HAWASSA UNIVERSITY, SCHOOL OF GRADTUATE STUDIES,

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES,

DEPARTMENT OF BIOLOGY

PREVALENCE OF INTESTINAL PARASITIC INFECTIONS AND ASSOCIATED RISK FACTORS AMONG PRIMARY SCHOOL CHILDREN IN KOKOSSA TOWN, WEST ARISI ZONE, OROMIA REGION, ETHIOPIA

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JUNE, 2024

Hawassa, Ethiopia

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MSC THESIS

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ADVISOR’S APPROVALSHEET-I

This is to certify that the thesis entitled **“**PREVALENCE OF INTESTINAL PARASITIC INFECTIONS AND ASSOCIATED RISK FACTORS AMONG PRIMARY SCHOOL CHILDREN IN KOKOSSA TOWN,WEST ARISI ZONE, OROMIA REGION, ETHIOPIA.”submitted in partial fulfillment of the requirements for the degree of Master's with specialization in Biology, the Graduate Program of the Department of Biology, and has been carried out by MAHAMMED SHERIFE (ID NO. BIO K/013**/11**).under our supervision. Therefore we recommend that the student has fulfilled the requirements and hence here by can submit the thesis to the department.

Mahammed Sherife ______________________ __________________________

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We, the undersigned, members of the Board of Examiners of the final open defense by Mahammed Sherife have read and evaluated his thesis entitled **"**Prevalence of Intestinal Parasitic Infections and Associated Risk Factors Among Primary School Children in Kokossa Town,West Arisi Zone, Oromia Region, Ethiopia." and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree Master in Biology.

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DECLARATION

I, the undersigned, declare that this thesis is my original work. I have undertaken the research work independently with the guidance and support of my research advisor. This study has not been submitted for any degree or diploma program in this or any other university and that all sources of materials used for the thesis have been well acknowledged.

Mahammed Sherife	_______________	_________________
Name of Candidate	Signature	Date

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Acronyms and Abbreviations

AOR = Adjusted Odd Ratio

CDC = Center for Disease Control and Prevention

CI = Confidence Interval

COR = Crude Odds Ratio

FMOH = Federal Ministry of Health

IPI = IntestinalParasiticalInfection

ONRS = Oromia National Regional State

OR = Odd Ratio

SAC =School AgeChildren

SPSS = Statistical Packages for Social Science

STH =SoilTransmitted Helminths

STHs = Soil Transmitted Diseases

WSH = Water Sanitation and Hygien

ABSTRACT

Intestinal parasitic infections are a major health concern in developing countries. It is important to monitor these infections and their associated risk factors in order to develop effective intervention strategies. This study aimed to assess the prevalence of intestinal parasitic infections and their risk factors among primary school children in Kokossa town, West Arisi Zone, Oromia Region, Ethiopia. The study used a cross-sectional school-based epidemiological investigation and a laboratory-based experimental survey method. A total of 403 student participants were selected using a systematic random sampling technique. Epidemiological data were collected using a structured questionnaire. Laboratory-based data were collected by examining stool samples for parasites. All data were analyzed using SPSS version 25 statistical software. Descriptive analysis, including frequency distribution, was used for processing the data. Bivariate and multivariate logistic regressions were used to analyze correlations.Out of the total 403 stool samples examined, 138 (34.2%) tested positive for at least one parasite infection. Among the positive cases, 82 (39.6%) were females and 56 (28.6%) were males.Seven species of intestinal parasite infections (IPIs) were detected. The most common was Ascaris lumbricoides, found in 34 (8.4%) cases. This was followed by Entamoeba histolytica in 24 (6%) cases, Giardia lamblia in 19 (4.7%) cases, and Hymenolepis nana in 11 (2.7%) cases. Taenia specie in s 8 (2% case) and Hook worm 5(1.2%)case and Trichuris trichiurain 3(0.7%)case.The rate of infection was highest among the age group 10-15 years 140(20.8%), as well as the infection rates of (39.6%: 82/207) and 28.6%: 56/196) were recorded among females and males respectively. The study revealed that the presence of (IPIs) has statistically significant association with socio-demography, environmental and behavioral factors ($p \leq 0.05$). Femaleness with adjusted Odds Ratio Grade level (AOR, 2.224, 95%CI, 1.333-3.370, p= 0.002), presence of latrine at home (AOR, 2.767, 95% CI 1.301-5.887 ,p= 0.000), Habit use latrine (AOR, 3.381, 95%CI 1.547-7.390,p= 0.000), finger nail not trimmed (AOR, 1.819, 95%CI, 1.003-3.289 , p= 0.049), school children who didn't wear shoes regularly.), (AOR= 2.097, 95% CI: 1.178-3.742, p=0.012) and lack of awareness about intestinal parasitic infection (AOR = 2.169; 95% CI: 1.211-3.883, p= 0.009) were the independent risk factors associated with the overall prevalence of IPIs, The finding implies that relatively high prevalence of intestinal parasitic infection was seen among school children & schools lack basic sanitary facilities. Therefore, schools should improve basic sanitary facilities, knowledge and practice of students.

Key words*:* Intestinal parasitic infections, Kokosa town.Prevalence, risk factors

1. INTRODUCTION

1.1. Back ground of the study

Intestinal parasitic infections (IPIs) have been a big concern for low-income countries as they are the major cause of high morbidity and mortality. Most infectious diseases caused by members of the intestinal parasites (protozoan and helminths) have been considered as Neglected Tropical Diseases (NTDs) (WHO, 2023 & Hotez *et al.*, 2022) and are affecting a large section of poor communities. Intestinal helminthiasis and protozoan infections are wide spread throughout the world (Ojha *et al.*, 2022 & Efstratiou *et al*., 2019) and in particular, millions of people in low-income countries are infected and/or ill with parasitic infections (PIs).Soil-transmitted helminth infections round worm, whip worm, and hookworm affect millions of people world wide (WHO, 2023). More than a third of the world's population is infected with soil-transmitted helminths (STH), mainly in the developing nations of Asia, Africa, andLatin America (Ross *et al.*, 2022 & Hernández *et al.*, 2019). The main species that infect people are the roundworm (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*), and the hookworms (*Necator americanus* and *Ancylostoma duodenale*) (WHO, 2020). Intestinal parasitic infections (IPIs) are major health problems in many developing countries, particularly among pre-schooled and schooled children (Legesse Chelkeba,2020). Intestinal helminths and protozoans are among the commonest infections in humans living developing countries (Houweling,2023)

Globally, millions of pre-schoole and schoolchildren are vulnerable to infections by parasitic worms and pathogenic protozoan species (Hotez *et al.*, 2022) and are demanding urgent treatment and preventive interventions. Children are disproportionately at risk for the infections, amongst others, owing to their increased nutritional requirements and less developed immune systems (WHO, 2020). Intestinal parasite diseases are linked with intestinal bleeding, nutrient malabsorption, nutrient deficiency, and cell and tissue destruction, anemia, intestinal obstruction, and mental and physical development retardation among children. Overall, these results in delayed growth, decreased mental development, school absenteeism, low academic achievement, prone to malnutrition and infection (WHO, 2023, Ali Yimam, 2016 & Dirs Tegen *et al.*, 2020).*Intestinal protozoan infections, particularly Entamoeba histolytica*

(E. histolytica) and Giardialamblia (G. lamblia), also cause significant morbidity and mortality in developing countries where water quality, waste disposal, sanitation, and hygiene conditions are poor (Kunwar *et al.,*2022).Poverty-linked factors such as poor sanitation, scarcity of potable water, unsafe human waste disposal systems, open field defecation, the prevailing bad climate, and local environmental conditions are the most important risk factors identified (Kunwar *et al.*, 2019). In addition,insufficient health services, as well as lack of the required awareness, due probably to the absence of effective health education are among the contributing factors for the elevated IPIs among poor communities (Baye Sitotaw *et al.*, 2020). IPIs are endemic in resource-limited regions due to high population density, low access to improved water sources, low latrine availability,poor hygiene conditions,low health awareness,and limited economic resources (FischerWalker,2021). Helminths such as *Ascaris lumbricoides*, Hookworm, *Strongloide stercolaris* and *Trichuris trichiura*, and enteric protozoan parasites such as *Entamoeba histolytica*, *Giardia lamblia* and *Cryptosporidium* spp. cause high incidences of health problems especially in children in low to middle income countries (Yaoyu .2019).Children due to their immature immune systems and frequent exposure to unhygienic environments are at high risk for IPIs including helminths (WHO,2023), and protozoa (Global Burden of Disease,2022).Interestingly, Ethiopia contributes to the highest burden of IPIs and accounts for 8% of the global STH infections (Pullan *et al.*, 2014). In the country, IPIs are the second most predominant cause of outpatient morbidity among preschool-age and school-age children(Daniel Tefera *et al.*, 2017).

According to studies conducted in Ethiopia, nearly one-third of schoolchildren are found to be infected by intestinal parasites (Yordanos Gezachew*et al.*, 2020). *A.lumbricoides, T. trichiura, H. nana, histolytica/dispar, and S. mansoni* are highly spread in the country (Alamneh Abera and Endalkachew Nibre,2022).High prevalence rates of HIPIs (as high as 84%) were reported among primary school children(Destaw Damtie *et al.,* 2021). There are, however, still several locations for which epidemiological data,including the research region, is not accessible (Mengistu Dessie, *et al.*, 2023).The distribution and prevalence of various species of intestinal parasites differ from region to region because of several environmental, social, and geographical factors. They spread mostlyin areas with poor sanitation and are most common in tropical developing countries of African, Asian, and South American continents (CDC, 2023).Studying the prevalence of various intestinal parasitic infections is essential for developing appropriate strategies for planning and the implementation of controlling and eradicating programs for intestinal parasites (WHO, 2022). There is scarcity of data on the prevalence of IPI and associated risk factors among school children in the study area. However, the prevalence is expected to be high given the poverty, poor hygiene,climate and lack of access to potable water Establishing base line prevalence and elucidating potentially modifiable risk factors for IPI and would help public health planners, policy makers and implementers to plan and design appropriate intervention strategies to reduce associated morbidity and mortality among school children. Based on these overall backgrounds this study was aim to investigate the prevalence of intestinal parasitic infections and associated risk factors among primary school children of Kokossa Town, West Arisi Zone, Oromia Region, Ethiopia.

1.2 statement of the problem

Human intestinal parasitic infections (HIPIs) have been a worldwide public health threat (Ojha *etal.*, 2022). In developing counties, intestinal parasitic infections are more prevalent among children as compared to the general population accounting for about 12% of the global disease burdens among children aged between 5 to 14 years (WHO, 2023). Studies show that more than 270 million preschool and 600 million school children leaves in the area prone to high transmission of parasitic worms (WHO, 2023). These indicated that children are the major groups at risk of parasitic infections (WHO, 2019). The high prevalence rate of IPIs in developing countries depends on several factors. Socio-demographic variables associated with poverty such as reduced access to adequate sanitation, scarcity of potable water, unsafe human waste disposal systems, open field defecations and unavailability of sufficient health care as well as the prevailing bad climatic and environmental conditions are the most important risk factors, (Wondwossen Birke and Firdu Zawide, 2022).

Young children are reported to be disproportionately affected by IPIs compared to adults due to their increased nutritional requirements and a less developed immune system (Zemical Gizaw *et al.*, 2022). IPIs in this age group have been linked with significantly reduced growth, increased risk of protein-energy malnutrition, iron deficiency anemia, and reduced cognitive/psychomotor development (Worku Awoke, 2017). The infections may lead to impaired growth, stunting, physical weakness, and low educational performance of infected children. Intestinal helminth worm infections damage a child’s internal mucosa, leading to impaired digestion and poor absorption of nutrients (G. Ross *et al.,* 2022). Studies in different parts of Ethiopia have shown a high prevalence of IPIs (Baye Sitotaw *et al., 2020;*Destaw Damtie *et al*.,2021; Workneh Torben *et al.*, 2014*).* Among the risk factors assessed, age, hand washing habit before meals, open field defecation habit, consistency of wearing shoes, a habit of eating raw and unwashed vegetables, and finger nail cleanliness and trimming habit were found to be the most important predictors associated with a high risk of IPIs (Baye Sitotaw *et al.*, 2019).

Despite the great efforts by the Ethiopian ministry of health to control IPIs, Ethiopia is still known to be heavily affected by IPIs due to the mentioned socio-demographic variables, behavioral factors, personal hygiene, and environmental sanitation factors (WHO, 2022; Mengistu Dessie*et al*., 2023; Destaw Damtie *et al*., 2021). In line with this, continuous monitoring of intestinal parasitic infections and their associated risk factors are essential among school children in the country in general and the current study area in particular to control the infections. To our knowledge, there was no well-organized previous research report on the prevalence of intestinal parasitic infections in the current study area. Therefore, this study was aimed to assess the prevalence of intestinal parasitic infections in relation to their determinant factors among schoolchildren in Kokossa primary School, West Arsi Zone, Oromia Region, Ethiopia.

1.3 Objective of the study

1.3.1. General objective

The general objective of the study was to assess the prevalence of intestinal parasitic infections and the associated risk factors of intestinal parasitic infections among school children in Kokosa Primary School at Kokossa Town, West Arsi Zone, Oromia Region, Ethiopia from September, 2023 to Decmber, 2023.

1.3.2. Specific objectives

- To identify the type of intestinal parasites among school children in Kokosa Primary School at Kokossa Town.
- To assess the prevalence of major intestinal parasites in school children in the study area.
- To identify factors associated with intestinal parasitic infections among school children in Kokosa Primary School at Kokossa Town.

1.4. Research Questions

- Which types of intestinal parasites are common among school children in Kokosa Primary School at Kokossa Town ?
- Which types of intestinal parasites are more prevalent in school children in in the study area?
- What are the risk factors associated with intestinal parasites infections among school children in Kokosa Primary School ?

1.5. Significance of the Study

The health and health related problems of primary school children are given minimal attention in public health research. This made the magnitude and factors associated with their health problems mainly unexplored through valid epidemiologic study designs. Revealing the health problems of this segment of population helps to design effective intervention modalities that suit their condition. This study helps to gear towards accomplishment of national and global targets concerning IPIs by providing decentralized and timely information on this segment of population. Findings of this study could be used as a reference and a base line data for upcoming studies. It is also important to the researchers and academicians as it will be a useful guide for future researchers interested in undertaking a study on the prevalence and its risk factors influencing the occurrence of IPIs in other parts of Ethiopia.

1.6 Scope of the study

This study was delimited with the prevalence of intestinal parasitic infections and the associated factors of intestinal parasitic infections among school children in some selected area of Kokossa district in West Arsi Zone of Oromia region. In this study, we collected information from primary school children and their parents for gathering accurate information that helps to construct this study. The study has focused on the personal hygiene, home sanitation, water related and food hygienic factors in homes of these patients that may predispose them to intestinal parasitic infection. Data was collected using questionnaire and Laboratory examination test.

1.7 Limitation of the study

The study was limited only to students attending primary schools in Kokossa town. The study was also limited to determination of the presence or absence of infections without quantifying the parasite load, which may not show that the infected students were diseased. Another limitation of the study was related to duration of the time used for data collection about the associated risk factors of IPIs. The study was conducted for about four months.

1.8 Operational definitions

- **Habit-related risk factors:** factors related to the play habit, ritual practice and life style of children, which are assumed to facilitate the fecal-oral transmission of intestinal parasites.
- **Intestinal parasite(s) positive:** a stool sample which contains a parasite ova, cyst or trophozoite in either of the two microbiological techniques.
- **Open defecation site (ODS) near residence:** the presence of fields, bushes, ditches or streets at the child's residence, where people are frequently defecating in the open.
- **School-aged children:** children from age 6 to 17 years.
- **Hand washingpractice**: The practice of washing hands after key times like after toilet, before and after eating meals and after contact with any contaminant with soap and water or water and ashes. Swimming in unprotected water bodies:The practice of swimming atleast once a week in the month preceding the data collection in unprotected rivers, lakes or ponds.
- **Cleanliness of fingernails**:Short finger nails with no visible dirt underneath after visual observation of each finger nail.
- **River water contact**: individuals who have contact with the river during activities such as washing clothes, bathing, swimming, irrigation working or during crossing.

2. LITERATURE REVIEW

2.1. Human protozoan and helminthic Parasites

Protozoan and helminthic parasitic infections are global health problems causing clinical illness in 450 million inhabitants in developing countries (Quihui *et al.*, 2006). Parasites found in the intestine can be categorized into two groups; as protozoan and helminths. The major intestinal parasites of global public health concern are the protozoan species such as *E. histolytica and G. intestinalis*, soil transmitted helminthes *A. lumbricoides*, *T. trichiura*, hookworm and schistosomiasis (WHO, 2018). Helminthic infections are enhanced by poor socio-economic conditions, lack of sanitary facilitates, improper disposal of human feces, insufficient supplies of potable water poor personal hygiene, poor housing conditions and lack of education (WHO, 2015). IPI and helminths in particular, are associated with increased risks for nutritional anemia, protein energy malnutrition and growth retardation in children, poor increase in body weight in pregnancy, intrauterine growth retardation, and low birth weight (Begna Tulu *et al.*,2014). Children infected with soil-transmitted helminths (STHs) have poor educational level and performance at school and a high level of truancy, thus impacting on their future earnings and productivity (Mohammed *et al*., 2015).The high prevalence rate of intestinal parasitic infections (IPIs) in developing countries depends on several factors. Socio-demographic variables associated with poverty such as reduced access to adequate sanitation, scarcity of safe drinking water, improper human waste disposal system,open filled defecations and unavailability of sufficient health care as well as the prevailing bad climatic and environmental conditions are the most important risk factors (WHO) (2021), (citedin Baye Sitotaw *et al*, 2019).

Intestinal parasites are the main cause of human illness in tropical countries (WHO, 2023).They can cause harm or make their host sick via an infection. Intestinal parasitic illnesses have a worldwide distribution. High levels of human infection are found in India, Africa,Central and South America (Botelho *et al*.,2022). The infection rate by intestinal parasites varies among countries, sanitary conditions, socio-economic status and populations as documented by Al-Harthi and Jamjoon (2019).Environmental, socio-economic, demographic, low education level and hygiene related behavior influence the transmission and distribution of intestinal parasitic infections (Norhayati *et al.*, 2023)

2.2 protozoa parasites

Numerous protozoa inhibit the intestinal tract of. Some of these organisms can cause severe disease under certain circumstances .It can be transmitted by faeco-oral route and tend to exhibit similar life cycles consisting of a cyst stage and a tropozoite stage. Factors which increase the chance of ingesting material contaminated with faecal material play a role in the transmission of these intestinal protozoa like situations involving human-human contact and unhygienic conditions promote transmission (Mengistu Legesse,2021). Protozoan parasitic infections are among the most common intestinal parasitic infections around the world. Protozoan parasitic infections are widespread mostly in developing countries including Ethiopia. High prevalence is found in people with low socio-economic status, poor living conditions over-crowded areas, poor environmental sanitation, improper garbage disposal, unsafe water supply, and unhygienic personal habits. Human beings have been exposed to diverse groups of protozoan parasites. Over 60 species of protozoan parasites cause diseases in humans worldwide. Among these, *Entamoeba histotytica* and *Giardia lamblia* are estimated to infect about 600 million and 200 million people worldwide, respectively, as described by Murry *et al*. (2021) (cited in Abiot Getachew,2018). Human intestinal protozoan parasites are identified as the cause of morbidity and mortality around the world particularly in developing countries including Ethiopia.

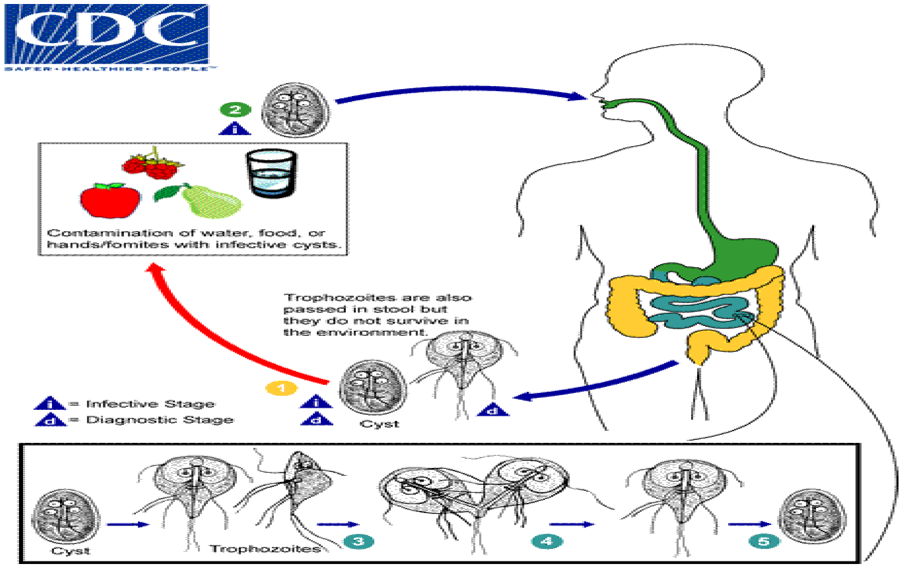
There is more prevalence throughout the tropics, especially among poor communities. A high prevalence of intestinal protozoan parasitic infections in humans is positively correlated with poverty and poor personal hygiene, lack of safe water supply and contamination of the environment by human excreta and animal waste. Intestinal protozoan parasitic infections increase hosts' susceptibility to other infections and reduce learning ability and growth especially in growing children (Karaman *et al*.,2019). Intestinal protozoan parasitic infections are public health problems around the world particularly among children of school going age and immuno-compromised (Aschalew Gelaw *et al.*,2019).

2.2.1 Giardia lambela

Giardiasis is caused by infection with the enteric pathogenic Giardia lamblia. *Giardia lamblia* (syn *Giardia intestinalis*, Giardia duodenalae). *Giardia lamblia* is a flagellate protozoan parasite that grouped with in the order diplonmonadida and family hexamitidae. There are three known species of the genus Giardia, but *Giardia lamblia* being the only species to infect human. The parasite inhibits the duodenum and upper jejunum where the alkaline PH is favorable for growth(Haji, Mamo 2022).*Giardia lamblia* infection is endemic throughout the world and epidemics of it occur sporadically. The various factors influence rates of morbidity due to *G.lamblia* infection; primary versus secondary exposure, age, concurrent infection, nutrition and immunological status the infecting dose of giardia, and possibly difference in giardia strains. Giardiasis is one of the common causes of acute or diarrhea in children in developing countries. Giardiasis interferes with intestinal absorption of nutrients and the growth rate of children (WHO, 2023).

Life Cycle of Gardia lambila

Giardiasis could be transmitted through drinking water or ingestion of contaminated food. The cyst passes through the stomach and enters the small intestine. The acidic environment of stomach could not harm the cyst because it has a thin protective wall to protect it until it reaches the alkaline environment in the small intestine. This alkaline environment initiates excitement of the cyst. During excitation, the cyst wall ruptures at the pole opposite to the nuclei. So that, the flagella and other projections appears from the rupture point.. They multiply and carried down the intestinal tract to undergo encystation. The trophozoites and infective cysts are excreted in the faeces (Mekete Girma and Haileyesus Adamu, 2019). Cysts are excreted in the host's feces and are transmitted to the next host when cysts contaminate food, water or fomites. Ingested,viable cysts excyst after passage through the stomach and exposure to an acid environment of stomach (Barwick *et al*., 2022). After excystation, trophozoites colonize and reproduce by binary fission in the host's small intestine where, in the presence of bile, they form cysts (Svärd *et al*., 2017).



Source CDC,2021

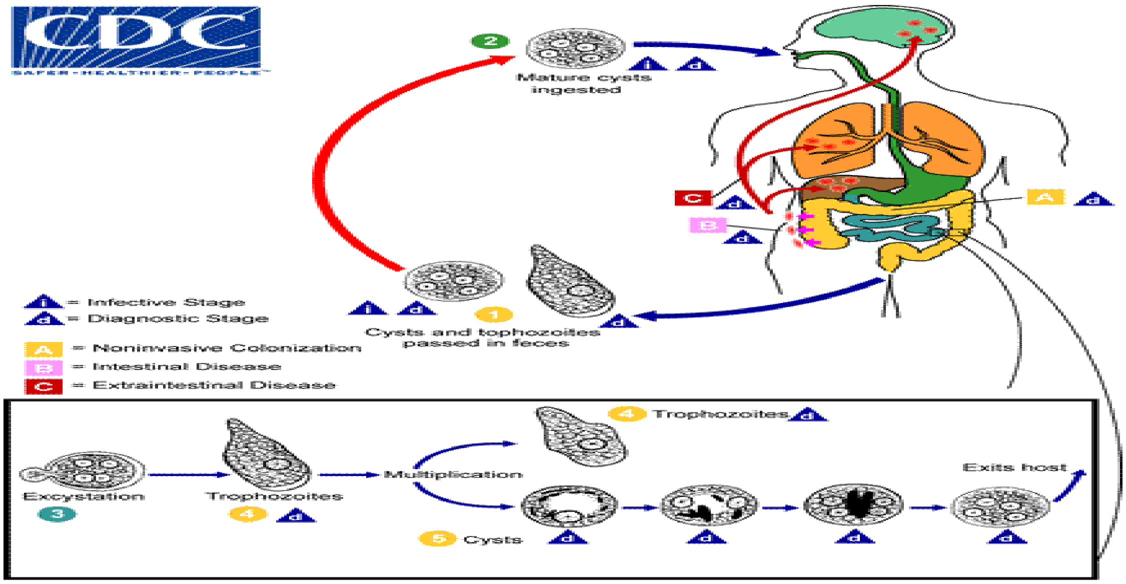
Figure2.1 life cycle of Gardia lamblie

2.2.2 Entamoeba histolytica

Amoebiasis is an infection with a protozoan parasite *Entamoeba histolytica* which is exists as infective cyst. Infection may be asymptomatic or cause acute severe diarrhea, with blood and mucus alternating with constipation. *Entamoeba histolytica* infection sometimes result invasive abdominal infection, severe liver diseases and death (Theodore *et al*, 2022). The most common amoeba seen in intestinal tract is *Entamoeba histolytica/ dispar*. *Entamoeba coli*, *Entamoeba hartmanni*, *Endolimax nana*, and *Lodamoeba butschlli*. All except *Entamoeba histolytica* are thought to be non-pathogenic. The cysts can be identified in an ethyl acetate concentrate by the addition of iodine to reveal the characteristic inclusion and also by measuring the cyst using an eyepiece gratcule. The trophozoites can be seen in a fresh saline preparation of the stool although accurate identification is on a permanently stained fecal smear. There are a large number of species of amoeba which parasitize the human intestinal tract. Of these, *Entamoeba histolytica* is the only species found to be associated with intestinal diseases. the pathogenic or invasive species has retained the name *Entamoeba histolytica* and the non-pathogenic, non-invasive species has been named *Entamobea dispar* (Cuomo, 2019).Among genus *Entamoeba histolytica*is considered pathogenic and the disease it causes amoebiasis or amoebic dysentery. It is morphologically identical to *E.dispar* (Haque *et al.,* 2019 cited in (Mengistu Wale, 2019). Most patients complained of diarrhea rather than chronic diarrhea which are the characteristic of amoebiasis. It is also not worthy that prevalence of *E.histolytica* or *E.dispar* detected by microscopy was the same in patients who had recently received treatments and those who had not. More than 70%of cases the diagnosis was based on the finding of tropozoite but details of the structure the nuclei were not really taken in to account. In routine clinical practice in Ethiopia, quarter nucleate cyst and tropozoite in faecal sample are assumed to be *E.histolytica* and the patient is given unnecessary treatment with an amoebicidal drug (Amha Kebede, *et al*, 2018).

Life Cycle of Entamoeba histolytica

Entamoeba histolytica requires a single host to complete its cycle. When mature cyst from contaminated food or drink or from hands contaminated with faces is ingested it excysts in the small intestine to produce Meta cyst trophozoites by a process of binary fission. The immature trophozoites migrate to the colon and grow to become mature trophozite stage, multiply by binary fission on to invade the mucus membrane of the membrane of the large intestine. Some time it can perforate the intestinal wall causing extra-intestinal amebiasis. The trophozoite stage may pass with diarrhea or dysentery. After a period of growth and multiplication encystement occurs in the large intestine in the process of cyst formation, the trophozoite discharge undigested food appears spherical in shape and condense to become pre-cyst. The pre-cyst secrets cyst wall to form a mono nucleated cyst which is followed by a nuclear division to produce a binucleated mature cyst. Cyst and pre-cyst will also pass in semi formed or formed stool, where cysts infective if it is ingested by any means of transmission (Mekete Girma and HaleyesusAdamu, 2019). Several protozoan species in the genus *Entamoeba* colonize humans, but not all of them are associated with disease. *Entamoeba histolytica is* well recognized as a pathogenic ameba, associated with intestinal and extra intestinal infections.



Source: CDC, 2022

Figure 2.2 LifeCycle of *E. histolytica*.

2.3 Helminthes

Parasitic helminthes (worms) that infect humans belong to two phyla, Platyhelminths and Nematoda. The common intestinal helminthes are *trematodes (flukes) includes Schistosomia mansoni*), nematodes (round worms) includes A. *lumbricoides, T. trichiura and hook worms (Necator americanus and Ancylostoma duodenale) and cestodes (tape worms) includes Hymenolepis nana, Taenia saginata and Taenia solium*. Helminthic infections are enhanced by poor socio-economic conditions, lack of sanitary facilitates, improper disposal of human feces, insufficient supplies of potable water, poor personal hygiene, poor housing conditions and lack of education (WHO, 2022) Intestinal helminthic infection is one of the commonest cause of chronic infection in humans in developing countries (Shally *et al.*, 2023) these parasitic worms adversely affect the health of human in many parts of the world (WHO,2022). Children of an endemic community can be expected to have intestinal parasites after weaning and high risk of re infection in the rests of their life (Shally *et al.*, 2023). In many developing countries, the most prevalent and important Helminths are those soil transmit nematodes particularly, *A.lumbricoides, T. trichiura Hookworm and schistosomes*. They cause hundreds of thousands of avoidable death each year, and are among the world's most common infectious disease .It is most prevalent especially in poor communities (WHO, 2022). According to Leykun Jemaneh

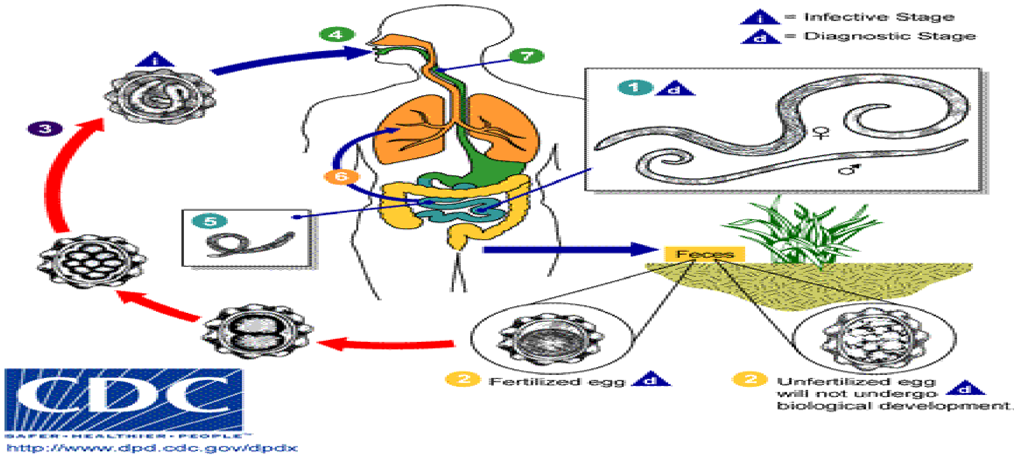
(2018).of the sample schoolchildren had 42.9%, 37.7%,and 19.4%were *A.lumbricoides*, *hookworms*, and *T. trichiura* respectively. The overall prevalence rate for one or multiple parasitic infections in the children was 64%. Children in grades one to three had higher prevalence of overall helminthic infection than grades four to seven (Girum Tadesse, 2015).

2.3.1 Ascaris lumbricoid

Ascariasis, also known as roundworm, is an intestinal infection caused by the parasitic worm *Ascaris lumbricoides*, and is part of a family of parasites known as the soil-transmitted helminths. Ascariasis is most prevalent in warm tropical and sub-tropical climates in subSaharan Africa and Southeast Asia, and it flourishes in areas with poor sanitation or where crops are irrigated by improperly treated waste water. Ascariasis is the most common human worm infection. More than one billion people worldwide are infected with ascariasis, and more than 60,000 die from the disease annually (Global network of neglected diseases, 2022).

Life cycle of Ascaris lumbricoid

Important factors associated with an increased prevalence of disease including socioeconomic status, defecation practices and cultural differences related to personal and food hygiene as well as housing and sewage systems. Most infections are subclinical; more severe complications occur in children who tend to suffer from the highest worm burdens (Stoker *et al.*, 2019). The adult worms live in the small intestine, attached firmly to the mucous membrane of the gut lining, and feed on blood and tissue. The adult females deposit their eggs whilst in the gut (they can produce up to 20,000 eggs per day), the eggs are then passed out in the faeces. The rhabditiform larvae hatch in warm, damp soil (light sandy loam), feeding on bacteria. After about one week during which they have gone through two moults become infective and climb into a suitable position waiting for a suitable host to pass by. The larvae enter the host by penetrating unbroken skin (it is now recognized that *A. duodenale* can successfully enter man by oral ingestion, this may be more important for this species than skin penetration). The larvae then enter blood vessels and are carried to the heart, lungs and trachea. They are then swallowed and develop into adult worms in the small intestine. Larvae that are initially swallowed may not show this migration (WHO, 2023).



Source: CDC, 2022

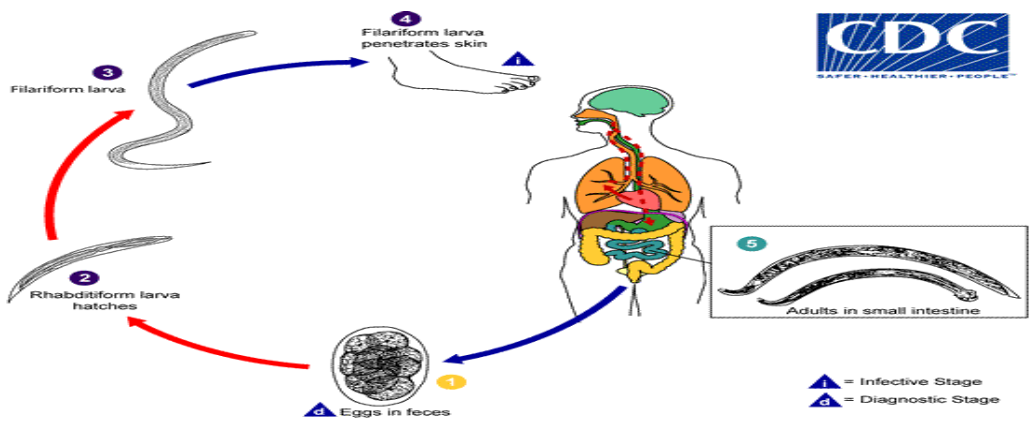
Figure 2.3. Lifecycle of *Ascaris lumbricoid*

2.3.2 Hookworm

Hookworm is an intestinal parasite of humans. The larvae and adult worms live in the small intestine can cause intestinal disease. The two main species of hookworm infecting humans are *Ancylostoma duodenale* and *Necator americanus*. Globally, there are 700 million people infected with hookworm (including 44 million pregnant women), 807 million people infected with ascariasis, and 604 million people infected with trichuriasis. Transmission mainly occurs in tropical climates where sanitation and hygiene are poor (WHO, 2022). Hookworm disease infection is the leading cause of iron deficiency anemia that an estimated576 million people throughout developing nations of the tropics, with highest prevalence in the east Asia /Pacific Islands and sub Saharan Africa. The degree of iron deficiency anemia induced by hook worms depends on the species (Hotez *et al*.,2022).Infection with *A. duodenale* causes greater blood loss than infection with *N. Americanus* (Necator 0.03ml/day, Ancylostoma 0.15ml/day. Therefore, hookworm species distribution pattern which is basically important in control of anemia as the consequence of infection with a species with greater blood shade (FekaduDemissie, *et al.*, 2021).The prevalence rate of hookworm varies from countries to countires, from region to region and from developed, developing and under developed locations of the world. Some of the researches who were reported includes: (Egwunyenga *et al*., 2015) 86.36%, (Mary, 2012) 15.9% (Saravanakumar *et al*., 2013) 38%, (Kattula *et al*., 2014) 8.4%, from different countries of the world.

Life Cycle of Hook worm

Eggs are passed in the stool, and under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days. The released rhabditiform larvae grow in the faeces and/or the soil, and after 5 to 10 days (and two moults) they become filariform (third-stage) larvae that are infective. These infective larvae can survive 3 to 4 weeks in favorable environmental conditions. On contact with the human host, the larvae penetrate the skin and are carried through the blood vessels to the heart and then to the lungs.. Some *A. duodenale* larvae, following penetration of the host skin, can becomedormant (in the intestine or muscle). In addition, infection by *A. duodenale* may probably alsooccur by the oral and transmammary route. *N. americanus*, however, requires atranspulmonary migration phase (WHO, 2022).



Source: CDC, 2022

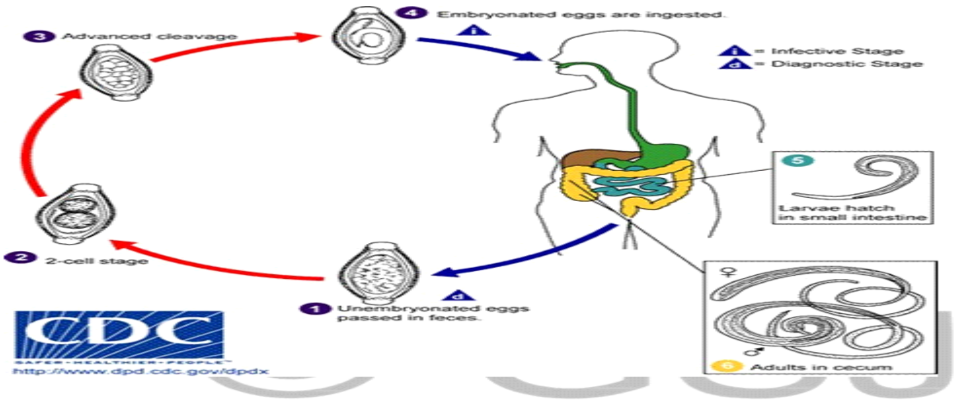
Figure 2.4.Life cycle of hookworm .

2.3.3Trichuris Trichiura

Trichuri trichiura is the third most common nematodes (roundworm) of humans. Of *T. Trichiura* is most frequent in areas with tropical weather and poor sanitation practices. Trichiuriasis occurs frequently in areas in which human faeces are used as fertilizer or where defecation onto soil takes place. The prevalence of *Trichuris trichiura* in the world varies. Knopp *et al*. (2018) were reported prevalence to be 47.9% and Usuanlele (2018) conducted a research among schoolage children from rural communities in Honduras and reported 16% prevalence of *Trichuris trichiura*. Ragunathan *et al*. (2021) were reported 10.8% prevalence of *Trichuris trichiura* infections in schoolchildren in Puducherry, South India. The epidemiology of *Trichuris trichiura* was reported by different researchers from different parts of Ethiopia. To mention, Zinaye Tekeste *et al*. (2016) reported 4.60% among primary schoolchildren in Gorgora, Northwest Ethiopia, Alemu Abebe *et al*. (2019) 2.5% among schoolchildren in Zarima town, Ashenafi Abossie *et al.* (2022) 41.5% in Bushulo village communities, southern Ethiopia, Biniam Mathewos *et al*. (2014) 6.1% among children in two primary schools in North Gondar, Northwest Ethiopia, Teha Shumbej *et al*. (2015) 6.4% among pre-schoolchildren in Butajira town, Southcentral Ethiopia, Leykun Jemaneh (2018) 14.8% in schoolchildren from Chilga District, Abraham Degarege *et al*. (2015) 12.7% in human populations from Dore Bafeno, southern Ethiopia and Alamneh Tesema and Endalkachew Nibret (2014) 7.8% among schoolchildren in Tilili town.

Life cycle of Trichuris trichiura

Adult female worms shed between 3,000 to 20,000 eggs per day, which are passed with the stool. In the soil, the eggs develop into a 2-cell stage, an advance cleavage stage and then embryonate. It is the embryonated egg that is actually infectious. Environmental factors such as high humidity and warm temperature quicken the development of the embryo. This helps explain the geographic predilection for tropical environments. Under optimal conditions, embryonic development occurs between 15-30 days. Infection. The nutritional requirements of *Trichuris* are unclear; unlike hookwormhowever, it does not appear that *Trichuris* is dependent on its host"s blood. Eggs are firstdetectable in the faeces of those infected about 60-90 days following ingestion of theembryonated eggs. The life span of an adult worm is about one to three years. Unlike *Ascaris* and hookworm, there is no migratory phase through the lung (Elizabeth, 2021; WHO, 2023).

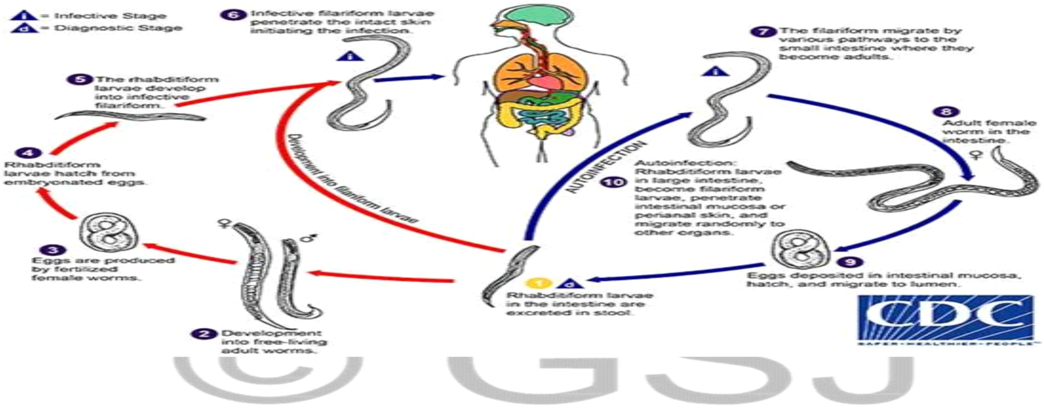


Source: CDC, 2022

Figure 2.5. Life cycle of *Trichuris trichiura*

2.3.4 Strongyloides Stercoralis

This is an important nematode parasite of humans because of its ability to auto infect and disseminate throughout the organ systems of immune compromised or immune suppressed individuals. This nematode parasite produces rhabditoid larvae instead of eggs, which are found in faeces. The larva measures 180-130um in length and 14-20um in diameter. It has a short buccal capsule as lender and pointed tail. The larva is easily recognized, either stained with iodine (WHO, 2022). This organism has worldwide distribution, but is especially common in tropical and subtropical regions. The number of individuals infected with this nematode is unknown, but estimates range from 30 million to 100 million (Alemnesh Tesema, 2014). Most round worms or eggs are found in the soil and can be picked up on the hands and ingested or can enter through the skin. Similar to that of the hookworm, infections are required when larvae penetrate the skin and migrate to duodenum and upper jejunum to mature (Kazuto *et al.*, 2018). An internal auto infective cycle allows the parasite to reside within a human for years. Once inside the human body they pass through the right side of the heart to the lungs. From the lungs, the adolescent parasites go up the windpipe in to the mouth, are swallowed, and reach the upper part of the small intestine where they develop in to mature worms. Mild to severe symptoms of pneumonia during migration to air sacks of lungs (case of reproduction in the air sacs have been observed but they are relatively rare). Inflammation of the intestinal mucosa may also result. This phase of *Strongloides* infection can present to the physician as an acute asthma attack (Satoskar *et al.*, 2019). Sometimes, the larvae become infecting before they are passed out causing out infection that is why people have remained infected with *S.stercoralis* for more than 30 years after leaving an endemic area (WHO, 2021).

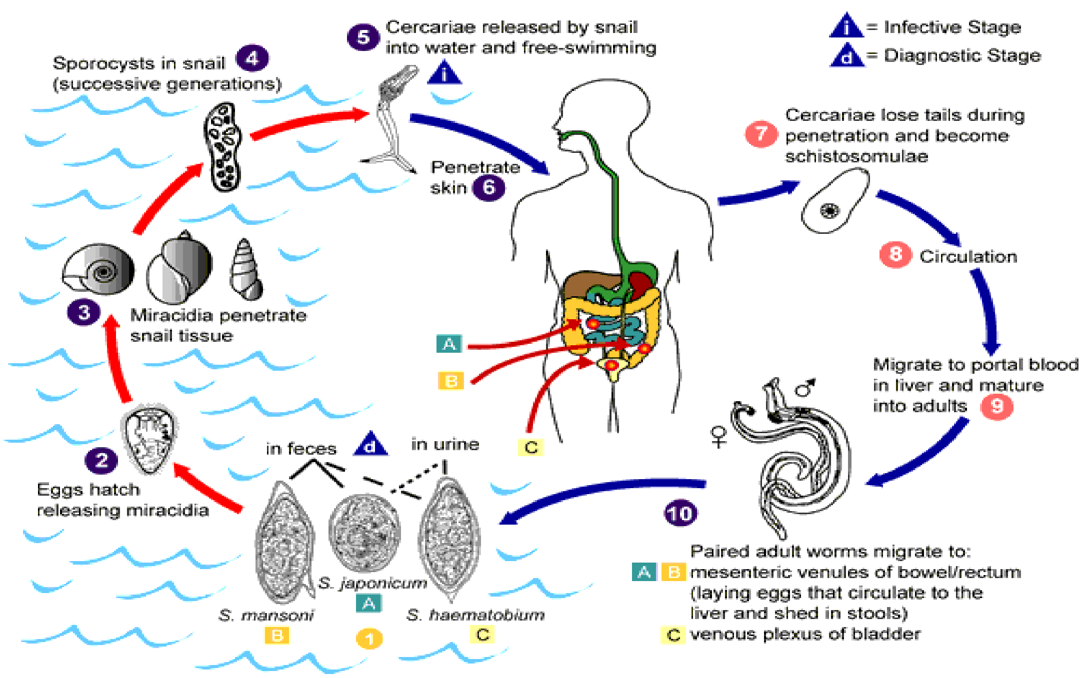


Source: CDC, 2023)

Figure 2.6. Life cycle of Strongyloides stercoralis

2.3.5 Schistosoma Manasoni

The schistosomiasis causes the most important trematode infections. They infect over 200 million people. These worms live in the small blood vessels associated with the live, intestine and bladder (depending on the species) and cause extreme pathology, morbidity and even death in individuals with heavy, chronic infections. They have a snail intermediate host and transmission is water-related. All of the schistosomiasis species produce non percolated eggs which are discharged in faeces or urine (depending on the species), and each egg has a spine on some part of the shell most intermediate hosts of human schistoma 7parasites belong to three genera, Biomphalaria, Bulinus and oncomelania (WHO, 2021). *Schistosoma manason*i one of the most widely distributed parasitic infections in the world and affects 67 million people, majority of them are developing world. The worms live in the blood vessels of colon and cause morbidity and some time death in individuals with heavy, chronic infections. In Schistosomes infection, each pair of male and female worms produces hundreds of eggs per day, egg associated glycolipids and glycoprotein are the main target of the host humoral immune response (De Silva *et al.*,2023; WHO, 2022). All endemic regions, the development of water source plays an important role in spread of schistosomiasis. For example, the introduction of agricultural scheme has been associated with the introduction of *Schistosoma manasoni* in the upper and middle part of Awash (Kloose *et al.*, 2021). The study conducted by Tadesse Dejenie and Beyene Petrosin 20 school children showed that 55% school children were positive for *S.manasoni.*Itwas prevalent in urban and rural communities. Urban centers with water body nearby had a much higher prevalence than urban centers with no water body nearby (Tadesse Dejenie and Beyene Petros, 2019).The rate of S. manasoni infection increased linearly with age from 1.8% forage 5 to age 9yrs, 4.3% for age 10 to 14yrs,nad1 1.6% for age15 to 19yrs old (Girum Tadesse , 2015). According to Girum Tadesse (2015), prevalence of *S. manasoni* infection was found to be higher in boys, who perform usually outdoor activities than girls. Girls has any history related of playing, fishing swimming in local water sources which increase their exposure to circarial infected water.



Source: CDC, 2023)

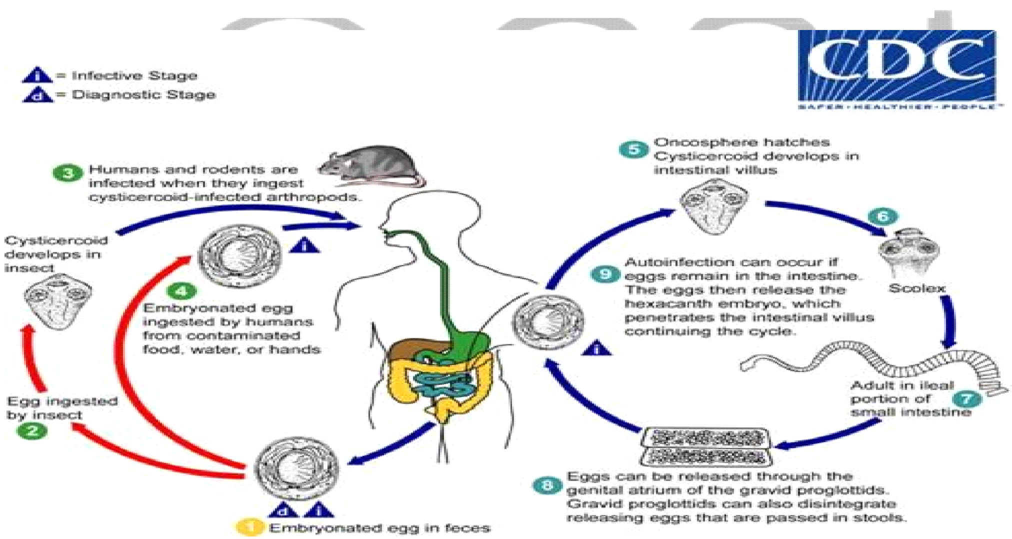
Figure 2.7.Lifecycle Schistosoma mansoni.

2.3.6 Taenia Species

The cestodes live in the human intestine and those of interest here produce eggs which are faeces. The adult live in the intestine and are very large worm, i.e., several meters in length. Proglottids as well as eggs appear in faeces. The eggs of the two species are identical; they are round to oval shape, measuring 35-43 in diameter and have a thick, radially striated shell. The egg contains a 6-hooked embryo called an oncosphere. These eggs must be handled with extreme care because the egg of *Taenia solium* is infective to humans and produces cysticercosis (WHO, 2022). Taeniasis is a tapeworm disease caused by *Taenia solium* from pork and *Taenia saginata* from beef. The illness result from the ingestion of raw meat or improperly cooked meat contaminated with larvae of tape worms. Symptoms appear within a few weeks and are digestive disorders. If an organ is infected by the larvae, especially a vital organ, the consequence can be severe (Ray and Bhnia, 2018).

2.3.7 Hymenolepis nana

Hymenoiepis nana, the dwarf tapeworm,is the smallest tapeworm to infect humans. This cestode belongs to a large family known as hymenolepidae (WHO, 2022).There are different important pathogenic species of *Taenia spp*. H. nana is one of them. Tape worms inhibit the intestinal tracts of vertebrates and *the* larvae inhibit the tissue of vertebrates.*H.nana* infection has cosmopolitan distribution and most commonly infects humans living under conditions of poor hygiene and poverty (Berhanu Erko and Shibiru Tedla, 2018). Humans become infected with *H.nana* by ingestion of water and food contaminated with mouse feces, and can also transmitted from one child to another by passing infective eggs on dirty hands (Alemnesh Tesema, 2014*).* *H.nana* differs from almost all other tapeworms in being able to complete its entire life cycle in a single host (ZahidaHerrador et al., 2013).



(Source:CDC, 2022)

Figure 2.8. Life cycle of *Hymenolepis nana*

2.4. Global prevalence of Intestinal Parasitic Infections (IPIs)

Human intestinal parasitic infections (HIPIs) have been a worldwide public health threat (Ojha *etal*., 2022). According to the Centre for Disease Control (CDC) stated that Intestinal parasitic infections (IPI's) enjoy a wide global distribution (CDC, 2021). Intestinal parasitosis refers to a group of diseases caused by one or more species of protozoa, Cestodes, trematodes, and nematodes (Enrique and Cruz, 2017). Several infectious diseases caused by some members of these previously listed organisms have been considered as Neglected Tropical Diseases (NTDs) (WHO, 2023). Such infectious diseases are already identified as neglected tropical diseases (NTDs) and received attention very recently (Hotez *et al.*, 2023).APIs are among the most prevalent human parasitic infections worldwide and constitute a global health burden causing clinical morbidity and mortality (CDC, 2022). According to the worldhealth organization (WHO,2021), 3.5 billion people are infected, out of which, about 450 millionare infected due to IPIs (WHO, 2021). The prevalence and distribution of IPIs differ fromregion to region due to several environmental, geographical, and social factors (Pullan *et al.*,2012). The major IPI's of global public health concern is the protozoan species E. histolytica and G. lamblia and the soil-transmitted helminths' Ascaris lumbricoides. The incidence and prevalence of these parasitic pathogens vary both between and within countries (Pullan *et al.*, 2014). The majority of infections are associated with poverty conditions such as reduced access to safe drinking water, adequate sanitation and hygiene, housing, and inadequate access to health care (Raj, *et al.*, 2018). Globally, millions of preschoolers and schoolchildren are vulnerable to infections by parasitic worms and pathogenic protozoan species and are demanding urgent treatment and preventive interventions (Bintsis, 2017). The risk of contracting parasitic infections via food in the developed world is presumed to be relatively low (CDC, 2023). It is certainly lower than in developing countries, because of the accompanying features of poverty i.e. lack of sanitation and control measures, malnutrition, illiteracy, and overcrowding (CDC, 2023). Nevertheless, most food-borne parasites have a worldwide distribution. Even in developed countries estimating the risk of food contamination is often difficult due to the lack of awareness of (public) health professionals and researchers in thisfield (Becker *et al.*, 2018). In the European Union (EU) for the year 2015, 26 member states reported a total of 4,362 foodborne outbreaks, including waterborne outbreaks. Most of the outbreaks reported in

2015 were caused by bacterial agents (33.7% of all outbreaks), in particular Salmonella spp. (21.8% of all outbreaks) and Campylobacter spp. (8.9% of all outbreaks), even though the reporting of outbreaks involving these agents has been declining over the recent years (EFSA, 2023). Parasites and other causative agents, in particular histamine, were reported in less than 3% of the outbreaks. Furthermore, for a third of the reported outbreaks (34%) the causative agent remained unknown (EFSA, 2023). In 2022, 158 confirmed trichinellids and 43 cases of congenital toxoplasmosis were reported in the EU. Lithuania reported the highest notification rate followed by Romania and Bulgaria. France reported data with 2-year delay, 216 confirmed congenital toxoplasmosis cases in 2023 (EFSA, 2023). Total control of the transmission of HIPIs and the reduction of possible aggravating factors are among the components of the sustainable development goals of the United Nations (2030 Agenda; Goal 3.3). Despite the efforts, intestinal parasites remain to be public health burdens, specifically in the tropical and subtropical regions (Hotez *et al.*, 2022). Intestinal parasitosis alone is one of the most common public health problems all over Nepal (Raj, *et al.*, 2018). Intestinal parasitosis has been a major public health issue for a long time, and the prevalence varies from 13 to 81% while the rate is even a hundred percent in some rural areas (Gupta *et al.*,2020).

2.5 Distribution of intestinal parasitic infections in Africa

In developing regions, particularly Africa, the protozoan parasite (*Entamoeba histolytica and Giardia intestinalis/lamblia*) and soil-transmitted helminths *(Ascaris lumbricoides, Trichuris trichiura, and hookworm*) are the most prevalent intestinal parasites causing high morbidity and mortality in sub-Saharan Africa, affecting nearly all inhabitants at some point in their lives (Ajayi *et al*., 2017). The prevalence of IPIs in the region is reported to be as high as 84% in Ethiopia (Yordanos Getachew*et al.*, 2020), 90% in Central Sudan (Ahmed *et al.,* 2010), and 84.7% in Burkina Faso (Emile *et al.*, 2013). Like other developing countriesIPIs are common in Ethiopia and cause serious public health problems such as malnutrition,anemia, and growth retardation as well as a higher susceptibility to other infections (Eshetu Gadisa and Kefiyalew Jote, 2019) and causes of outpatient morbidity in the country (Belete Habetamu *et al.*, 2022).

In developing countries, particularly those with tropical climates and at low altitudes, intestinal infection infections remain a serious medical and public health problem among the poor, who are negatively affected by low socio-economic conditions, poor personal and environmental hygiene, overcrowding, and limited access to clean water (Amare Mengistu *et al*., 2022). Gastro intestinal protozoa and helminthic infection rate are highest in children living in sub Saharan Africa. It is estimated that approximately a quarter of the total population is infected with one or more, typically the nematode worms, which are the most prevalent of intestinal parasites.The 2016 estimated proposed that of 181 million school aged children in sub Saharan Africa, almost half (89 million) were affected by one or more of these parasitic worms, while the whole populations will be geographically at risk. Children are observed to disproportionately carry the greatest burden of infection (Brooker *et al.,* 2016). Regarding the at-risk population by Schistosomes, an estimated 660 million were concentrated in Africa, accounting for 85% of the global at-risk estimate. The prevalence of the disease is higher in sub-Saharan countries including Ethiopia. Children whose age ranged 10-14 are the most affected groups (WHO, 2023). The specific parasite prevalence for *Ascaris lumbricoides* was 55%, *Strongyloides stercoralis* was 25%, hookworm was 15%, *Schistosoma haematobium* was 10%, *Enterobius vermicularis* was 2.5% and *Schistosoma mansoni* was 1.25%. Similar study was conducted in School Children in Oshodi Lagos Nigeria (2017) three species of intestinal parasitic infections were identified with overall prevalence of 58.3%. The predominant parasites were *Entamoeba histolytica* (35.8%), *Entamoeba coli* (22.0%) and *Ascaris lumbricoides* (5.1%). The prevalence among sex is 25.1% in males and 33.2 % in females (Ajayi *et al.,* 2017).

2.6 Distribution of Intestinal parasitic infections (IPIs) in Ethiopia

Gastrointestinal diseases including those caused by intestinal parasites rank the first among communicable diseases in Ethiopia as well as in other developing countries (AlemuGebrie and Anmut Alebel, 2020). Despite the efforts, Ethiopia is still at a high burden of IPIs due to the afore mentioned sociodemographic variables, behavioral factors, personal hygiene, and environmental sanitationfactors (WHO, 2023). Particularly, ascariasis, hookworm, andtrichuriasis are listed among the most common public health burdens in Ethiopia (Yimam Ali, 2016).

Studies in the different regions of Ethiopia have shown a considerably high prevalence of IPIs.According to studies conducted in Ethiopia, nearly one-third of school children are found to be infected by intestinal parasites (Yordanos Gezachew*et al.*, 2020). For instance, an extremely high prevalence (84%) was reported among Dumal Town, Bale Zone, Ethiopia (EshetuGadisa and Kefiyalew Jote,2019). In other studies, conducted in the different regions of Ethiopia, the overall prevalence of IPIs, ranging from 54.5% to 83%, was reported from primary school children (Fekadu Damtie *et al*.,2021). Another, study done on the prevalence and associated risk factors among elementary school children in Merawi town, northwest Ethiopia, showed that a relatively high prevalence of HIPIs (42.9%) was observed among students. Single infections accounted for 39.7% of the infectionsfollowed by double infections (3.2%) (FekaduDamtie *et al.,* 2021). Studies in different areas of Ethiopia have shown a high prevalence of IPIs in poor families (Baye Sitotaw and Wakgari Shiferaw, 2020). A perusal of the literature indicates that in Ethiopia, nearly one-third of school children are found to be infected by some sort of intestinal parasites (Yourdanos Getachew*et al.,* 2020). On the other hands the study reported from Oromia regione mojo primary school children indicates, of 348 study participants the prevalence of Ascaris lumbricoides, *Trichiuris trichiura* and *hookworm* infections were 5.2%, 2.6%, and 0.8%, respectively with the overall prevalence of 9.6 % (11.5% for males and 8.2% for females (Baye Sitotaw and Wakgari Shiferaw, 2020). The study conducted in Northwest Ethiopia Debub Achefer District reported that the five species of STHs that were encountered during stool examination of 384 school children. The overall observed prevalence of hookworm species, *Ascaris lumbricoides*, *Trichuris trichiura*, *Enterobius vermicularis*, and *Hymenolepis nana,* was 54.9 % in the study area. Thepredominant helminthic infection was hookworm infection with the prevalence of 46.9% followed by *Ascaris lumbricoides* 13.8% and *Trichuris trichiura* 2.34% infections. (Tilahun Aleligh, 2010).

School based studies in Northern Ethiopia also showed the prevalence ranging from 25.8% in Dembiya to 84.3% in Debre Elias primary school.(Zemical Gizaw. *et al*.2022). This figure stands at 65.5%for the primary school students in Dona Berber primary school near Bahir Dar town (Tmirat Hailegebriel,2017). In western Ethiopia the prevalence among school children ranged from as low as 12.6% in Ambo town to 54.9% in Durbete town (DanielTefera, 2017). Many cross sectional studies are also conducted in Southern Ethiopia to reveal the magnitude of this diseases among school aged children. The results of these studies showed the prevalence ranging from 22.3% in Butajira to 81.0% in Chencha town (GetachewAlemu,2018).The toll is also found to be very high in Mizan town and Wolaita Zone with the magnitude of these conditions among school children being 76.7% and 72.2% respectively (Alemayehu Worku,2017). Lastly, the prevalence among school aged children in Jimma town showed near the half and showed marked difference between the private and government schools(Daniel Tefera,2017).

2.7 Factors associated with intestinal parasitic infection

2.7.1. Socio demographic factors

Intestinal parasitic infections among children is found to be associated with some demographic factors; among these are age and sex of children.Studies conducted in Malaysia, Western Nigeria and Sudan showed significant association between IPIs and age of children (Siddig,2017).. Inaddition, a study conducted in Bahirdar revealed higher odds of IPIs among older children aged nine years and above when compared to younger children with age five up to nine years while another study conducted in Butajir reported the reverse with higher odds being among younger children(Mebratom Hailu. *et al.*, 2018). Regarding sex of children,studiesconducted in Poland and Iran showed higher odds of infection among males (Tamirat Hailegebriel,2017). In Ethiopia similar finding was reported from a study conducted in Bahirdar town (MebratomHailu. *et al.* 2018). Conversely,reports from cross sectional studies among school aged children in Ambo and Jimma towns revealed higher odds of infection among females (Daniel Tefera,2017)

Additional findings from studies conducted in Poland and Nigeria outside Ethiopia;and Bahirdar and Durbete towns in Ethiopia also showed significant effect of birthplace and place of residence on the infection status.This studies showed higher odds of IPIs infection among rural children when compared to urban ones (Amsalu Feleke,2017). Several factors that reveal socioeconomic status of children were also identified as determinants of infection status.Educational achievement of children was found to be associated with the infection status a finding from study carried out in Malaysia showed income as a determinant; while others in East Gojjam zone and Gondar town depicted higher odds of infection among children of lower grades and lower incomes (Workneh Torben ,2014)

2.7.2. Water, sanitation and hygiene(WASH) Factors

Many factors that could be summarized as water,sanitationand hygiene were found to be significant factors associated with IPIs among children. Source of water for both drinking and bathing is a well-established determinant of infection.According to crosssectional studies conducted inWestern Brazil andNigeria,children who used untreated water for drinking and bathing had higher odds of developing infections (Gyang. *et al.*, 2017)).Cleanliness and trimming of finger nails are also found to affect the likelihood of developing infections.According to crosssectional studies conducted on schoolage children in Butajira, Ambo and Jimma towns,children who had not had their finger nails cut short are up to three times more likely to develop IPIs (FikresilseSamuel,2017). Cleanliness of finger nails was also found to predispose children to IPIs.A study conducted in Bahirdar town among school age children revealed upto five fold increase in the odds of developing infections in children with unclean fingernails when compared to their counter parts (Tamirat Hailegebriel,2017). A study conducted in Yirgachefe also underlined the importance of sucking fingers as a determinant of infection status(EshetuMolla,2018).Crosssectional studies conducted in Bahirdar,ChenchaJimma and other several areas in Ethiopia showed significant association between shoe wearing habit and IPIs (Workneh Toreben ,2014).

2.7.3. Health system related factors.

Intestinal parasitic infections among children are also affected by the performance and coverage of comprehensive health services. Studies conducted in Peru,Vietnam,Cameroon,and Kenya showed that poor access to deworming service as a significant determinant to the IPI status (Worrell. *et.al.*, 2016).Inaddition poor access to health education concerning the prevention strategies of IPIs is also reported as a factor associated with infection in south Eastern Ethiopia (Begna Tulu ,2014).

2.7.4. Feeding practices

Feeding practices of children was also identified as an important factor that predisposes children to the infection. A cross sectional study conducted among street residents showed that consumption of left over foods to increase the likelihood of acquiring infections (Mekonnen Teferi, 2014). Inaddition, habit of not washing fruits and vegetables before eating is also found to affect infection status in Western Brazil and Arbaminch (Luz,2017). Furthermore, studiescarried out in Malaysia and Amhara regional state of Ethiopia also indicated habit of eating raw vegetables to increase the risk of acquiring infections(Tamirat Hailegebriel,2017).

2.7.5 Leisureactivities

Some leisure activities in which children involve poses them at an increased riskof diseases and specifically intestinal parasites.Studies conducted in different parts of Ethiopia revealed upto three fold increase in odds of developing IPIs among children swimming in unprotected water bodies(Getachew Alemu,2018)

2.7.6. HIV/AIDS infection

HIV/AIDS reduces the capacity of individuals to protect themselves from diseases that healthy individuals do.A study conducted in Gondor among street dwellers revealed high prevalence of HIV /AIDS and Intestinal parasitic co-infections among street dwellers(Beyene Moges. *et al.* 2019).

2.8. Transmission for intestinal parasitic infection

Most intestinal parasites are transmitted through faecal –oral contact transmission. The role of intestinal parasites in causing morbidity as well as in the pathogenesis of other infectious diseases differs from species. Similarly, the distribution and prevalence of various species of intestinal parasites also differs from region to region because of several environmental, social and geographical factors. The organism itself or cyst, ova or its tropozoite are expelled through the rectum of their host and find their way in some fashion to the mouth of their next host. These parasites are transmitted by ingestion of the infective eggs, larvae or cysts depending on the specious of the parasite from contaminated raw vegetable food, food, water and hand. Helminths are transmitted by the ingestion of the infective eggs from contaminated food, hands and water (MengistuWale,2019). Infection occurs by filari form of hookworm, schistosomiasis and strongloidiasis are transmitted through penetration when the infective larvae in the contaminated moist soil or water body. It is more prevalent in the areas of poor sanitation coupled with the habit of walking bare foot as seen in the rural farming community (WHO, 2021).

2.9. Prevention and control of intestinal parasitic infection

For human hosts, there are three major strategies for the control of soil transmitted Helminths ;reducing parasite intensity (and consequent morbidity) by means of improvement in sanitation, health education and ant- helminthic treatment (Dolda and Holand, 2022). Lack of community awareness about parasitic and socio-economic condition of the community could contribute to the spread of disease. Promoting health education through encouraging healthy behaviors such as use of latrine, defection habits becomes a simple and economical strategy to control various intestinal parasitic infections (Thompson, 2022). Use of anti Helminths/protozoan drugs is another method of controlling intestinal parasitic infection. As World Health Organization (WHO), recommended against soil transmitted helminths include albendazole, mebendazole, livamisol and pyrantel while for schistosomiasis paraziquantel. Metrondazole, quinacrine and chloroquinine are drugs of choice against protozoanparasites(WHO, 2022)

2.9.1. Improved sanitation

Prevent faecal contamination of the environment by using latrine and protecting water supply from faecal contamination. Control programs based on sanitation aim to reduce or interrupt transmission, prevent reinfection and gradually reduce worm loads (Bahmani *et al*., 2017). However, to be effective in a short period of time they need to be combined at their first stage with chemotherapy. Long term sanitary control programs need to add elements to improve the economic conditions of a region, to ensure a reliable and permanent sanitation system and have permanent health education programs (AschalrewGelaw *et al*., 2019).

2.9.2. Treatment

Iodoquinol is used to treat asymptomatic infections and Metronidazole is used for symptomatic and chronic Amebiasis, including extra-intestinal disease. In acute clinical cases of giardiasis the disease is often self-limiting and therefore may require only supportive therapy, which usually consists of fluids to compensate for fluid losses in the diarrhea. Metronidazole is the drug of choice for Giardia infection. Recommended drugs used in the treatment of soil-transmitted helminths are albendazole, mebendazole; and older drugs including pyrantel, tiabendazole and niclosamide (Heelan, 2019).

2.9.3. Health education

Health education and promotion of healthy behaviors can play a key role in reducing the incidence of human intestinal parasitic infections. However, the effectiveness of those activities in reducing transmission of infection varies according to different reports. In some cases, health education can decrease costs, increase levels of knowledge, and decrease reinfection rates. Health education efforts can build trust and engage communities in aspects that are crucial to the success of public health initiatives (Mbae *et al*., 2014

2.10 Conceptual Framework

Conceptual Framework shows the occurrence of intestinal parasites among students were interlinked to cause illness and that one factor alone might not lead to an intestinal parasite but a combination of factors can cause disease. The dependent variable is the status of the intestinal parasite. The dependent variable was affected by independent variables like Socio-demographic/economic condition of primary school students like Sex, Age, Residence, parental educational, Parental occupation, Family size, Personal hygiene practices like hand washing habit, wearing shoes, Finger nail status, Swimming, Eating raw /uncooked Environmental risk factor like Water source, Availability of water and soap, Toilet facility, Shower facility, hand wash facility, Farming activity and Knowledge of student were used to predict intestinal parasite. (Rivero *et al.*, 2017).

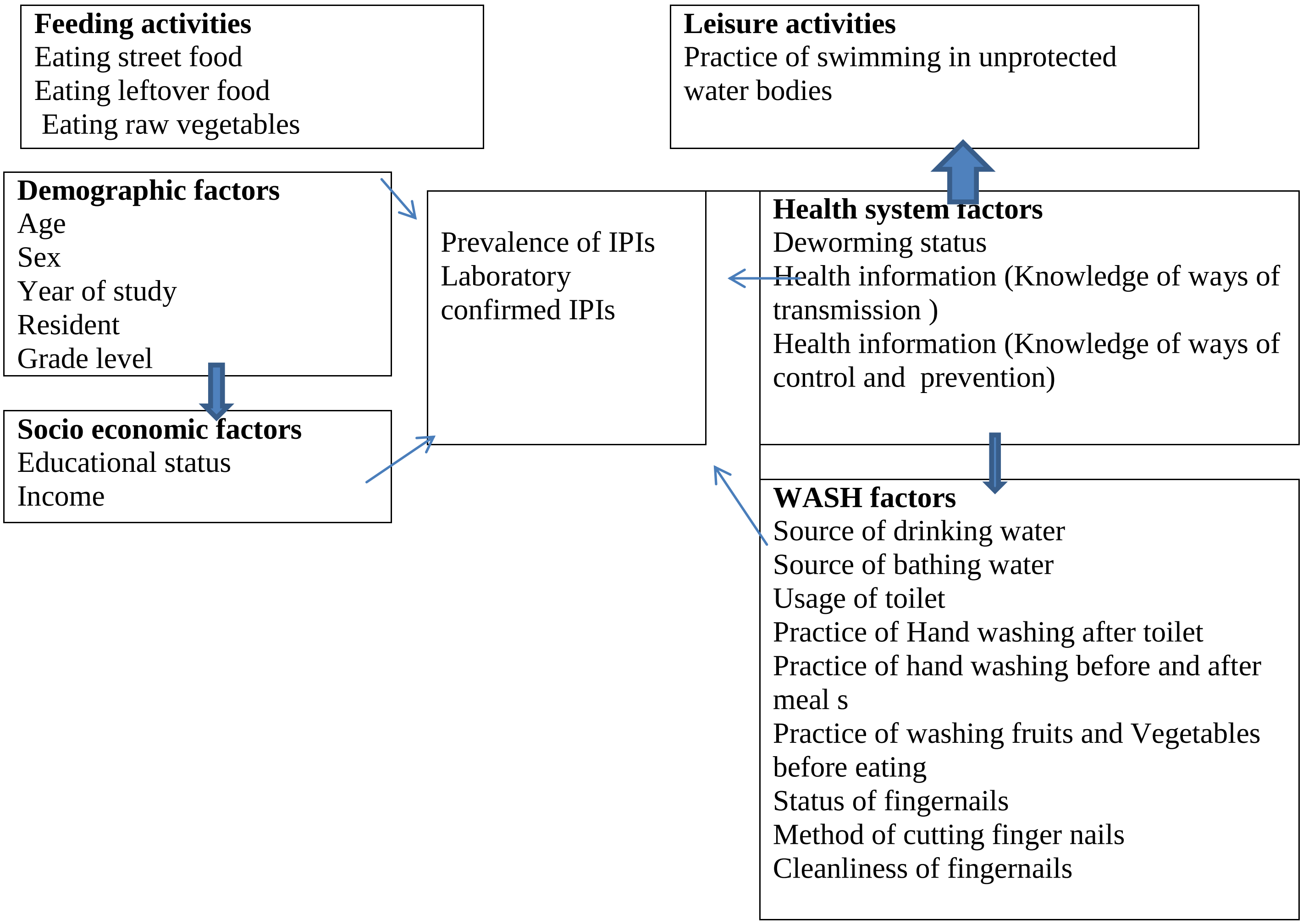


Figure 2.9: Conceptual framework was developed for factors associated with Intestinal parasitic infection and associated risk factors among school-age children from different literatures (Rivero et al., 2017), (Eshetu Gadisa and Jote, 2019) & (BiniyamSahiledengle*et al.*, 2020).

3. MATERIALS AND METHODS

3.1 Description of the Study Area

This study was conducted from September 2023 to December, 2023, in Kokossa Primary Schools. Kokosa is one of the districts in west Arisi zone of the Oromia Regionl state. Kokosa is bordered in south and west by the Sidama Region; in the north by the Kofele district, in the northeast by Dodola district, and in the southeast by Nensebo district. It is located about 322 Km from Addis Abeba, the capital city of Ethiopia and 130 km away from Shashemane ,the capital city of Westi Arsi Zone at 6° 43' 59"' north and a longitude of 38° 46' 59” east. The town is located on a plateau with an elevation ranging from 1,826 to 2,107 meters above the sea level. The major socio-economic activities of the population of Kokossa are agricultural and commercial activities. The minimum and maximum average annual temperature is 12 and18°C respectively. The average rain fall ranges from 1300 to 2000 mm per annum with a bimodal rainfall season for the area that usually extends from December to May and which extends from June to October (KWARDO, 2023). The total population of Kokosa is 15,225 out of which 6696 and 8529 were males and females respectively (Kokossa District Administrative Office Development plan, 2023).

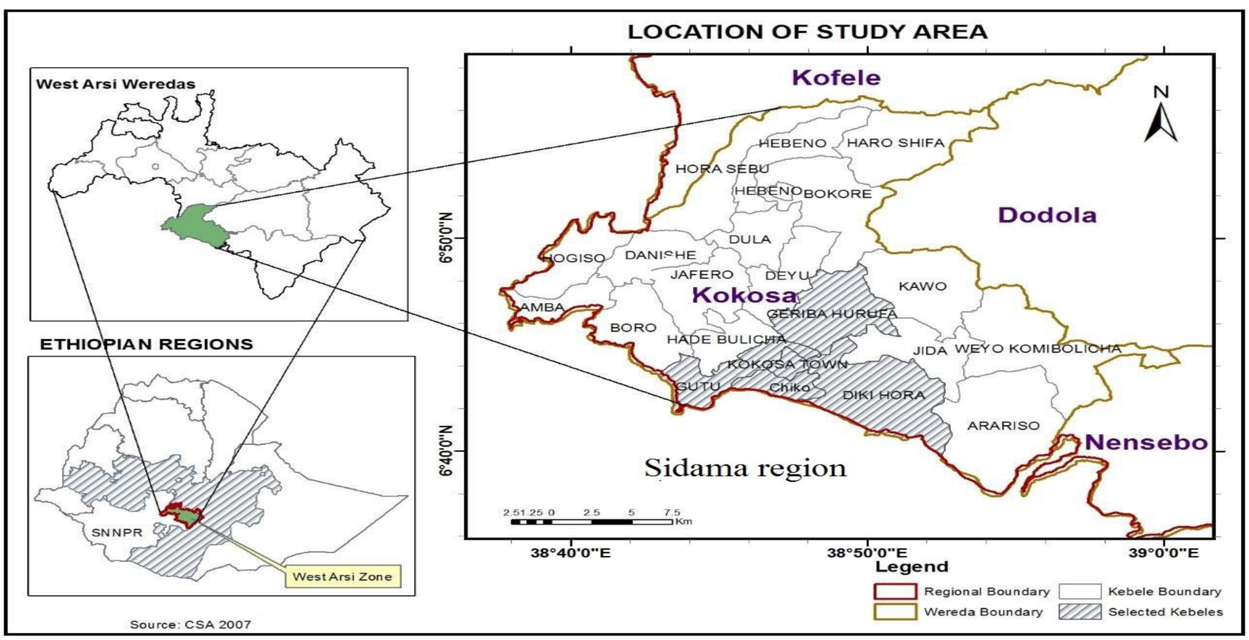


Figure 3.1. Map of the Study area (Source; Kokosa Town Administration)

3.2 Study Design

School based cross- sectional study was conducted from September, 2023- December, 2023 to collect stool samples from students attending two selected primary school (Gutu and Windisa). In addition, structured questionnaire was used to collect socio-demographic data on the student's sex, age and other socio- demographic information to assess associated risk factorsof intestinal parasitic infections.

3.3. Study Population

Study population was all students attending the selected two primary schools (grades 1-8) in Kokosa town. The total number of students these primary schools were 1733: Gutu primary school (1003), Windisa primary school (730), which gives the total number of 1733 (845 males, 888 females).

3.4. Inclusion and exclusion criteria

3.4.1. Inclusion criteria

All registered students attending grades 1 to grade 8 and capable of providing a written informed consent form signed by their parents or guardian were included in the study.

3.4.2. Exclusion criteria

Students who were absent from their class session due to illness or who did not show willingness to participate in the study, Students who took treatment /anti parasitic drug for any intestinal parasitic infection within the three months prior to the study. Students who showed clinical symptoms such as diarrhea, abdominal discomfort, and vomiting during the data collection were intentionally excluded from the study participants.

3.5 Study Variables

3.5.1 Dependent variables

The dependent variable of the study was the Prevalence of Intestinal Parasitic infection (IPIs)

3.5.2 Independent variables

- **Socio-economic variables**: Gender and age of the study child, Residence mother's/guardian's educational status and occupation

- **Environmental variables**: type of latrine, availability of latrine, , open defecation, source of water, waste disposal sites, availability of live stock and live stock in the house
- **Behavioral factors/Personal practice related variable** – critical time of hand washing, habits of shoe wearing, using soap for hand washing, habits of swimming, habits of washing clothes in the rivers, habits of nail trimming, and habits of eating raw vegetables
- Knowledge and Awareness related variable: Information, Transmission, Prevention, Treatment, Contamination and health education.

3.6 Sample size determination and sampling techniques

3.6.1 Sample Size

The sample size was determined based on statistical formula developed by Cochran (1977), according to this formula to calculate representative sample for proportions as where, n_o is the sample size, z is the selected critical value of normal distribution at 95% confidence level, p is the proportion of the target population estimated to have the desired characteristics that is 50% for this survey, q=1-p and e is level of precision with ±5%,p = 0.5, q =1-0.5 = 0.5, e = 0.05 and z=1.96 then the required sample size):

(n_o): $n_o = \frac{z^2\,pq}{e^2}$

$$n_o = \frac{(1.96)^2(0.5\times0.5)}{(0.05)^2} = 384$$ Where:

- n= number of sample size
- d= marginal error between the samples and populations (0.05)
- zα/2= critical value for normal distribution at 95% certainty/confidence interval(1.96)
- Expected prevalence of infection (p) = for estimating the sample size, 50% of the prevalence was taken, because there was no data recorded for the prevalence of common intestinal parasitic infection in the study area.
- Non- response rate was considered and adjusted adding 5% contingency to generate representative sample size (n= 19+384=403) (196 male and 207 female) in the randomized cross-sectional survey study.

3.6.2 Sampling Technique

Students was stratified according to their grade level (grade 1-4 and grade 5-8) to select the target groups in three schools the quota was allocated for each school, grade levels and sections based on their number of students.Finally, a systematic random sampling technique was used in each class room based on their attendance as a sample frame. The total number of students in two sampled schools is 1733 (1003 from Gutu primary school and 730 from Windisa primary school). To determine the number of students from each sampled schools, a simple proportion formula adopted from Cochran (1977), was applied as:-

$ni = n \times \frac{Ni}{N}$,

Where i=1, 2, 3...,

ni =sample size of each *schools*,

Ni=population size in each *schools*,

n=total sample size,

N=population size of sampled *schools*

(0.2325)

Where **C** represents proportionality

Then the number of sampled students was 233 from Gutu primary school and 170 from Windisa primary school.

Table 3.1 Proportional distribution of sampled school children in two Sampled school

School name	Sex	*Total population*	Proportionality	Sample size(n)	Sample size (%)
	M	*522*	522×0.2325	121	30
Gutu	F	*481*	481×0.2325	112	28
	T	1003	1003×0.2325	233	58
	M	323	323×0.2325	75	18
Windisa	F	407	407×0.2325	95	24

	T	730	730×0.2325	170	42
Total			1733×0.2325	403	100

3.7 Data Collection

Data were collected using questionnaire and stool for microscopic examinations structured questionnaire was used to assess the major socio-demographic characteristics and hygienic practice risk factors associated with the prevalence of intestinal protozoan parasitic infections among school children in the study area. Stool samples were also collected and observed under microscope for parasites to identify the major parasites and determine the prevalence of intestinal protozoan parasitic infection among the target students in the school.

3.7.1 Questionnaires

The researcher developed a valid questionnaire based on factors which are expected to have association with intestinal protozoan infection and the objectives of the study to gather data onSocio-demographic characteristics such as sex, age, family occupation, family education status,and hygienic practices risk factors like source of water, water treatment at home, place of excretion, cleanness of kitchen, eating unwashed fruits and vegetables, freshness of food, habitof playing with mud or soil, hand washing habit, cleanness of finger nails, food handling practice, waste disposal system, and environmental sanitation.

The entire questionnaire was checked for accuracy and completeness according to Babakhani *et al*. (2017). The structuredQuestionnaire was first prepared in English and then translated into Afan Oromo (local language) and administered to each participant. the questionnaire generally contained Thirty one structured questions. Finally, the Afan Oromo version of the questionnaire was distributed to each participant to gather data on possible risk factors having association with intestinal protozoan infections. During the questionnaire administration, the data collector properly explained about the purpose of the study and the way how the participants should respond to questions. After the data had been collected the responses were translated back to English language for analysis.

3.7.2 Stool Sample Collection

After proper instruction was given for stool sample donor(study participants)by the researcher, each study participant had been provided with a clean dry plastic cup and applicator stick with which they were asked to provide fresh stool samples of their own weighing about 2mg. All the cups were labeled with the students name, identification number, sex and age. The students were also guided by the researcher how they collect their own stool samples in proper hygienic and safe conditions. Finally, the labels of all stool samples had been checked as the samples were from all participants.

3. 8 Parasitological Examination Procedures

Stool samples were diagnosed for the presence of intestinal parasites using direct wet-mount. The processed stool samples were checked for the presence of intestinal parasitic ova or cysts under light microscopy using objectives10X and 40X. Identification of the parasite species was done on the basis of morphology and size by the principal investigator assisted by experienced laboratory technicians and referring the parasitological laboratory manual (Elizabeth, 2021).

3.8.1. Microscopic examination of stool samples

The laboratory examination of the stools from study participants involved preparing stool sample and observing the parasites under the microscope. These procedures were used for determining the prevalence of intestinal infection and identification of the type of intestinal parasitic species that cause intestinal infection among students in the study area (at Kokosa Primary School).

The stool samples were then taken to Kokossa primary Hospital Laboratory by stool sample collectors for diagnosis. All stool samples were subjected to direct wet mount test.Using markers, the identification number of each participant were written at one end of the slide. At the center of each labeled slide, a drop of normal saline was placed. About 2mg of stool was added to the normal saline using an applicator stick and mixed form a thin uniform saline suspension on the microscope slide. The suspension was carefully covered with microscope slide cover slip to avoid air bubble formation between the slide and the coverslip. Then the slide was placed on the microscope stage and examined systematically under the low power(x10) objective to determine presence or absence of different intestinal parasites (cysts/trophozoites). High power (x40) objective was used to observe the morphological details of the parasitic species.

3.9 Data quality control

Licensed clinical nurses were selected for the collection of the interview-based data. To ensure quality of data collection, all the laboratory procedures including collection and handling of specimens were carried out in accordance with the standard protocols (WHO, 2020). During data collection, all the activities of the work (stool collection, handling and parasite identification) were carefully monitored by the laboratory technologist and the researchers. Furthermore, to control the data quality, 10% of the total numbers of positive stool sample were preserved in 5% formalin for protozoan parasite and 10% formalin for helminthic parasites (WHO, 2022) and were examined in Kokosa hospital laboratory room by the anonymous laboratory technologist

3.10. Data Analysis

The collected data was coded, entered and analyzed using SPSS Version 25.0 statistical analysis software. Appropriate statistical model that is suitable for the particular type of data was also used. Percentage and frequency was used to describe the study participants in relation to relevant variables using tables. Descriptive statistics including tables, frequencies and proportions were used to give a clear picture of background characteristics such as age, sex, educational background, family size, and family monthly income, prevalence of parasitic infections and associated predisposing factors of infections, infection rate and the distribution of the parasites among the asymptomatic primary school children. Chi-square test was also used to verify the possible association between the prevalence of intestinal protozoan infections and socio-demographic, behavioral, hygienic, and environmental factors. Values were considered to be statistically significant when p-values was found to be less than or equal to 0.05. Univariate and multivariate logistic regression models were used to test the association between each intestinal parasite with risk factors and demo graphic structure. Odds ratios (OR), crude and adjusted was calculated at 95% confidence interval (CI) and a p-value ≤0.05taken as statistically significant.

3.11. Ethical consideration

Ethical clearance was obtained from Department of Research and Ethical Review Committee (DRERC) of Hawassa University, college of natural and computational science, Department of Biology. Permission letter was obtained from local health bureau. The aim of the study, benefits and rights were explained to study participants/ relatives and informed consent was obtained. Stool samples were taken from those individuals who were volunteers and signed on consent form. Any information obtained during the study was kept confidential. All children who were tested positive for *intestinal parasite*s were treated free of charge with an anti-helminthic and anti-protozoal drug prescribed by the physician.

4. RESULTS OF THE STUDY

4.1 Socio demographic characteristics of respondents

From the sampled study subjects (403), about 196 (48.6%) were males and 207 (51.4%) were females.. Students were grouped into three age groups. The mean age of the study participants was 11 years old with minimum and maximum age groups of 6 and 17 years old respectively (Table 4.1). Most of the study participants were Lessthan10 years old (40.7%) while study participants aged greater than 15 years (26.3%) were the least. About 233(57.8%) and 170(42.2%) participants were selected from Gutu and Windisa primary school respectively. Students were further grouped into two grade levels numbers of students in grades 1- 4, were 193 (47.9%) and grades 5-8, were 210 (52.1%). Regarding their residence area, 272(67.5%) of the study participants were from urban whereas the remaining 131 (32.5%) were from the rural areas (Table 4.1).

Furthermore, most of the study participants 236(58.6%) came from family with more than five children, attended primary schools 177(43.9), and Government employee 105(26.1) farmers105 (26.1). The average monthly income of families of most of the study participants 124(30.8) was between 4000-5000 birr (Table 4.1)

Table 4.1.**Sociodemographic characteristics of the study participants and their families (*****N***** = 403)**

Demo graphic	Categories		Percentage (%)
Sex	M	196	48.6
	F	207	51.4
Age	<10	164	40.7
	10-15	133	33.0
	>16	106	26.3
Grade level	1-4	193	47.9
	5-8	210	52.1
Residence	Urban	272	67.5
	Rural	131	32.5
School type	Gutu	233	57.8
	Windisa	170	42.2
Family size	<5	167	41.4
	>5	236	58.6
Family income	<1000 ETB	71	17.6
	1000-2000 ETB	19	4.7
	2000-3000 ETB	18	4.5
	3000-4000 ETB	56	13.9
	4000-5000 ETB	124	30.8

	>5000 ETB	115	28.5
Parental educational status	Illiterate	115	28.5
	Elementary	177	43.9
	High school & above	111	27.5
House hold occupation	Government employee	105	26.1
	NGO employ	11	2.7
	Daily labor	5	1.2
	Merchant	99	24.6
	Farmer	105	26.1
	House wife	78	19.4

Source: Field data, 2023

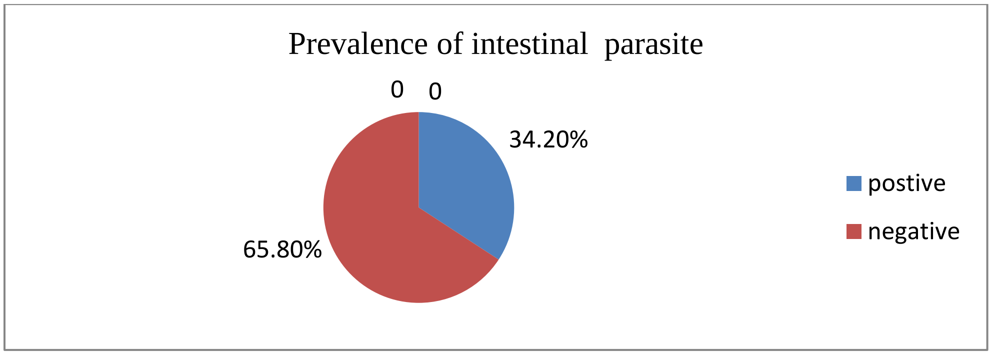
4.2. Prevalence of Intestinal Parasitic Infections among the Study Participants

Among the 403 primary school children included in the study, 138(34.2%) (95% CI: 54.1–62.1%) were infected by one or more intestinal parasites. (*Ascaris lumbricoids*, *Entamoeba histolytica*, *G. Lamblia*, *Hymenolepis nana*.*Taenia species* and Hook worm and *Trichuris trichiura* ((Table 4.2). Seven different intestinal parasitic organisms were detected of which *Ascaris lumbricoids* was the most common 34(8.4 %). The lowest prevalent intestinal parasite identified in the study area was *Trichuris trichiura 3* (0.7%). Single and double infections were identified at the rate of 104 (75.36%) and 34 (24.6%) respectively. No triple and above infections were found in the present study (Table 4.2). The prevalence of protozoan, helminths and mixed parasitic infections in the study area were 47(11.6%), 59 (14.6%), and 21 (5.2%) respectively. The most common protozoans found was*Entamoeba histolytica* 24(6%) follwed

Giardia lamblia 19(4.79%). The most common helminthes found were ,*Ascaris lumbricoides 34*(8.4%) H.nana 11(2.7%) and *Taenia species 8*(2%)..

Prevalence of Intestinal Parasite.

The prevalence of Intestinal Parasite among school children in Kokosa primary school was .34.2%, (95% CI; 27.5-36.3).



Source: Field data, 2023

Figure 4.1.Percentage prevalence of intestinal infection among the school children in Kokosa primary school,2023

Table 4.2Prevalence of different parasitic species Detected in the study area.

No	*Parasitic species*	Number(%)infected individuals
1	*Ascaris lumbricoids*	34(8.4%)
2	*Entameba histoletica*	24(6%)
3	*Gardia lamblie*	19(4.7%)
4	*Hymenolepis nana*	11(2.7%)
5	*Taenia species*	8(2%)
6	*Hook worm*	5(1.2%)
7	*Trichuris trichiura*	3(0.7)
8	*Double infection;E.histoletica&A.lumbricoid*	21(5.2)
9	*E.histoletica&G.lamblia*	13(3.2)

Source: Field data, 2023

4.3. Prevalence of intestinal parasitic infections related to socio demographic characters

The prevalence of Intestinal Parasite among school children in Kokossa primary school was 34.2%, (95% CI; 27.5-36.3). The current study result revealed that prevalence of intestinal parasites significantly associated with sex of school age children ($p<0.05$) (Table 4.3). From the 138 stool sample tested positive, 82 (39.6%) were females while 56(28.6%) were males. Regarding the prevalence of IPIs in relation to the age of the school children, the highest prevalence rate was observed in an age category of 10-15years 70 (70/133 = 52.6%) and the lowest was in age category of above 16 years (16/106 = 15.1%). However, the association between age categories with prevalence of intestinal parasites was statistically significant ($P < 0.05$).

Regarding the prevalence of IPs in different grade levels, higher prevalence was observed in grade 1- 4, 85 (44.%)Compared to grade 5- 8,53(25.2%). these difference statistically significant (Table 4.3).Result of the current study also shows statistically significant associations between the prevalence of IPIs and other risk factors including residence, family size, and family income, parental educational status, occupation of the participant ($p<0.05$). Higher prevalence rate of IPIs were observed among students coming from rural area (48.1%), attending Windisa primary chool(48.1%), those coming from families with more than 5 children (42.4), had an monthly income of < 1000 (60.6%), illiterate(48.7%) and farmers (49.5%). In this study, prevalence of IPIs among children attending Windisa primary school had the higher prevalence than Gutu primary school (Table 4.3).

Table 4.3prevalence of IPIS in socio demographic characterstics

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Demo graphic Characteristics	Categories	No-examined n(%)	Positive n (%)	Negative n (%)	X^2	P- value
Sex	Male	196(48.6)	56(28.6)	140(71.4)	15.396	0.000
	Female	207(51.4)	82(39.4)	125(60.3)		

Age	< 10	164(40.9)	52(31.7)	112(68.2)	16.5	0.033
	10-16	133(33.0)	70(52.6)	63(47.3)		
	>16	106(26.3)	16(15.5)	90(84.9)		
Grade level	1_4	193(47.9)	85(44)	108(55.9)	7.55	0.017
	5_8	210(52.1)	53(25.2)	157(74.7)		
Residence	Urban	272 (67.5)	75 (27.6)	197 (72.4)	16.531	0.000
	Rural	131 (32.5)	63 (48.1)	68 (51.9)		
School type	Gutu	233 (57.8)	91 (39.1)	142(60.9)	5.681	0.017
	Windisa	170 (42.2)	47 (48.1)	123 (72.4)		
Family size	<5 Family size	167(41.4)	38 (22.8)	129 (77.2)	16.715	0.000
	>5 Family size	236(58.6)	100 (42.4)	136 (57.6)		
Family income	<1000 ETB	71(17.6)	43 (60.6)	28 (39.4)	28.286	0.000
	1001-2001 ETB	19(4.7	3(15.8)	16 (84.2)		
	2002-3002 ETB	18(4.5)	5 (27.8)	13 (72.2)		
	.3003-4003 ETB	56(13.9)	16 (28.6)	40 (71.4)		
	4004-5004 ETB	124(30.8)	35 (28.2)	89 (71.8)		
	>5004 ETB	115(28.5)	36 (31.3)	79 (68.7)		
Parental educational status	Illiterate	115(28.5)	56 (48.7)	59 (51.3)	15.369	0.000
	Elementary	177(43.9)	53 (29.9)	124 (70.1)		
	High school & above	111(27.5)	29 (26.1)	82 (73.9)		
House hold occupation	Government employee	105(26.1)	39 (37.1)	66 (62.9)	24.122	0.000
	NGO employ	11(2.7)	2 (18.2)	9 (81.8)		
	Daily labor	5(1.2)	2 (40)	3(60)		
	Merchant	99(24.56)	18 (18.2)	81(81.8)		
	Farmer	105(26.1)	52 (49.5)	53 (50)		
	House wife	78(19.4)	25 (32.1)	53 (67.9)		
Total		403(100)	138(34.2)	265(65.8)		

Source: Field data, 2023

4.4. The risk factors associated with the occurrence of Intestinal Parasitic Infections among the Study Participants

4.4.1 Hygiene practices among the children

Ten key variables were identified to assess the relationship between hygiene, sanitation, and the study subjects (Table 4.4). The results of the study showed a statistically significant association ($p<0.05$) between the prevalence of parasitic infections and the tested variables; absence of latrine in their households, defection in the open field, lack of hand washing habit after visiting toilets and before eating food, eating uncooked vegetables and meat,not trimming finger nails, bare footedness and eating street vended foods (Table 4.4).

Of the students' households, 81.1% (327 households) had latrines, and out of these, 27.8% (91 households) tested positive for parasitic infections. On the other hand, 76 households that did not have latrines, 47 (61.8%) were found to be positive for parasitic infections.

Of the 291 (72.2%)respondents that eat raw vegetables,117(40.2%)were positive for parasitic infections. Similarly majority of the respondents who practiced open field defection 65(16.1%), do not wash their hands after visiting toilets224 (55.6%) and before eating food211 (52.4%), who consume uncooked vegetables 112(27.8)s raw meat 156(38.7) were more prone to parasitic infections. Students who did not regularly trim their finger nails, did not wear shoes and consume street food were also at higher risk of parasitic infections (Table 4.4).

Table.4.4 Correlation between Hygiene practices variables with infected cases of intestinal parasites

Risk factors	Responses	Frequency n (%)	Positive n (%)	Negative n (%)	χ^2	p-value
Latrine availability at home	Yes	327 (81.1)	91(27.8)	236(72.2)	31.684	0.000
	No	76 (18.9)	47(61.8)	29(38.2)		
Defecation habit in	Yes	338 (83.9)	106(31.4)	232(68.6)	7.731	0.005
Latrine	No	65 (16.1)	32(49.2)	33(50.8)		
Eating raw vegetables	Yes	291 (72.2)	117(40.2)	174(59.8)	16.535	0.000

	No	112 (27.8)	21(18.8)	91(81.3)		
Trimming finger nail	Yes	168 (41.7)	45 (26.8)	123(73.2)	7.116	0.000
	No	235 (58.3)	93(39.8)	142(60.4)		
Eating un cooked Meat	Yes	247 (61.3)	99(40.1)	148(59.9)	9.657	0.002
	No	156 (38.7)	39(25)	117(75)		
Shoe wearing	Always	276 (68.5)	77(27.9)	199(72.1)	15.657	0.000
	Sometime	127 (31.5)	61(48)	66(52)		
Hand washing after latrine	Yes	179 (44.4)	44(24.6)	135(75.4)	13.352	0.000
	No	224 (55.6)	94(42)	130(58)		
Hand wash before meal	Always	192(47.6)	55(28.6)	137(71.4)	5.012	0.024
	Some times	211(52.4)	83(39.5)	128(60.7)		
Enough latrine at school	Yes	211(52.4)	61(28..9)	150(71.1)	5.594	0.021
	No	192(47.6)	77(40.1)	115(49.9)		
consume street foods	Yes	245(60.8)	100(40.8)	149(59.2)	11.991	0.001
	No	158(39.2)	38(24.1)	120(75.9)		

Source: Field data, 2023

4.4.2 Environmental sanitation related factors

Results from environmental sanitation related variables such as place of swimming, source of water for drinking showed statistically significant ($p<0.05$) association between these variables and intestinal parasitic infections (Table 4.5). Accordingly majority of the students who used to swim in rivers (39%) and used water from rivers for drinking (35.4%) were infected more with the parasites. However, no significant differences ($p>0.05$) were observed between those who had swimming habit, use river water for bathing and washing cloths and those who do not use river water (Table 4.5).

Table. 4.5 Correlation between environmental variables with infected cases of intestinal parasites among school children in Kokossa primary school, in West Oromia region, Ethiopia, 2023 (n = 403).

Risk factors	Responses	Frequency n (%)	Positive n (%)	Negative n (%)	χ^2	p-value
swimming habit	Yes	247(61.3)	80(34.9)	167(67.6)	0.783	0.376
	No	156 (38.7)	58(37.2)	98(62.8)		
Swimming place	River	166(41.2)	65(39.2)	101(60.8)	1,331	0.046
	Ponds	237 (58)	73(30.8)	164(69.2)		
Source of water for drinking	Pipe	61(15.1)	18(29.5)	43(70.5)	1.617	0.034
	River	158(39.2)	56(35.4)	102 (64.6)		
	Well	184(45.7)	64 (34.8)	120(65.2)		
Wash Body or cloth in the rivers	Yes	273(67.7)	75(31.6)	162(68.4)	1.520	0.218
	No	130(32.3)	42(32.3)	88(67.7)		

Source: Field data, 2023

4.4.3 Participant's knowledge about intestinal parasite

Among the study participants, 241(59.8%)of them have ever heard about the intestinal parasite,.The awareness about IPIs was significantly associated with IPIs infection in school going children ($\chi2$ =17.385 P=0.000). Out of the total study participants, 203(50.4%) know the source of the intestinal parasite, and 233(21.6%)answer source of the intestinal parasite is contaminated water, regarding the transmission of intestinal parasite 287(71.2 %).Also know about transmission of IPIs was significantly associated with IPIsinfection in school going children ($\chi2$ =8.104 P=0.004). On the other hand 240(59.6 %) of study participants answer intestinal parasite is preventable. The results of this study showed a statically significant relationship between know about Source of intestinal parasite and being tested positive for IPIs ($\chi2$ = 11.458, p = . 0.003) (Table 4.6)..

Table 4.6: Knowledge about intestinal parasite among school children in Kokosa primary school, Kokosa Town, West Oromia region, Ethiopia, 2023 (n = 403).

Variable	Category	Frequency n (%)	Positive n (%)	Negative n (%)	χ^2	p-value
Have you ever heard about intestinal parasite	Yes	162(40.2)	36(22.2)	126(77.8)	17.385	0.000
	No	241(59.8)	102 (43.2)	139(53.7)		
Do you know the source of the intestinal parasite	Yes	203(50.4)	54(26.6)	149(73.4)	1.617	0.034
	No	200(49.6)	84(42)	116(58)		
Source of intestinal parasite	Contaminated food	83 (20.6)	41(49.4)	42(50.6)	11.458	0.003
	Contaminated water	233(57.8)	74(31.8)	159(68.2)		
	Contaminated soil	87(21.5)	23(26.4)	64(73.6)		
Can intestinal parasites be transmitted	Yes	287(71.2)	86(30)	201(70)	8.104	0.004
	No	116(28.7)	52(44.8)	64(55.2)		
How intestinal parasite transmitted	Fecal contamination	169(41.9)	68(40.2)	101(59.8)	4.643	0.031
	Direct contact	234(58.1)	70(29.9)	164(70.1)		
Can some intestinal parasites have transmitted during bare foot movement?	Yes	194(48.1)	55(28.4)	139(71.8)	5.769	0.016
	No	209(51.9)	83(39.7)	126(60.6)		
Can some intestinal parasite be transmitted by eating contaminated food	Yes	153(38)	33(21.6)	120(78.4)	17.596	0.000
	No	250(62)	105(42)	145(58)		
Can some intestinal parasite be transmitted by drinking contaminated water	Yes	203(50.4)	54(26.6)	149(73.4)	10.609	0.001
	No	200(49.6)	84(42)	116(58)		
Can some intestinal parasite be transmitted during swimming un protected water body	Yes	259(64.3)	73(28.2)	186(71.8)	11.813	0.001
	No	144(35.7)	65(45.1)	79(54.9)		

Can intestinal parasite preventable	Yes	240(59.6)	72(30)	168(70)	4.745	0.029
	No	163(40.4)	66(40.5)	97(59.5)		
How intestinal parasites could be prevented	Keeping food hygiene	119 (29.6)	64(53.8)	55(46.3)	17.385	0.000
	Maintain Environmental Sanitation	108(26.8)	26(24.1)	82(75.9)		
	Keeping personal hygiene	91(22.6)	27(29.7)	64(70.3)		
	Keeping water hygiene	85(21.1)	21(24.7)	64(75.3)		

Source: Field data, 2023

4.5 Factors associated with Intestinal Parasitic infections

Bivariable and multivariable logistic regression was used to assess factors associated with IPI among primary school in Kokosa town. Majority of independent variables showed significant association on the Bivariable model. After taking the independent variables to the multivariable model, IPI status was found to be significantly associated with status of finger nails at the time of data collection, shoe wearing at the time of, swimming habit, habit of eating street food and knowledge of at least on transmission method of IPIs.Those exposure variables with p-values < 0.95 were entered into multivariable logistic regression analysis. In bivariable logistic regression analysis, sex, age, the status of a finger nail, wearing shoes, hand washing after toilet, hand washing with before meal, washing fruit and vegetable before eating, source of drinking water was having p-values < 0.05 so that entered into multivariable logistic regression analysis. Out of the 403 student tested, 138(34.2%) were positive and the rest 265(65.8%) negative (Table 4.7). Stoll test positive males were 56(28.6 %:) and females 82(39.6 %:)

4.5.1 Univarate analysis of potential risk factors associated with intestinal parasitic infections

Associated risk factors for IPIs were identified by bivariate followed by multivariate logistic analysis. Among the potential risk factors assessed using bivariate logistic regression analysis, sex,age grade level, residence, family size, family income, parental education, available home latrine, hand washing before eating, defecation habit, hand washing habit after toilet, eating unwashed fruits and vegetables, eating uncooked meat, water source, finger cleanness, execration place and awareness about IPIs were associated with IPI at P value less than 0.05 Univariate analysis results showed that IPIs prevalence was significantly higher among individuals age group 10-15 years (COR *0.243*, 95% CI *0.124-9.47*p 0.000), female individuals (COR *1.168*, 95% CI *0.738-1.84*, p 0.005).grade level 1-4 (COR *0.438*, 95% CI *0.260-0.73*, p 0.002). Rural (COR 0.524, 95% CI 0.332-0.85, p<0.0001). Illiterate parentse were almost four times at increased risk of IPIs than those who got some kind of education (COR 0.487, 95% CI 0.22-0.753, p<0.004).

Members belonging to a household with size 5and more were twice at odds of having IPIs than those with lower family size (COR 2.308 95% CI 1.417-3.76 p 0.001). Lack of toilet was also found to be a significant contributor of IPIs (COR 0.309, 95% CI 0.147-0.651,p 0.002) (Table 4.7).no habit use latrine (COR 0.297 95% CI 0.134-0.655, p 0.003), uncooked green vegetable eaters (COR 2,48, 95% CI 1.214-5.068, p 0.013),un trim fingers properly (COR 0.769, 95% CI 0.429-1.381, p 0.038), uncooked meat eaters (COR 1.511, 95% CI 0,835-2.733, p 0.017), who didn't wear shoes regularly (COR 0.444, 95% CI .249-0.792, p 0.006),who did not wash hand after defection (COR 0.361, 95% CI 0.197-0.664, p 0.001), did not wash hand before meal (COR *0.833*, 95% CI 0.464-1.495, p 0.050), who did not aware about IPIs (COR *0.925*, 95% CI 0.505-1.695, p 0.008) . Finally, those variables were entered for multivariate analysis. After adjustment, grade level,water type used, washing hands before eating, defecation habit, washing hands after toilet, habit of eating unwashed fruits, and eating uncooked vegetables were significantly associated with intestinal parasite.

4.5.2 Multivariable analysis of potential risk factors associated with intestinal parasitic infections

Multivariable logistic regression analysis was used to identify the most significant risk factors for IPIs among primary school children in Kokosa town (Table 4.7). Data about twenty-nine potential risk factor variables within three categories (i.e. sociodemographic, hygiene and environmental sanitation, and habit and Participant's knowledge about intestinal parasite risk factors) were gathered from the study participants. In the modeling process, a bivariate logistic regression analysis was first done for each of the risk factors. Those independent variables with a p-value < 0.5 in the bivariate analysis were selected for multivariable analysis (Zoran Bursac,2018). The multivariable logistic regression analysis showed that the socio demographic factors femaleness with adjusted Odds Ratio (AOR of 0.714, 95% CI, 0.460-1.110,p= 0.001), age group 10-15 years (AOR 1.112, 95% CI 0.798-1.50, p= 0.000.), Residence of school being rural (AOR, 0.409, 95%CI, 0.259-0.650 p= 0.000), Grade level (AOR, 2.224, 95%CI, 1.333-3.370, p= 0.002), family size (AOR, 0.416, 95%CI, 0.263-0.656 p= 0.000), presence of latrine at home (AOR, 2.767, 95% CI 1.301-5.887 ,p= 0.000), Habit use latrine (AOR, 3.381, 95%CI 1.547-7.390,p= 0.000), eat row vegetable (AOR, 0.421, 95%CI 0.223-0673,p 0.020) and finger nail not trimmed (AOR, 1.819, 95%CI, 1.003-3.289 , p= 0.049), school children who didn't wear shoes regularly.), (AOR= 2.097, 95% CI: 1.178-3.742, p=0.012) and lack of awareness about intestinal parasitic infection (AOR = 2.169; 95% CI: 1.211-3.883, p= 0.009) were identified as the independent risk factors associated with the overall prevalence of IPIs (Table 4.7).

Table 4.7 Bivariable and Multivariable logistic regression analysis result for factor associated with IPs amongKokosa primary school West Arisi Zone, Oromia Region, Ethiopia.2023.(N=403)

Character	Response	Total	IPIs Positive	COR	95% CI	P-value	AOR	95% CI	P-value
Age	Less than 10	164(40.7)	52 (31.7)	0,615	0.295-1.275	0.193	4.643	5.031-6.132	0.051*:
	10-15	133(33.4)	70(52.6)	0.243	0.124-9.47	0.000*	1.112	0.798-1.550	0.000*:
	Above 16	106 (26.3)	16 (15.1)	1.00			1.0		
Sex	Male	196(58.6)	56(28.6)	1.00			1.0		
	Female	207(51.4)	82 (39.6)	1.168	0.738-1.84	0.005	0.714	0.460-1.110	0.001*:
Grade level	1-4	193(47.9)	85(40)	0.438	0.260-0.73	0.002	2.224	1.333-3.370	0.002*:
	5-8	210 (52.1)	53 (25.2)	1.00			1.00		
Resident	Rural	272 (67.5)	75 (27.6)	0.524	0.322-085	0.001	0.409	0.259-0.650	0.000*:
	Urban	131 (32.5)	63 (48.1)	1.00			1.00		
Family size	<5 Family size	167(41.4)	38 (22.8)	2.308	1.00		1.00		

	>5 Family size	236(58.6)	100 (42.4)	2.308	1.417-3.76	0.001	0.416	0.263-0.656	0.000*:
Family income in ETB	<1000	71(17.6)	43 (60.6)	0,334	0.17-0.653	0.001	1.211	1.077-1,363	0,001*:
	1001-2001	19(4.7	3(15.8)	1.721	0.443-6.669	0.0434	1.00		
	2002-3002	18(4.5)	5 (27.8)	1.09	0.335-3.546	0.886			
	3003-4003	56(13.9)	16 (28.6)	1.09	0.518 -2.290	0.821			
	4004-5004	124(30.8)	35 (48.1)	1.082	0.599-1.956	0.794			
	<5004	115(28.5)	36 (31.3)	1.00					
parents' education	Illiterate	115(28.5)	56 (48.7)	0.487	0.22-0.753	0.004	1.589	1.183-2.134	0.000*
	Elementary	177(43.9)	53 (29.9)	0.89	0.502-1.577	0.65	1.223	1.177-1,463	0,056
	High school & above	111(27.5)	29 (26.1)	1.00			1,00		
Parental occupation	Civil servant	105(26.1)	105(26.1)	1.00			1.00		
	NGO	11(2.7)	11(2.7)	2.484	0.484-12.74	0.275	0,947	0.866-1.095	0.659
	Daily labor	5(1.2)	5(1.2)	0.46	0.065-3.27	0.348			
	Merchant	18(18.2)	18(18.2)	2.749	1.39-5.436	0.004			
	Farmer	105(26.1)	105(26.1)	0.674	0.37-1.22	0.197			
	House wife	78(19.4)	78(19.4)	1.1	0.565-2.14	0.779			
Latrine at home	Yes	327 (81.1)	91(27.8)	1					
	No	76 (18.9)	47(61.8)	0.309	0.147-0.651	0,002	2.767	1.301-5.887	0.008*:
Habit use latrine	Yes	338 (83.9)	106(31.4)	1.00					
	No	65 (16.1)	32(49.2)	0.297	0.134-0.655	0.003	3.381	1/547-7.390	0.002*:
Habits of eating raw vegetable	Yes	291 (72.2)	117(40.2)	2,48	1.214-5.068	0.013	0.421	0.223-0673	0.020*:
	No	112 (27.8)	21(18.8)	1.00			1.00		
Trim your finger properly	Yes	168 (41.7)	45 (26.8)	1.00			1.00		
	No	235 (58.3)	93(39.8)	0.769	0.429-1.381	0.038	1.819	1.003-3.289	0.049*:
Eating un	Yes	247 (61.3)	99(40.1)	1.511	0,835-2.733	0.017	0.586	0.323-1.064	0.079:

cooked	No	156 (38.7)	39(25)	1.00					
Meat									
Shoe	Always	276 (68.5)	77(27.9)	1.00			1.00		
wearing	Same times	127 (31.5)	61(48)	0.444	0.249-0.792	0.006	2.097	1.178-3.742	0.012*:
Wash hand	Yes	179 (44.4)	44(24.6)	1.00					
after using	No	224 (55.6)	94(42)	0.361	0.197-0.664	0.001	2.823	1.542-5.168	0.001*:
latrine									
Wash hand	Always	192(47.6)	55(28.6)	1.00					
before meal	Some times	211(52.4)	83(39.5)	0.833	0.464-1,495	0.050	1.219	0.677-2.194	0.051*:
latrine at	Yes	211(52.4)	61(28..9)	1.00			1.00		
school	No	192(47.6)	77(40.1)	0.637	0.364-1.114	0.013	1.833	1.039-3.232	0.036*:
Consume	Yes	245(60.8)	100(40.8)	1.719	0.971-3.043	0.063	0.628	0.352-1.117	0.113*:
street foods	No	158(39.2)	38(24.1)	1.00			1.00		
Defecation	Field	155 (38.5)	52(33.5)	0.833	0.364-1,695	0.000	0.951	0.623-1.452	0.000*:
place	Toilets	248(61.5)	86(34.7)				1.00		
Swimming	Yes	247(61.3)	80(34.9)	0.49	0.214-0.870	0.008	2.380	1.516-4.305	0.004*:
habit	No	156 (38.7)	58(37.2)	1.00			1.00		
Swimming	River	166(41.2)	65(39.2)	1.871	0.927-3.778	0.007	0.608	0.312-1.188	0.018*:
place	Ponds	237 (58)	73(30.8)	1.00			1.00		
Source of	Pipe	61(15.1)	18(29.5)	0.547	0.236-1,272	0.016	1.416	0.608-3.300	0.042*:
water	River	158(39.2)	56(35.4)	0.748	0.324	0.032	0.747	0.403-1.387	0.035*:
	Tap	184(45.7)	64 (34.8)	1.00			1.00		
Body or	Yes	273(67.7)	75(31.6)	0.709	0.394-1.27	0.025	1.304	0.725-2.345	0.003*:
cloth wash	No	130(32.3)	42(32.3)	1.00			1.00		
in river									
Awareness	Yes	162(40.2)	36(22.2)	1.00			1.00		
about IP	No	241(59.8)	102 (43.2)	0.925	0,505-1.695	0.008	2.169	1.211-3.883	0.009*:
know the	Yes	203(50.4)	54(26.6)	1.00			1.00		
source of	No	200(49.6)	84(42)	0/37	0.175-0.781	0.009	1.424	0.818-2.476	0.000*:
the IP									

Source: Field data, 2023

COR: crude odds ratio, AOR: adjusted odds ratio, CI: confidence interval, n: number of people, N: total participants, %: percent, *: Statistically significant, N=403

5. DISCUSSION

Intestinal parasites are present throughout the world in various degree of prevalence and are the major health problems in areas where there is overcrowding, poor environmental sanitation and personal hygiene practice especially in developing countries (WHO, 2023).

Locally relevant epidemiological data on IPIs and prevalence among primary-school children in communities and identification of potentially modifiable predisposing factors, is essential to design appropriate intervention strategies.Epidemiological studies on the prevalence of intestinal parasitic infections (IPIs) and potential risk factors in different localities are vital to update the risk of communities under consideration and to enhance control strategies.

Accordingly, this study tried to assess the prevalence of IPIs and potential risk factors including the habit and culture-related practices among primary school children in Kokosa town.In this study, seven types of intestinal parasites were detected among the participants with an overall prevalenceof 34.2% (Figure 4.1)and have identified inadequate sanitation and clean water supplies and a requirement for family hand hygiene education as potentially modifiable associated factors. Improvements in these areas could address both short and long-term consequences of these conditions in this vulnerable population.

Intestinal parasitic infections (IPIs) prevalence 138(34.2%) in our study was comparable with previous reports from Homesha district, Northwest Ethiopia (35.44%) by Gebremichael Gebretsadik (2017), Mizan Misgana Acadamy, Ethiopia (35.5%) by Mengistu Dessie (2019), Sheko primary school children in Sheko town (31.8%) by Netsanet Worku (2020). The prevalence found in this study is higher than study conducted in Sebeya primary school (29.9%), by(Mengistu Dessie *et al.*, 2017), Harbu Town (21.5%) (Daniel Gebretsadik *et al.*,2020), and Shashamane town 19.7% of Ethiopia (Sahiledengle *et al.*, 2020). lower than studies conducted in Deneba primary school of Deneba town, Central Ethiopia 49.7% (191/384) Gebre Hana ,2020**)** but very lower than 53.5% of government school (Serkadis *et al.,* 2013) in Jima town.This variation could be due to geographical settings differences, sanitation facility coverage,accessibility of safe water, and personal hygienedissimilarity (Destaw Damtie *et al.*, 2021). These variations in the prevalence of IPIs could be due to differences in geographical location and socioeconomic activities of the people, low level of awareness about the transmission of intestinal parasites and ignorance of health-promotion practices, the level of environmental sanitation and source of drinking water (Fiseha Wadilo,2021).

In the current study, the prevalence of *A. lumbricoides* (8.4%) was found to be comparable to studies conducted in Gurage, southern central Ethiopia (9.6%) by Melese Birmeka *et al.* (2017) and Less than Wondo Genet, south Ethiopia (84.3%) by Birhanu Erko (2019). This variation might be due to the differences in study population size, socio-demographic conditions and environmental conditions and time of the study. In the present study, the prevalence of *A. lumbricoides*13(38.2.%) and 21(61.7%) in males and females respectively. This is in line with the study conducted in Bahir Dar where females were more affected than males (Tamirat Hailegbrel, 2017).

The prevalence of *T.trichura* in the present study was 0.7% , which was less than 2.34% of the previous finding by Tilahun Aleligh (2017) in the Northwest part of the country. Similarly, 2.5% prevalence was reported by Alamneh Abebe *et al.(*2011) in Zarima town, northwest Ethiopia. On the other hand, the results of the present finding showed lower prevalence than reported by Gezahegn Solomon (2018) as19.3% in southern Ethiopia in Abomsa around Lake Zuway and 9.5% reported by Lekyun Jemaneh (2018) from South Gondar Zone. The difference of finding in the present study area might be due to several factors like study time and methodology used. On the other hand, climate is an important determinant of transmission of these infections with adequate moisture and warm temperature essential for larval development in the soil (Brooker, 2016)

In the present study, the prevalence of *E. histolytica*(6%), Table 4.2 was less than Mulusew Alamir (2014) who reported 17.1% prevalence of intestinal parasitic infection among primary school children in Motta Town, Western Amhara and also FetleworkAndargachew (2011) who reported 16.4% Cureent result was comparable to study among schoolchildren in Debre Elias, East Gojam (6.6%) (Workneh Toreben *et al*., 2014). This variation might be in difference with habit of washing hands before meal and after latrine usage, eating uncooked vegetables, unclean storage of water container and source of drinking water(Tamirat Hailegbrel, 2017).

The current prevalence of *Giardia lamblia* in the study area was (4.7%).. This result was lessthan the research result reported by Legesse and Erko(2010) who reported 6.2% and also the studies conducted in Ethiopia byDawit Ayalew (2006) who reported 38%, Haileeyesus Adamu and Beyene Pteros (2009) who reported 16.5% , Sintayehu Bedaso Daba (2010) who reported 21.4%, Fetlework Andargachew(2011) who rported 6%, Mulat Alamir*et al*. (2013) who reported 22.8%.. Variations of the results may be due to predisposing factors such asunsafe drinking water source, dirt and unclean finger nail, frequent river water contact, open field defecation practices, poor hand washing habit before meal and after defecation, and habit of eating raw vegetables and unwashed fruits (Baye Sitotaw,2019).

The associations of intestinal parasitic infections with sex, age, residence, grade interval, educational level of both father and mother, occupation of parents, family size, place to defecate, water availability for drinking and the presence of dirty matter in finger nails, not hand washing after toilet and before eating food were significantly associated ($p \leq 0.05$) with intestinal parasitic infections.

the current study age had a significant association with intestinal parasites among school children, In where children their age lie between < 10 years and 10-15 years were 4.643 and 1.112 times more likely to had an intestinal parasite in comparison with children their age were greater than >16 years respectively. This is supported by the study conducted in Merawi Town and Jawi town (Destaw Damtie*et al.*, 2021) &(BayeSitotaw*et al*., 2019). Young children have the habit of inserting in to their mouth whatever they got, which makes them to susceptible the intestinal Parasites. In this study, the intestinal parasite had a significant association with sex, where female children were more likely to have an intestinal parasite in comparison with male children. This result is in agreement with studies carried out in Gondar (Aschalew Gelaw,2019).This variation of exposure among the different sex groups might be due to differences in occupational exposure in different communities and study area.

The current finding showed IPIs was associated with shoe wearing habits, Status of a fingernail, hand washing habit before a meal, hand washing habit after defecation, and Source of water for drinking and bathing. Results of the present study is in agreement with the previous studies reported in Gondar (Aschalew Gelaw ,2019), in Mota Town (Mulusew Andualem,2014) in Delgi school North Gondar (AgumasAyalew ,2021), and in Arbaminch Southern Ethiopia (Ashenafi Abossie,2014).

latrine availability, latrine usage, and fruit washing before eating were associated with the prevalence of IPIs.This finding was contradicted the study in Jawi town, north -west Ethiopia (Baye Sitotaw,2019), in Chencha town southern Ethiopia (AshenafiAbossie,2014) and Mota Town (Mulusew Andualem,2014). The contradictory reports could be due to the category of the study population, the period of the study, and the methods employed for stool examination.

Multivariate logistic regration analysis for socio demographic, environmental and factors of life style factors such as use of toilet (AOR (95% CI)=3.381 (1.547-7.390), p-value= 0.002) washing hands before eating food (AOR (95%CI)= 1.219 (0.677-2.194), p-value=0.051) and wash hands after using toilet (AOR (95% CI)=2.823(1.542-5.168), p-value=0.001) were important risk factors ($p \leq 0.05$) to facilitate the occurrence of intestinal parasitic infections in schoolage children in the current study area Shoe wearing status was another significantly associated variable with IPIs; AOR=2.097 ;95% CI (1.178-3.742). In this study, barefooted children were found to be nearly two times more likely to acquire infections. Studies from different parts of Ethiopia supported this finding. These studies found that children who were bare footed at the time of data collection had increased likelihood of acquiring IPIs(Hailu T. *et al*. 2018)

6. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1. Summary

The present study was conducted to determine the prevalence of parasitic infections and their associations with risk factors in Kokossa Primary School at Kokossa Town, West Arisi

Zone, Oromia Region, Ethiopia.. The design of the study was a descriptive cross-sectional survey of major intestinal protozoan and *helminthic* parasite(s) infection from school children and the associated risk factors (socio-demographic characteristics) among school children at Kokossa Primary School at Kokossa Town, West Arisi Zone, Oromia Region, Ethiopia from september to December, 2023.During the study, a total of 403 stool samples were collected and examined using direct microscope examination, Formali ether concentration and Modified Zeihi-Neelsen techniques on the fresh collected stool samples. After examining the 403 stool samples, the overall prevalence of intestinal parasitic infections was1 138 (34,2 %), were 82 (39.6%) females while 56(28.6%) males were positive for at least one parasite infection. Out of the seven species of IPIs detected, *Ascaris lumbricoids* was 34(8.4%), followed by *Entamoeba histolyticr* 24 (6%), *G. Lamblia* 19 (4.7%), *Hymenolepis nana* 11(2.7%). *Taenia* species 8 (2%),*Hook worm* 5(1.2%) and *Trichuris* trichiura 3(0.7%).This finding also identified a number of risk factors associated with intestinal parasite infection such as environmental sanitation, awareness of parasiticinfection and latrine availability in home vicinity were significantly associated with intestinal parasitic infection and play an important role in touching prevalence of intestinal parasites infections.

6.2 CONCLUSION

According to this study Kokosa primary school children were highly infected with an intestinal parasite,indicating that intestinal parasite is still public health problem in the study area. The main intestinal parasite species identified among school children of Kokossa Primary School at Kokossa Town were*Ascaris lumbricoids*, *Entamoeba histolyticr*, G. Lamblia , *Hymenolepis nana*,. *Taenia* species, *Hook worm* and *Trichuris* trichiura . In this study, *Ascaris lumbricoids* was the most prevalent than other parasites.Among the 403 participating primary school children, 138(34.2%) (95% CI: 54.1–62.1%) were infected by one or more in parasites.

This study also identified a number of risk factors associated with intestinal parasite infection such as awareness of transmission and prevention, personal hygiene and environmental sanitation, knowledge of parasite infection and latrine availability in home vicinity were significantly associated with intestinal parasitic infection and play a significant role in prevalence of intestinal parasitic infection. Based on the socio demographic characteristics of sampled school children, females than males, younger than older, lower grade level students than higher and rural than urban were more exposed. A significant relationship was observed between distribution of gastrointestinal parasites and status trimming of fingernail which was closely linked to improper hand wash before meal and after visiting toilet. This study has, therefore, provides baseline information for future studies and investigation on important risk factors for intestinal parasite infection in the study area.

6.3 RECOMMENDATIONS

Based on the present findings the following recommendation can be forwarded:

- Local health sector should work together with school health program for delivering health education to increase the knowledge of school children as to how intestinal parasite infections are transmitted and prevented
- Children were recommended to improve their hygiene practice and shoes wearing habit.
- Children and members of the comminuty should learn the proper use of latrine. Once they started to us then it is expected of them to scale-up the proper use of laterin.
- Children should improve proper hand washing after toilet and before food (meal).
- Health sector, education office and parents should collaborate and support the school to build enough toilets and water supply in the school that may restrict children from open field and near river defecation.
- Teachers should inspect their students' personal hygiene specially trimming finger nail andtheir class room neatness.

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Appendices

Appendix I. STANDARD OPERATING PROCEDURES (SOP) FOR STOOL EXAMINATION

A. DIRECT WET MOUNT METHOD

1. A drop of fresh normal saline will be placed on the slide and mixed with small amount of stool specimen using a piece of stick.
2. The smooth preparation will be covered with cover glass.
3. The entire saline preparation will be examined systematically using 10x and 40x objective

B. Standard operational procedure for the Formal-Ether concentration technique

1. using a stick, emulsify about 1g (pea size) of faces in about 4ml of 10% formal water. Add more 3- 4ml formal water
2. Mix well by shaking and sieve into another tube made of glass or polypropylene
3. Add 3-4ml of ether (anaesthetic). Stopper tube and mix for 1 min
4. Loosen the stopper (there is pressure inside tube)
5. Centrifuge immediately at 750-1000g (~ 3000rpm) for 1 min
6. using a stick loosen the layer of faecal debris from the side of the tube and discard the supernatant, the sediment remains
7. Allow the fluid from the side of the tube to drain to the bottom. Tap the bottom tube to re suspend and mix sediment
8. Transfer a small portion of the sediment to a slide and cover it
9. Examine the preparation first with 10X and then 40X objective

Appendix II; Consent form English Version

HAWASSA UNIVERSITY, SCHOOL OF GRADTUATE STUDIES,

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES,

DEPARTMENT OF BIOLOGY

DATA COLLECTIONTOOL FOR ASSESSMENT OFTHEPREVALENCE OF INTESTINAL PARASITIC INFCTIONANDASSOCIATED RISKFACTORSamong primary school children in Kokossa Town**,** October 2023

My name is ---

Iam working as a data collector forastudy that is being conducted in Kokossa town to assess the prevalence of intestinal parasitic infections and associated factors among primary schoolchildren.the principal investigator is Mr.Mohammed Sherife,a student at HawassaUniversity,College of Natural and Computational Sciences, School of Graduate Studies ,Departmentof Biology. He is doing this study as a fulfillment of partial requirements of masters of science in of biology

Objective and significance of the study:The objective of this study is to determine the prevalence of intestinal parasitic infections and associated factors among primary school childrenin Kokossatown. This study helps to document the magnitude of intestinal parasitic infections and factors associated with infection sothat the town health office,and other responsible bodies take actions to solve the problem.Furthermore,the aim of this study is to write final thesis as a fulfillment of impartial requirements of the postgraduate study in thefield of Biology for the principal investigator.

RisksandBenefits:This study entails no risk except the time you give for the information you provide.This study will benefit You by providing you a free stool examination that helpyou know your infection status.Inaddition,you willbe provided with a free medical treatment if you are found positive for the parasites.

Rights:You will be included in this study only if you are voluntary to do so.You have the right to decline to participate in this study from the start or withdraw at any time during the study.In addition,you havethe right to refuseto answer questionsyou think unfavorable.

Confidentiality:I assure you that the information you provide and your laboratory result will not be accessed by a third party and your name or any thing that may identify you will not be included in the reports

Do you agree to participate?   1) Yes   2) No

Dear datacollector,if the individual says No to the above question stop there:ifhe/she says Yes thank him/her and proceed

Appendix III; Survey Questionnaires

HAWASSA UNIVERSITY, SCHOOL OF GRADTUATE STUDIES,

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES,

DEPARTMENT OF BIOLOGY

This Survey questionnaire is used for data gathering for the study which is conducted under the title**“prevalence of gastrointestinal parasitic infections and associated risk factors among primary school children in** Kokossa Town, West Arisi Zone, Oromia Region, Ethiopia **.”**The questionnaire will be filled by school children of Kokossa town in Kokossa woreda, West Arisi Zone, Oromia Region. Ethiopia. The outcome of this research will help to address information about the distribution of this disease in the study area. Your cooperation in filling the questionnaires is the paramount importance. Hence, please take your time to fill in the questionnaires. Therefore, I kindly request the respondent to fill this questionnaire. I assure you that all your responses will be held confidentially

Instruction: All questions mentioned here are equally important to achieve the objectives of the study. If you fill without understanding any question, it will negatively affect the result of the study. Therefore, please read the questions carefully, encircle the multiple choices and indicate your response in the space provided accordingly.

Thank you for your cooperation!!!

- **Demographic and socio-economic characteristics of respondents**

1. Sex 1. Male□ 2. female□
2. Age A. <5□ B. 10-15 □ C. >16□
3. Grade and section--- A. 1-4 □ B. 5-8 □
4. Residence □ 1. Urban □ 2. Rural□
5. Income status 1. <1000 □ 1000-2000□ 3 3000-4000 □ 4. 4000-5000 4.>5000□
6. What is your family size? 1) <5 □ 2) above 5□
7. Household head's education 1. Illiterate□ 2. Elementary□ 3. High school & above□

8. household head's occupation 1. Government employee□ 2.NGO employ□ 3.Daily labor□ 4.Merchant□ 5.Farmer□ 6.House wife□ 7. Other□

B. Questions about prevalence of intestinal parasitic infections

9. Have you ever heard about intestinal parasite? 1) Yes □ B) No □

10. Do you have latrine in your home? 1) Yes □ 2) No □

11. If your answer is yes do you and your family have habit to use latrine? 1) Yes □ B) No □

12. If no where you and your family use latrine? A. open field (forest) B. near water bodies

13. Do you eat raw vegetables? 1) Yes □ 2) No □

14. Do you trim your fingernails properly? 1) Yes □ B) No □

15. Do you eat uncooked/raw meat? 1) Yes □ B) No □

16. How often do you were shoes? A. Always □ B. Some times □ C. Not at all □

17. Do you have habit to wash your hand after using latrine? 1) Yes □ B) No □

18. How often do you do you wash your hands before meal? A. always□ B. sometimes□

19. What type of water source you use for drink /cooking? 1. pipe □ 2. stream/river□ 3. tape water □

20. Do you contact with river /stream water when you are watering plants or washing your cloth or body? 1) Yes □ B) No □

21. Do you have enough latrines in the school? 1) Yes □ B) No □

22. Have you ever been sick in the last 1 month? 1) Yes □ B) No □

23. If Q no 14 is yes what was/ were your sickness? A/ Fever□ B/Diarrhea □ C/ Abdominal pain□ D/ Vomiting□ E/Headache□ F/ Others□

24. How often do you cut your fingernails? 1/Usually □ 2/ Some times□

25. Doyou swim? 1) Yes □ B) No □

26. Wheredoyouswim? 1/River □ 2/pound□

27. Do you consume street foods? 1) Yes □ B) No □

28.How often do you wear shoes 1/Usually□ 2/Some times □

29.Doyou know ways of transmission of intestinal parasites? 1) Yes □ B) No □

30. Intestinal parasites can be transmitted by not keeping personal hygiene1) Yes □ B) No □

31. Intestinal parasites can be transmitted by eating contaminated food. 1) Yes □ B) No □

32. Intestinal parasitescan be transmitted by drinking contaminated water 1) Yes □ B) No □

33. Intestinal parasitescan be transmitted by swimming in unprotected water bodies. 1) Yes □ B) No □

34.Intestinal parasites can be transmitted by not wearing protective shoes. 1) Yes □ B) No □

Thank you for your contribution!!

Appendices IVQuestionnaire for Students (Afan Oromo version)

Gaafilee barattootaaf dhihaatan:-

Yuunivarsitii Hawaasaatti Barnoota Digrii Lammaffaa Muummee Barnoota Baayolojii.

<u>Mata duree Qorannoo;-</u>

Facaatii (tatamsa'iina) ramolee biyyoon daddarbanii fi haalota nama saaxilan Shawa kaabaam Aanaa Kuyu mana barumsa Garba Guracha lakka sadiitti Barattoota:Akkam ooltaan/bultan? Ani maqaan koo Baayyisaa Adareeti Gaaffannoon kun qarannoo barnoota digirii lammaffaatiif kan oolu ''tatamsa'ina raamolee(maxxantoota) biyyoodhaan daddarbanii fi haallan nama saaxilan adda baasuuf akka mana barumsa keessniitti sakkata'uuf oola. innis too'annoodhaaf gahee guddaaqaba.

<u>Hubachiisa:</u>

- Gaafileen kun hanga tatamsa'inaa raamolee(maxxantoota) kanaa baruuf qophaa'e
- Gaafficha waan deebistaniif rakkoon mudatu hin jiru
- Deebii sirrii deebisuun qorannichaaf bu'aa guddaadha
- Duub deebiin qo'annichaa ittisa dhibee kanaatiif ni gargaara.
- Maqaa keessaan barreessuunf hin dirqamtan.

A.Odeeffannoo□ B. Dhuunfaa□ C. Hirmatota□

1. Salaa A. Dhira□ B. Dubara□

2. Umuri A.<10□ B.10-15 □ C. >16□

3.kutaa fi daree A.1-4□ B.5-8□

4.Bakka jireenya A.Magaalaa □ B. Badiyaa□

5.Galli A/<1000□ B/1000-2000□ C/3000-4000 □ D, 4000-5000 D/>5000□

6. Baayyinni maatii keessanii meeqa? A. <5□ B.5 ol□

7.sadarkaan barnoota maatii kee maali? A.dubbisu/bareessuu kan hin dadeenyedha□
B.barnoota sadarkaa tokkoffaa □ C/Sadarkaa 2faa□ D/dippilomaa □ E/Digrii ol□

8Hojii abba koo A/Hojjataa mootummaa□ B/Daldalaa □ C/Qotee bulaa□ D/NGO□
E/Haadha manaa □ F/hojii biraa□

B/Gaaffii Waa'ee daddarbiinsaa fi midhaa maxxantuu mar'imaanii

9.Waa'ee maxxantuun mar'ummaanii dhegetaa? A/Eeyyee□ B/Mitti□

10. Mana ficaanii qabduu? A. Eeyyee□ B. Lakkii□

11. Yoo kan qabduu ta'ee maatii keessaa ni fayaadama. A.Eeyyee□ B.Lakkii□

12.Yoo kan hin qabanee ta'ee eesatii fadamituu? A.diree ti□ B. bishaan cinaati□

13.Kuduuraa fi muduuraa osoo hin miciin ni fadamituu?A.Eeyyee□ B. Lakkii□

14.Qeensa kee kan harkaa siriti cirattaa A/Eeyyee □ B/Miti □ C/ Yeroo hundaa D/Yeroo too took□

15.Foon Dheedhii hin bilchaanne ni nyaataa? A/Eeyyee□ B/Miti□

16.kophee hammam fayyadamta?A/Yeroo hundaa □ B/Yeroo toko toko □ C/HIN Fayyadamu□

17.Mana fincaanii booda aadaa harka dhiqatta? A/Eeyyee□ B/miti□

18.Qubaa harkaa kee hammam ni dhiqaataa? A/yeroo hundaa□ B/yeroo toko toko□

19.Dhugaatiif nyaata bilcheesuuf bishaan kam fayyadamtaa?A/Bishaan bola□ B/burkaa □ C/ Laga□ D/Bishaan bombaa□

20.yeroo bishan uffata dhiqattu ykn lagaa ykn burqaa tutuqxaa A/Eeyyee □ B/miti□

21.mana barumsaatii mana fincaanii gaha qabduu A/Eeyyee □ B/miti□

22.Ji'a tokko dura dhukkubsattee beektaa? A/Eeyyee□ B/Miti□

23.Yoo deebii koo eeyyen tee'e maiiatoo dhukubaa maalinee? A/Hoe'nsuu□ B/Haacachuu □ C/Baa'suu □ D/Mataa dhukubaa □ E/Garaa dhukuba□ F/kanbiraa□

24.Qeensa kee kan harkaa siritii cirattaa? A/Yeroo hundaa□ B/ Yeroo toko toko□

25.Bishaan daaktaa?A/Eeyyee □ B/Miti□

26. bishaan kam daaktaa?A/Laga B/ haroo xiqaa C/bishaan daakaaf tolfame

27..Dandii nyataa nyatertaa bektaaa? A/Eeyyen □ B/Miti□

28.kophee hammam fayyadamta ? A/yeroo hudaa□ B/Yeroo toko toko□

29.Waa'ee raammoo mar'ummaani dhageessee beektaa?A/Eeyyee□ B/miti□

30.Qulqullina dhunfaa eeggachuu dhabuu maxxantuu mar'ummaani dabarsuu dand'aa?A/Eeyyee □ B/miti□

31.Maxxaantuu mar'ummaani nyaata faalamaan darbuu danda'aa? A/Eeyyee□ B/miti□

32.Maxxantuun mar'ummaanii bishaan faalamaan darbuu danda'aa? A/Eeyyee□ B/miti□

33.maxxantuun mar'ummaanii daaktaa darbuu danda'aa? A/Eeyyee□ B/Miti□

34.Maxxantuun mar'ummaanii kophee godhachuu dhabuun darbuu danda;aa?

A/Eeyyee □ B/Miti□

C. Laboratory results ofstool examinations forintestinal parasites

Participants laboratory data		stool	Ova
Parasites isolated from stool/ova	*A. lumbrcoid*		
	T. trichuria		
	E. histolica/dispare		
	S. stercolaris		
	Hook worm species		
	G. lamblia		
	H. nana		
	Taenia species		
	Mixed		
	Other specify		
Status of intestinal parasite	1.posative 2.Negative		

Appendix V : Some photos taken from the area while conducting the study

Figure IIA. Photos showing while giving orientation to students

Figure IIB. Photos showing while students fill forms and preparing to bring samples

Figure IIC. Photos showing out side view of Kokosa primary school and Hospital

Figure IID. Photos showing Samle laboraty matrials (kato-katz materials)and slide preparation

Figure IIE Photos showing while collecting and preparing samples for diagnosis

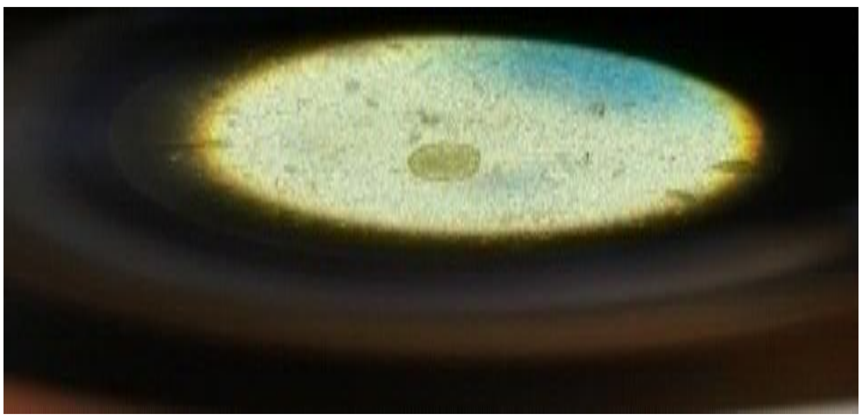

Figure IIF. Photos showing laboraty result of Asscarisa egg