይተሓፀበ ኣትክልቲ በሊዕካ ዶ ትፈልጥ? 1.እወ 2.ኣይፋሉን

23. ፍልፍል ንመስተ ትጥቀምሉ ማይኩም እንታይ እዩ 1. ጉድጓድ ማይ 2. ሩባ 3.ማይቡንባ 4.ዕሹግ ዝተፃረየ ማይ

24. ንመሕፀቢ ክዳን ማይ ካብ ምንታይ ትጥቀሙ 1. ጉድጋድ ማይ 2. ሩባ 3. ማይ ቡንባ 4. ማይ ዚንጎ

25. ፍልፍል መሕፀቢ ሰዉነት ማይ ካብ ምንታይ ትረክቡ 1. ጉድጓድ ማይ 2. ሩባ 3. ማይ ቡንባ 4. ማይ ዚንጎ

26. ጉሓፍ ከመይ ትጉሕፉ

1. ትሕቲ መሬት ብምቕባር 2. ላብ ክፍቲ ቦታ

3. ላብ መቃፀሊ ጉሓፍ ብምቅፃል 4. ላኪብካ ናብ ጉሓፍ ዝእክባ መኪና ምሃብ

Annex 4: Procedure for stool examination using wet mount preparation

1. Instruct the participant how to collect the stool in the labeled, clean, dry and leak proof container.
2. Receive the sample and check with participant Id and observe the appearance of the stool and record it.
3. Place a drop of fresh physiological saline on a slide
4. Using a wire loop or piece of stick, mix a small amount of specimen, about 2 mg, (matchstick head amount) with the saline.
5. Make smooth thin preparations.
6. Cover each preparation with a 22x22 cover glass.
7. Examine systematically the entire saline preparation for larvae, ciliates, helminthes eggs, cysts, and oocysts. Use the 10x objective with the condenser iris closed sufficiently to give good contrast.
8. Use the 40x objective to assist in the detection and identification of eggs, cysts, and oocysts.
9. Always examine several microscope fields with this objective before reporting "No parasites found".
10. Use the iodine preparation to assist in the identification of cysts
11. Report the presence of larvae, ciliates, helminthes eggs, cysts, and oocysts

Annex 5: Procedure for Preparation of duplicate Kato-Katz smears

1. Place a small amount (at least 2 gram) of stool on the scrap paper or newspaper.
2. Mark the slide as "Subject ID – A".
3. Place the 41.7mg containing template with the hole on the center of the marked microscope slide.
4. Press a piece of small nylon screen on top of the stool so that part of the stool is sieved through the mesh and accumulates on top.
5. Scrape the sieved stool from the upper surface of the screen using the spatula.
6. Fill the hole of the template on the microscope slide completely with stool from the spatula and remove any excess stool with the spatula.
7. Carefully remove the template by lifting it vertically. Avoid horizontal movements.
8. Place pre-soaked cellophane clipping on top of the stool aliquot on the microscope slide.
9. Remove excessive glycerol-malachite green solution using tissue paper before placing the cellophane clipping on the aliquot.
10. Take a second, clean, microscope slide and place it on top of the cellophane. Press the top microscope down so the stool aliquot spreads evenly. Avoid lifting, wrinkling or moving the cellophane when spreading the smear.
11. Caution: support the slide from below to avoid cracking/breaking.
12. Place the slide in the microscope slide box.
13. Mark a second microscope slide as „subject ID - B".
14. Repeat steps 1-12 to prepare the A and B smear of remaining samples
15. Take a smear, either A or B smear,
16. Examine the whole smear systematically using 10x or 40x objective by two laboratory technologist independently
17. Count the number of egg for each soil-transmitted helminthes species
18. Take an average number of eggs from A and B smears and multiply the number of eggs by 24 and report number of eggs per gram of faces/EPG/

NB: For Hookworm slide should be read within 30–60 minutes

Annex 6: Physical examination and Medical history

1. History of chronic illness A. Yes B.No
2. Symptoms of acute infection A. Fever B. Cough C. Head ache D. Abdominal pain E. Vomiting Diarrhea G. Nausea Other specify
3. Medication for intestinal parasites within 3 months

   A. Yes B.No
4. Anthropometric measurements.

   A. Height in Cm.----------

   B. Weight in Kg.----------

Annex: 7 Laboratory Report Format for Stool Examination

Code: _____ Age: _____Sex:_____

1. Wet Mount: _____parasite species_____

stage of parasite_____

2. Kato-Katz: _____ parasite species _____

stage of parasite_____

2.1 Egg count:_____

2.2 Parasite intensity (EPG) _____

Annex 8: Standard operating procedure

1. Wear protective safety gloves and laboratory coat when processing specimen
2. Do not eat, drink, smoke, apply cosmetics or manipulate contact lenses in work area.
3. Decontaminate work surface at least once a day and after any spill of potentially infectious material
4. If you have cuts, abrasions on the skin of your hands, cover with adhesive dressing.
5. If you use any sharp instruments, dispose of them in a " sharps" container for decontamination
6. Remove gloves and wash your hands after completing any task