PREVALENCE OF INTESTINAL PARASITIC INFECTIONS AND THEIR ASSOCIATED RISK FACTORS AMONG PATIENTS VISITING ADARE HOSPITAL HAWASSA, ETHIOPIA

MSc. THESIS

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HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA

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This is to certify that the thesis entitled "**PREVALENCE OF INTESTINAL PARASITIC INFECTIONS AND THEIR ASSOCIATED RISK FACTORS AMONG PATIENT VISITING ADARE HOSPITAL HAWASSA, ETHIOPIA**" submitted in partial fulfillment of the requirements for the degree of Master's with specialization in Biomedical Science the Graduate Program of the Department of Biology, and has been carried out by BONTU DESU ID. No. GpBiscR/0004/15, under my supervision. Therefore I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

MelesaBimirka (**PhD**) ______________________ ______________

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DECLARATION

I hereby declare that this MSc thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been properly acknowledged.

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This MSc thesis has been submitted for examination with my approval as thesis advisor.

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ACRONYMS/ABBREVIATION

AIDS-Acquired Immunodeficiency Syndrome

AOR -Adjusted Odds Ratio

CDC -Center for Disease Control and Prevention

CI -Confidence Interval

COR -Crude Odds Ratio

ELISA-Enzyme-Linked Immunosorbent Assay

HIPI -Human Intestinal Parasite Infection

HIV-Human Immunodeficiency Virus

IPI -Intestinal Parasitic Infection

IP-Intestinal parasite

IPP - Intestinal Protozoan Parasite

MDA -Mass Drug Administration

MoH-Ministry of Health

NTS-Net Salary

NTDs -Neglected Tropical Diseases

PCR- Polymerase chain reaction

SPSS -Statistical Package for Social Science

STH- Soil Transmitted Helminths

WASH -Water Sanitation and Hygiene

WHO-World Health Organization

ABSTRACT

Intestinal parasitic infections (IPIs) remain a significant public health issue, especially in regions with poor sanitation and hygiene practices. This study aimed to assess the prevalence of IPIs and identify the associated risk factors among patients visiting Adare Hospital in Hawassa, Ethiopia. A health facility based cross-sectional study was conducted, with socio-demographic data collected through semi-structured questionnaires and stool samples analyzed using Direct Microscopy (Wet Mount) and Formal-Ether Concentration methods.. Data was analysed using SPSS version-27, by descriptive statistics and Logistic regression analyses. A p-value < 0.05 indicated statistical significance .Out of 422 stool samples, 152 (36.0%) tested positive for intestinal parasites. The most commonly detected parasites were Giardia lamblia (14.9%), Entamoeba histolytica (10.4%), and Ascaris lumbricoides (7.6%), while Hymenolepis nana was less frequently identified. Additionally, 16 participants (3.8%) had double infections. This study investigates the risk factors associated with intestinal parasitic infections (IPIs) in a specific population, focusing on age, income, occupation, hygiene practices, and access to clean water, dietary habits, and medical history. Findings reveal that Children aged 0-5 and 6-15 years face a higher risk of infection (AOR 1.509, p = 0.018), (AOR 1;59, P=0.17)respectively *and low-income households, particularly those earning below 1000 NTS, are at greater risk (AOR 1.304, p < 0.01). Among occupations, students show a notably high risk (AOR 13.39, p < 0.001). Hygiene practices, especially hand washing with soap and water, significantly reduce IPI risk (AOR 0.188, p = 0.030), while limited access to clean water increases it (AOR 3.436, p < 0.001). Dietary habits, such as consuming raw meat or fish, are linked to higher infection rates (AOR 0.368, p = 0.001).These finding highlight critical risk factors, including age, income, occupation, hygiene, and water access and underscore the need for improved hygiene practices, sanitation, and access to clean water in Hawassa to mitigate the spread of parasitic infections. This study provides essential insights that can inform targeted public health interventions in the region.*

Keywords: Adare Hospital, Intestinal Parasites, Prevalence, Risk Factor.

1 INTRODUCTION

1.1 Background of the study

Intestinal parasitic infections (IPIs) are a major public health concern, particularly in developing regions where sanitation and hygiene are inadequate. These infections, caused by a variety of parasites such as protozoa and helminths, affect millions of people worldwide (WHO, 2020).

The World Health Organization (WHO) estimates that over one billion people are infected with soil-transmitted helminths, contributing to malnutrition, impaired cognitive development, and other serious health issues (WHO, 2020). Despite global efforts to reduce the burden of parasitic diseases, IPIs remain highly prevalent in many parts of the world, especially in regions with poor sanitation and limited access to clean water. Recent studies have highlighted the persistent prevalence of intestinal parasitic infections in several parts of the world. Over 1.5 billion people globally are affected by parasitic worms, with the highest burden in Sub-Saharan Africa, South Asia, and Latin America (Hotez *et al.,* 2021). The prevalence rates, however, vary significantly across regions and populations, often influenced by factors such as geographic location, socio-economic status, and environmental conditions. In many rural and impoverished communities, the prevalence of IPIs can exceed 50%, particularly among children (Nash *et al.,* 2022).

IPIs are caused by protozoa and helminths, such as *Entamoeba histolytica*, *Giardia lamblia*, *Ascaris lumbricoides*, and hookworms, and continue to affect millions worldwide. According to the World Health Organization (2020), over 1.5 billion people are infected with soil-transmitted helminths alone, with the highest burden in Sub-Saharan Africa, South Asia, and Latin America. In regions such as Sub-Saharan Africa, studies have reported that more than 75% of schoolchildren in some areas are infected with at least one type of helminth (Adeyeba and Akinlabi, 2021).The transmission of intestinal parasites is closely linked to environmental and socio-economic factors. Poor sanitation, lack of access to clean water, and inadequate hygiene practices are among the primary risk factors for these infections. Additionally, population groups such as children, the elderly and agricultural workers are particularly vulnerable to IPIs due to increased exposure to contaminated soil or water. Individuals living in areas with limited access to sanitation facilities are at a five-fold higher risk of contracting parasitic infections (Schmidt *et al*., 2020) .

1.2 Statement of the Problem

Intestinal parasitic infections are the major causes of morbidity and mortality in sub-Saharan countries (Tadesse *et al.,* 2020).In Ethiopia, despite continuous efforts to control IPIs during the past decade, the burden of intestinal parasites (IPs) is extremely high (Girma and Aemiro, 2022).

Intestinal parasitic infections pose a significant public health challenge across many developing nations, including Ethiopia. Despite efforts to control and prevent these infections, they continue to be a significant burden on the health and well-being of the population, recent studies conducted in Hawassa, Ethiopia, provides critical insights into the prevalence and associated risk factors of intestinal parasitic infections (IPIs). A 10-year retrospective study at Hawassa University identified an overall IPI prevalence of 47.9% among patients, with the protozoan *Entamoeba histolytica/dispar* being the most prevalent parasite at 18%. This study also reported significant protozoan infections caused by *Giardia lamblia 9.6%* highlighting the role of poor hygiene and environmental sanitation in facilitating fecal-oral transmission of parasites. (Menjetta *et al*., 2019) These findings align with global concerns raised by the World Health Organization, which underscores the public health threat posed by intestinal protozoa in Ethiopia and other developing regions. A parallel study focusing on children under five years old attending health facilities in Hawassa revealed an IPI prevalence of 26.6%. The most common parasitic infections were *Entamoeba histolytica/dispar* (11.4%) and other intestinal protozoa like *Giardia duodenalis* and *Cryptosporidium species* (Mulatu *et al.,* 2015).

While numerous studies have explored the prevalence and contributing factors of intestinal parasitic infections (IPIs) in Ethiopia, many regions particularly in the southern part of the country still lack detailed epidemiological data. Hawassa has been noted for its high prevalence of IPIs; however, specific data on prevalence and associated risk factors are limited. This gap in information hinders the development of effective prevention and control strategies. Therefore, this study aims to determine the prevalence of intestinal parasitic infections and associated risk factors at Adare Hospital in Hawassa.

1.3 Objectives

1.3.1 General objective

The general objective of this research was to examine the prevalence of intestinal parasitic infections and the associated risk factors within the study population.

1.3.2 Specific objectives

The specific objectives were;

- To assess the prevalence of intestinal parasitic infections in the area.
- To identify the different species parasites in the study population.
- To identify which stage of parasite is more common.
- To identify demographic, socioeconomic, and environmental risk factors associated with intestinal parasitic infections.

1.4 Research Questions

In line with the specific objectives the study were focused on the following questions:

- What is the prevalence of intestinal parasitic infections in the study population?
- What are the identified different species of parasite in the study population?
- What demographic, socioeconomic, and environmental risk factors are associated with intestinal parasitic infections in the study population?

1.5 Significance of the Study

Understanding the prevalence and associated risk factors of intestinal parasitic infections is crucial for developing effective prevention and control strategies. While many studies have documented the burden of IPIs, there is still a need for updated data in specific regions to inform public health interventions. This study aims to fill this gap by providing current data on the prevalence of intestinal parasitic infections and identifying the key risk factors contributing to their transmission in Hawassa. The findings of this research will help guide public health policies and targeted interventions aimed at reducing the burden of IPIs in vulnerable populations.

1.6. Scope of the study

The scope of the study included collecting stool samples from a representative sample of the study population and analyzing them for the presence of intestinal parasites. Demographic, socioeconomic, and environmental data were also collected from participants to identify risk factors associated with parasitic infections. The study was conducted over a certain period of time and it included all age groups and both sex. Additionally involved statistical analysis of the data collected to draw conclusions about the prevalence, risk factors, and impact of intestinal parasitic infections in the study population.

1.7 Limitation of the study

The findings of this study should be considered alongside its limitations. Because this is a health-care facility-based study, its findings may not represent the prevalence of IPIs and associated risk factors in the general population. This study used only Wet mount and formol-ether concentration method.Alternative methods that could be employed include polymerase chain reaction (PCR) for molecular detection, enzyme-linked immunosorbent assay (ELISA) for antigen detection, or quantitative polymerase chain reaction (PCR) for more sensitive and specific identification of parasitic DNA. Incorporating these additional diagnostic techniques could enhance the accuracy of prevalence estimates and provide a more comprehensive understanding of the epidemiology of IPIs.

1.8 Conceptual framework

The socio demographic factors, Socio Economic And associated risk factors, that might lead to the occurrence of intestinal parasites among patients .One factor alone might not lead to intestinal parasites, but a combination of factors can cause the disease.The conceptual framework illustrates how dependent and independent variables are related to each other. The dependent variable is the prevalence of intestinal parasites. This variable is influenced by independent variables such as the socio demographic and economic status of Patients, including age, residence, income, educational status, and occupation. Other independent variables include potential risk factors like hygiene practices, dietary habits, Access to clean water.

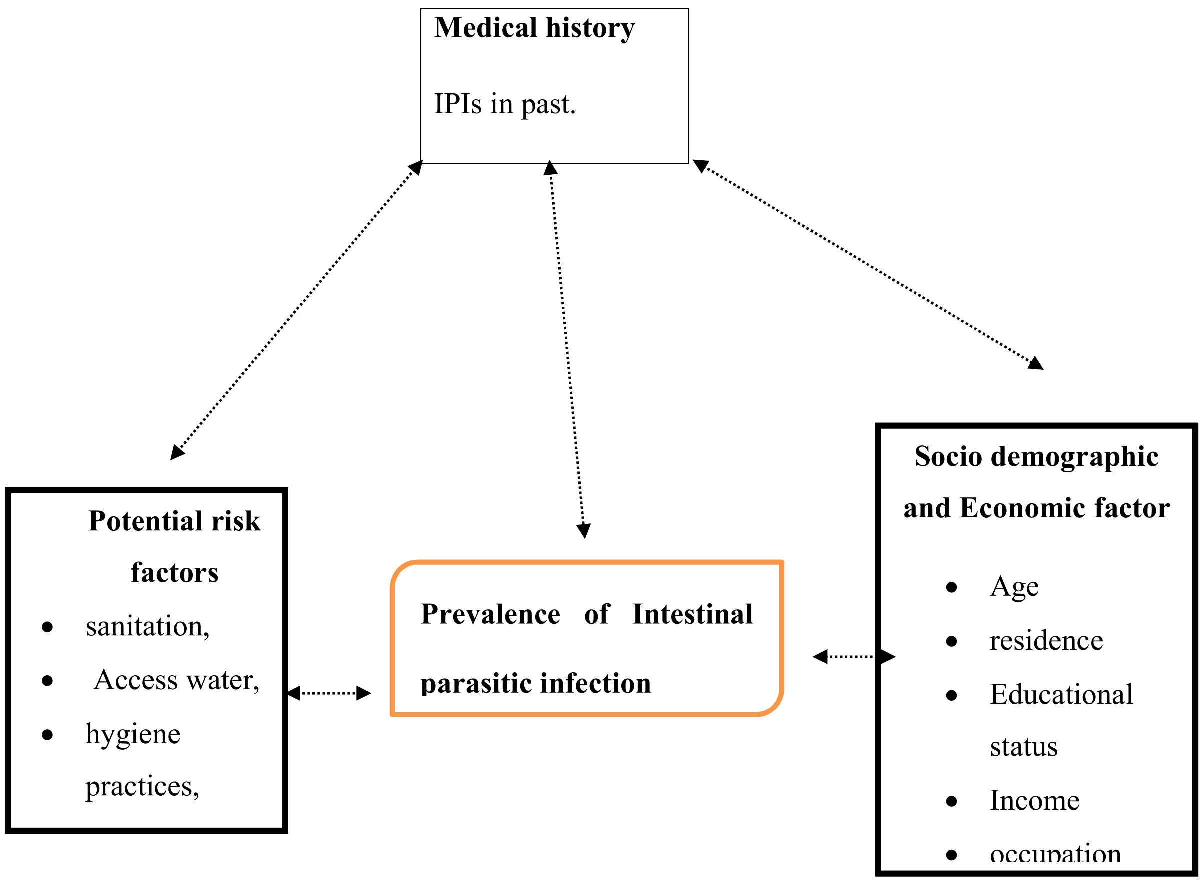


Figure 2: Conceptual Frame Work shows the relationship of dependent and independent Variables among patients Attending Adare Hospital, Hawassa Ethiopia, 2024.

2. LITERATURE REVIEW

2.1. Overview of Intestinal Parasitic Infections

Intestinal parasites are an organism that lives in or on and takes its nourishment from another organism and live in the intestinal tract. It includes both helminthes and protozoa; Helminthes are worms such as tapeworms, pinworms and roundworms. All of these worms can live, but typically not reproduce inside the human intestine. In contrast to the worms, which are composed of many cells, protozoa are single-celled organisms that can multiply inside the body (Charles, 2021).

Intestinal parasitic infections (IPIs) are caused by a variety of protozoa and helminths, which infect the gastrointestinal tract of humans, primarily through the fecal-oral route. These infections pose a significant public health challenge globally, especially in developing countries where poor sanitation, limited access to clean water, and inadequate hygiene practices are prevalent. Common parasites responsible for IPIs include protozoa such as *Entamoeba histolytica* and *Cryptosporidium spp.*, as well as soil-transmitted helminths like *Ascaris lumbricoides*, *Trichuristrichiura*, and *Ancylostomaduodenale* (WHO, 2022).

These infections are often associated with inadequate sanitation, poor hygiene practices, and contaminated food and water supplies. The WHO reports that approximately 2 billion people worldwide are infected with soil-transmitted helminths, leading to substantial morbidity, especially in vulnerable populations such as children and those with compromised immune systems (WHO, 2019).

Parasitic infections caused by intestinal helminths and protozoan parasites rank among the most common infections in humans, particularly in developing countries. In contrast, developed countries typically see a higher prevalence of gastrointestinal infections caused by protozoan parasites rather than helminths (Haque, 2007). According to the World Health

Organization (WHO), an estimated 1.5 billion people, mostly in low-income countries, are infected with soil-transmitted helminths (WHO, 2022).

Infections with these parasites often result in a range of health issues, including malnutrition, anemia, stunted growth, and impaired cognitive development in children. Among the most common protozoan infections, *Entamoeba histolytica* can cause amoebiasis, a condition that may lead to severe diarrhea or even life-threatening complications such as liver abscesses (Shiferaw*et al.,* 2021). Similarly, *Giardia lamblia* infections, also known as giardiasis, contribute to diarrheal diseases, particularly in young children and immune-compromised individuals (Tadesse *et al.,* 2020).

In tropical countries, intestinal protozoan infections are among the common infections causing significant morbidity and mortality (WHO, 2015).Parasitic infections caused by intestinal helminths and protozoa's are among the most prevalent infections in the globe, carrying a high burden of morbidity and mortality. Globally, 2 billion people, majorly children, were infected by soil-transmitted helminthes (STHs) and schistosomiasis, of whom more than 300 million suffer from associated severe morbidity (WHO, 2017).IPIs are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China, and East Asia (WHO, 2020).

Globally, approximately 3.5 billion people are affected by intestinal parasitic infections, leading to over 200,000 reported deaths each year (WHO, 2021). More than 267 million preschool-aged children and over 568 million school-aged children reside in areas where these parasites are transmitted intensively, making them in need of treatment and preventive measures (WHO, 2021).

The distribution of helminths and protozoan parasites varies across different regions. In developing countries, enteric protozoa, particularly *Giardia intestinalis* (also known as

Giardia lamblia) and *Entamoeba* species, are prominent. Were common in children. The systematic review and meta-analysis study on prevalence of gastrointestinal pathogens in developed and developing revealed Giardia intestinalis as the most frequently detected protozoa in developing regions, with the prevalence of 3.0 and 2.7% in South Asia and Sub-Saharan Africa respectively (Zemene *et al.*, 2018).In Sub-Saharan Africa, Ethiopia has the second-highest ascariasis, third-highest hookworm, and fourth-highest trichuriasis infections (Deribe *et al.*, 2012).

The number of individuals living in helminthes endemic areas, particularly soil-transmitted helminthes, is estimated to be 81 million in the country, including 9.1 million preschoolers, 25.3 million school-aged children, and 44.6 million adults. Like many other African countries, intestinal parasitic infections (IPIs) are prevalent in Ethiopia due to factors such as poverty, inadequate personal hygiene, poor environmental sanitation, overcrowding, low education levels, and a lack of access to safe drinking water (MoH, 2016). Over half of the country's population still practices open defecation, and many residents in urban slums rely on unimproved sanitation facilities (Beyene *et al.,* 2015). In regions like sub-Saharan Africa, including Ethiopia, the prevalence of IPIs remains high, particularly among schoolchildren and individuals in rural or per urban areas. Studies in Ethiopia show that the overall prevalence of intestinal parasites ranges between 26.6% and 47.9%, with parasites such as *Entamoebahistolytica* and *Giardia lamblia* being the most frequently reported (Alemu *et al* 2021). Factors contributing to these high rates include open defecation, inadequate sanitation, and reliance on contaminated water sources for drinking and household use. Efforts to control IPIs have focused on mass drug administration (MDA) campaigns, particularly for soil-transmitted helminths, as well as health education and improvements in water, sanitation, and hygiene (WASH) practices. However, despite such interventions, re-infection remains a major challenge, especially in communities where environmental conditions favor the continued transmission of parasitic infections (Mekonnen $et\ al., 2021$)

Intestinal parasites (IP) have also been found on plants, fruits, fingers, utensils, and door handles. Commonly consumed raw produce such as bananas, mangos, tomatoes, salads, and green peppers serve as significant pathways for IP transmission to humans (Alemu *et al.,* 2020). Additionally, the Global Burden of Disease study indicates that amoebiasis accounts for over 55,000 deaths and 2.2 million disability-adjusted life years, while giardiasis affects approximately 5–10% of the population (Al Saquar *et al.,* 2017).

Human intestinal parasitic infections (HIPIs) pose a global public health threat and are recognized as neglected tropical diseases (NTDs), gaining increased attention recently (Ojha *et al.,* 2014). Total control of HIPIs transmission and addressing potential aggravating factors are integral to the United Nations' Sustainable Development Goals. Despite ongoing efforts, intestinal parasites continue to burden public health, particularly in tropical and subtropical regions (Hotez*et al.,* 2014). Various risk factors for HIPIs in impoverished communities have been well documented Key contributors to the high prevalence of HIPIs include poverty-related issues (such as poor sanitation, lack of potable water, unsafe waste disposal, and open-field defecation), conducive environmental conditions for parasites, inadequate health services, and low awareness levels(Alum *et al.,* 2010).

School and preschool children are particularly vulnerable to HIPIs due to behaviors that expose them to these parasites. Urgent treatment and preventive measures are necessary (Palmeirim *et al.,* 2018). Young children are at a heightened risk due to their less developed immune systems, poor personal hygiene, and tendency to play on contaminated soil. HIPIs can lead to significant health issues, including an increased risk of protein-energy malnutrition, iron deficiency anemia, growth retardation, impaired cognitive development, and susceptibility to other infections in young children (Sackev, 2001).

The global burden of protozoan intestinal parasites is substantial; for instance, *Entamoeba histolytica* infects approximately 48 million people. Giardiasis also has a high global prevalence (WHO, 2010). Additionally, parasitic worms, including roundworm, hookworm, and whipworm, are common in low-income countries (Mascarini-Serra, 2011). Both protozoan parasites and soil-transmitted helminths contribute to high morbidity and mortality rates among children in sub-Saharan African nations (WHO, 2010). Key intestinal parasitic infections of global public health concern include protozoan species such as *Entamoeba histolytica* and *Giardia lamblia*, as well as helminthic species like *Ascaris lumbricoides*, *Trichuristrichiura*, hookworm species, *Enterobius vermicularis*, *Taenia* species, and *Schistosoma mansoni* (WHO, 2020).

Reports indicate a high prevalence of HIPIs in this African region, affecting nearly everyone at least once or multiple times during their lifetimes. The Federal Ministry of Health of Ethiopia has made efforts to combat HIPIs and other diseases by training thousands of health extension workers and deploying them to every village (Abossie and Mohammed, 2014). In Ethiopia, prevalence rates of HIPIs among primary school children have reached as high as 84% (Sitotaw and Shiferaw, 2020). Intestinal parasites produce a variety of symptoms in those affected, most of which manifest themselves in gastrointestinal complications and general weakness. Gastrointestinal conditions include inflammation of the small and/or large intestine, diarrhea(dysentery), abdominal pains and nausea (vomiting) These symptoms negatively impact nutritional status, including decreased absorption of micronutrients, loss of appetite, weight loss, and intestinal blood loss that can often result in anemia. It may also cause physical and mental disabilities, delayed growth in children, and skin irritation around the anus and vulva (Kiani *et al.,* 2016).

2.1.1. Intestinal Protozoa Infection

Protozoans are a group of single celled eukaryotes, either free-living or parasitic, that feed on organic matter such as other microorganism, organic tissues or debris. Historically protozoans were regarded as "one-celled animals “because they often possess animal -like behaviors, such as motility and predation, and lack a cell wall as found in plants and many algae (Scholtyseck, 2012).Intestinal protozoan parasite (IPP) infections are widespread public health problems, particularly in developing countries where they contribute to significant morbidity and mortality. These infections are closely linked to inadequate sanitation, poor access to clean water, and the lack of health services. Communities in these regions face a disproportionately high burden of protozoan infections, which are responsible for various gastrointestinal illnesses, malnutrition, and even death, especially in vulnerable populations like children, the elderly, and immune-compromised individuals (Castellanos *et al*.,2018).Protozoa such as *Entamoeba histolytica*, *Giardia lamblia* (also known as *Giardia intestinalis* or *Giardia duodenalis*), *Cryptosporidium spp.*, and *Balantidium coli* are some of the most common pathogens causing severe illnesses in humans. These parasites are mainly transmitted through the ingestion of contaminated food or water, and sometimes through direct human contact, making them easily transmissible in settings where hygiene is poor (Hajissa *et al* 2020).

Among these, *Entamoeba histolytica* is particularly notable for causing amoebiasis, which is the third leading cause of death from parasitic infections globally, ranking after malaria and schistosomiasis (Tegen *et al* 2020). Amebiasis can cause symptoms ranging from mild diarrhea to severe dysentery, and in some cases, it can lead to liver abscesses, a life-threatening condition. Similarly, *Giardia lamblia* and *Cryptosporidium spp.* are major non-viral causes of diarrhoeal diseases, particularly in children. Infections caused by these parasites are often associated with prolonged diarrhea, which can result in dehydration and malnutrition, further exacerbating the health challenges in affected populations (Squire and Ryan, 2017). *Cryptosporidium* infections are particularly concerning in immune-compromised individuals, such as those living with HIV/AIDS, where the infection can become chronic and lead to severe dehydration, weight loss, and even death if left untreated (Hajissa *et al* 2020).The high prevalence of these protozoan infections in Africa and other developing regions is intimately tied to socioeconomic factors such as poverty, poor environmental conditions, and a lack of education on health-promoting behaviors. Many communities lack access to clean drinking water and proper sanitation facilities, which increases the likelihood of waterborne transmission. Inadequate waste disposal systems further contribute to the contamination of water sources, making it easier for these parasites to spread (Ngowi, 2020).

The lifecycle of intestinal protozoa typically involves both a cyst and a trophozoite stage. The cysts, which are resistant to harsh environmental conditions, are often ingested through contaminated food or water. Once inside the host, the cysts release trophozoite, the active form of the parasite, which multiply in the intestines and cause infection. For example, *Giardia lamblia* releases trophozoites that attach to the small intestine's lining, interfering with nutrient absorption and leading to symptoms such as diarrhea, abdominal pain, and weight loss (Squire and Ryan, 2017).Diagnosing these infections often requires stool examinations to detect the presence of cysts or trophozoites, although advanced diagnostic techniques, such as PCR, ELISA, and antigen detection tests, can offer more accurate results (Hajissa *et al* 2020).

2.1.1.1 Entamoeba Histolytica

Entamoeba histolytica is an anaerobic parasitic amoebozoan within the genus *Entamoeba*, primarily infecting humans and other primates and causing amoebiasis. This infection, which leads to significant tissue destruction and clinical disease, affects approximately 35-50 million people worldwide, with an estimated 55,000 deaths annually (Rawat *et al.,* 2020). The trophozoite, or active stage of the parasite, thrives only within the host or in fresh, loose feces, whereas cysts can survive outside the host on moist surfaces, such as water, soil, and food. Infection typically occurs through ingestion of *E. histolytica* cysts, either by consuming contaminated water or food or through contact with contaminated surfaces or hands (Nayyef *et al.,* 2022). *E. histolytica* remains a pressing global health concern as the third leading cause of death from parasitic infections. Although approximately 90% of infections are asymptomatic, nearly 50 million cases develop symptoms annually, with up to 100,000 deaths. Among infected individuals, *E. histolytica* is responsible for pathogenic infections, such as amoebic colitis and extra intestinal amoebiasis, while *E. dispar*, a related species, is generally considered nonpathogenic and does not produce symptoms (Ghosh *et al.,* 2019).

2.1.1.2 Giardia lamblia

Giardia lamblia is a flagellated parasitic protozoan of the genus *Giardia* that inhabits the small intestine, leading to giardiasis, a diarrheal illness. The parasite attaches to the intestinal epithelium using a ventral adhesive disc and reproduces through binary fission (Adam, 2021). Giardiasis remains localized within the lumen of the small intestine, as the infection does not spread to the bloodstream or other parts of the gastrointestinal tract. *Giardia* possesses a robust outer membrane, enabling it to survive outside the host and resist chlorine disinfection. As anaerobes, *Giardia* trophozoites absorb nutrients directly from the intestinal lumen (Dixon, 2021). *Giardia* infections are a global concern, affecting around 200 million people annually and contributing to approximately 500,000 deaths each year. Between 2-5% in the developed nations and 20-30% in the developing countries (Hajare et *al*., 2022).

2.1.2. Intestinal helminthic parasite infection

Soil-transmitted helminth infections are among the most prevalent infections globally, predominantly affecting impoverished and underserved communities. The primary species infecting humans include roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and hookworms (*Necatoramericanus* and *Ancylostomaduodenale*) (Capello, 2004).Soil-transmitted helminths are commonly grouped together because they share similar diagnostic procedures, transmission routes, and treatment protocols. These infections are diagnosed through stool examinations to identify the presence of worm eggs, and treatment is usually administered using broad-spectrum ant-helminthic medications, such as albendazole or mebendazole, which are effective against all three main species of STH (WHO, 2022).

Despite their commonality, the clinical manifestations of these infections can vary depending on the worm burden and species. *Ascaris lumbricoides* infections, for example, can cause abdominal discomfort, intestinal obstruction, and growth retardation in children, while *Trichuristrichiura* infections may lead to chronic diarrhea, rectal pro-lapse and impaired cognitive development. Hookworm infections are particularly dangerous because they can cause significant blood loss, leading to iron-deficiency anemia, which is especially harmful to pregnant women and children (Hotez *et al*., 2008).

These soil-transmitted helminth (STH) species are typically treated as a group because they share similar diagnostic methods and respond to the same medications. Globally, over 1.5 billion people, or 24% of the world's population, are infected with soil-transmitted helminths. These infections are prevalent in tropical and subtropical regions, with the highest numbers found in sub-Saharan Africa, China, and East Asia. More than 267 million preschool-aged children and over 568 million school-aged children reside in areas with high transmission rates of these parasites and require treatment and preventive measures (WHO, 2022).

The health impacts of soil-transmitted helminth infections are particularly severe in children, as they can lead to malnutrition, stunted growth, and impaired cognitive development. Chronic infections can contribute to a cycle of poverty by reducing children's ability to attend school and adults' ability to work, thereby limiting economic productivity at both individual and societal levels. In addition to their direct effects on health, STH infections weaken immune responses, increasing susceptibility to other diseases, including malaria and tuberculosis (Hotez *et al*., 2008).

Preventive measures for soil-transmitted helminth infections focus on improving sanitation, providing access to clean water, and promoting hygiene practices such as hand washing with soap. Mass de-worming campaigns have been widely implemented in endemic areas, particularly targeting school-age children, who are most at risk. These programs, supported by organizations like the WHO and various non-governmental organizations, aim to reduce the prevalence of these infections through periodic administration of ant-helminthic drugs, alongside efforts to improve public health infrastructure (WHO, 2022).

2.1.2.1 Ascaris lumbricoides

Ascaris lumbricoides is a nematode, or roundworm that parasitizes the human gastrointestinal tract. Worldwide, ascariasis is among the most common helminthic human infections with an estimated 800 million to 1.2 billion people infected and which causes more than 60,000 deaths annually. In fact, it is considered as one of the "neglected tropical diseases (NTDs) a diverse group of infectious diseases that exist in tropical and subtropical environments in 149 countries across the world, and which affect more than 1 billion individuals, costing developing economies billions of dollars each year (Hadush and Pal, 2016).

2.1.2.2 Hymenolepis nana

Hymenolepis nana is found worldwide. Infection by the worm is most common in children, in persons living in institutional settings, and in people who live in areas where sanitation and personal hygiene is inadequate. This can happen by ingesting fecally contaminated foods or water, by touching your mouth with contaminated fingers, or by ingesting contaminated soil. People can also become infected if they accidentally ingest an infected arthropod (intermediate host, such as a small beetle or mealworm) that has gotten into food (Muehlenbachs *et al*.,2015).Hymenolepis nana is cosmopolitan in distribution and is possibly the most common cestode parasite of humans in the world, especially among children. It is prevalent worldwide with estimates of at least 50 to 75 million people infected (Al-Daoody *et al*., 2016).

2.2 Prevalence of Intestinal Parasite Infections in Ethiopian Communities

In Ethiopia, intestinal parasites are prevalent due to factors such as poverty, poor personal hygiene, poor environmental sanitation, overcrowding, lack of access to safe drinking water, and limited knowledge about health practices. Evaluating the morbidity patterns of intestinal parasites in low-income countries like Ethiopia is crucial for designing effective intervention programs that aim to reduce the disease burden (Workineh $et\ al.,2022$).

Numerous studies have been conducted across different regions of Ethiopia to assess the prevalence of intestinal parasite infections and the associated risk factors. For instance, a cross-sectional study conducted in Jimma Health Center found that the overall prevalence of intestinal parasite infections was 20.6%, with a higher infection rate among females (68%) compared to males (32%). The study identified eight types of intestinal parasites, with *Giardia lamblia* being the most prevalent (6.5%), followed by *Ascaris lumbricoides* (5.7%).

Single infections were more common, found in 17.4% of the patients, while 3.1% had double infections (Belete *et al.,* 2021).

In Southern Ethiopia, a retrospective study at Hawassa University Students' Clinic showed that of the 13,679 patients who visited the clinic for stool examinations, 47.9% tested positive for intestinal parasites. The prevalence of helminth infections was 20.3%, while protozoan infections were more common at 27.6%. The most frequently identified parasites were *Entamoeba histolytica/dispar* (18.0%), *Ascaris lumbricoides* (15.0%), and *Giardia lamblia* (9.6%) (Menjetta *et al*., 2019).These high rates of infection are largely attributable to poor socioeconomic conditions, inadequate water supply, and lack of knowledge about parasite transmission, which are common challenges in many low-income countries.

Similarly, a study conducted in Adama, Oromia region, reported an overall prevalence of 20.1% among students. Two protozoa and three helminth species were detected, with *Entamoeba histolytica* (13%) and *Giardia lamblia* (6.5%) being the predominant species. Factors such as eating raw vegetables, walking bare foot, and poor hygiene practices were significantly associated with the risk of infection (Zemene *et al*., 2022).

In Northwest Ethiopia, a study focusing on pregnant women revealed a high prevalence of intestinal helminth infections, with 21.1% of the participants infected. The study also highlighted a low rate of preventive and control practices among the women, with only 17.8% practicing proper hand washing after using the toilet and 22.2% regularly wearing shoes (Shiferawu *et al*., 2017).

A school-based study in Debrebirhan, Amhara region, showed that 52.9% of the 645 participating children were infected by one or more intestinal parasites, with helminths (33.8%) being more prevalent than protozoa (20%). The predominant parasites were *Ascaris lumbricoides* (22.6%), *Entamoeba histolytica/dispar* (18.1%), and *Hymenolepis nana* (5.7%).

Risk factors such as poor hygiene, playing with wastewater, and open defecation sites near residences were significantly associated with the prevalence of infections (Hailu and Tesfahun, 2021).

A similar school-based study in Gondar, Amhara region, found that 34.2% of 304 students were infected with one or more intestinal parasites. The infection rate was higher in females (35.9%) compared to males (32.1%), and the highest prevalence was observed in children aged 10–12 years. The dominant parasite was *Hymenolepis nana* (13.8%), followed by *Entamoeba histolytica/dispar* (9.2%) and *Ascaris lumbricoides* 5.9% (Gelawu *et al.,* 2013).

In a rural area of Ethiopia, a study on school-age children (6–14 years old) found an overall prevalence of 74.5% for intestinal parasitic infections. The most common parasites identified were *Entamoeba histolytica/dispar/moshkovskii* (35.9%), *Giardia lamblia* (25.5%), and *Ascaris lumbricoides* (12.5%). Multiple infections were present in 28.6% of the children (Bimerkas, 2018).Chagni town, Northwest Ethiopia, a community-based study of food handlers revealed a prevalence rate of 14.75% for intestinal parasites, with *Entamoeba histolytica* (57.63%) and *Ascaris lumbricoides* (18.64%) being the most common species. Factors such as lack of regular hand washing before meals and poor personal hygiene practices were significantly associated with the risk of infection (Alemu *et al.,* 2019).

In Northern Ethiopia, a study of food handlers in Tigray region found a prevalence of 33.2% for intestinal parasites. The most common parasites were *Entamoeba coli* (37.4%), *Entamoeba histolytica/dispar* (18%), and *Giardia lamblia* (12.8%). Helminth infections included *Schistosoma mansoni* (6%) and *Hymenolepis nana* (5.3%) (Regassa *et al.,* 2021).In a study conducted in Jimma town, Ethiopia, among 434 participants, the prevalence of intestinal parasitic infections (IPIs) was found to be 48.2% (209 out of 434). The most frequently detected parasite was *Ascaris lumbricoides*, identified in 27.6% (120 individuals) of the participants, followed by *Trichuristrichiura*. The protozoan parasite *Entamoeba histolytica/dispar* was also prominent, detected in 5.5% (24 individuals) of the participants. Key predictors for IPIs included younger age (below 10 years), lack of formal education (illiteracy), a family income of less than 500 Ethiopian Birr, and inconsistent hand washing practices before meals. These factors were identified as independent predictors contributing to the high prevalence of IPIs in the area. (Ayalew *et al.,* 2014).

A cross-sectional study conducted among children at Yadot Primary School in Delo-Mena district, Bale Zone, southeastern Ethiopia, found an overall intestinal parasitic infection (IPI) prevalence of 26.2% based on microscopic stool examinations. Among the ten identified species of intestinal parasites, *Schistosoma mansoni* was the most common, detected in 12.6% of students, followed by *Entamoeba histolytica/dispar* (5%), *Ascaris lumbricoides* (4.7%), and *Hymenolepis nana* (4.4%). Instances of multiple infections were also observed: 4.7% of students had double infections, 1.2% had triple infections, and 0.3% had quadruple infections. The study highlighted those students unaware of the reasons for hand washing before meals showed significantly higher rates of IPIs. Additional risk factors included water-related activities, such as swimming and fishing, and not wearing protective footwear, which increased exposure to IPIs in the study area (Tulu *et al*., 2014).

In a study among school children in Homesha District, Benishangul-Gumuz Regional State, western Ethiopia, the overall prevalence of intestinal parasitic infections (IPIs) was 35.44%. *Entamoeba histolytica/dispar* was the most frequently identified parasite, affecting 14.17% of participants, followed by *Giardia lamblia* at 12.65% and hookworm at 10.2%. Key risk factors significantly associated with IPIs in this study included poor hand washing habits, consumption of unwashed or undercooked vegetables, inadequate waste disposal, lack of shoe-wearing, and irregular fingernail trimming practices. These findings highlight the importance of hygiene and sanitation practices in reducing the risk of IPIs in this population (Gebremichael, 2016).

A study conducted in Axum town, northern Ethiopia, examined 404 fecal samples from school children and identified nine species of intestinal parasites, with an overall prevalence of 44.6% (108/404). The most common parasites were *Entamoeba histolytica* (17%), *Giardia lamblia* (14%), and *Ascaris lumbricoides* (9%). Infection rates were highest among children aged 9–14 years (24.3%), followed by those aged 5–9 years (20%), with only 0.2% infection observed in the 15–19-year age group, though differences between age groups were not statistically significant. Multivariate logistic regression analysis indicated that low household income, lack of hand washing after defecation and before eating, and the practice of consuming unwashed or uncooked vegetables were significant predictors of IPIs in this population (Gebreslassie *et al.,* 2015).

A cross-sectional survey, involving 463 school children, was conducted in Gurage Zone, south Ethiopia. According to this research the overall prevalence for at least one intestinal parasitic infection was 42.1 % (195/463). The most frequent intestinal parasitic species were *G. lamblia*, *A. lumbricoides* and *E. histolytica* with a prevalence of 47.7 %, 19.0 % and 11.8 %, respectively. Several independent predictors were identified as contributing factors for intestinal parasitic infections (IPIs) in the study area. These included being female, the rural location of the school, and poor sanitation practices, such as infrequent use of latrines and lack of hand washing after defecation. Additional risk factors were observed, such as hand washing inconsistently or not at all before meals, infrequent use of shoes, and untrimmed fingernails. Collectively, these factors underscore the significant role of behavioral and environmental influences on IPI prevalence, highlighting the need for improved hygiene and sanitation initiatives, particularly in rural school environments (Admasu *et al*., 2017).

2.3. Associated Risk factor for the prevalence of intestinal parasitic infection

Intestinal parasitic infections (IPIs) represent a significant global health challenge, particularly in developing countries. These infections disproportionately affect the poorest communities in low- and middle-income nations, where they often have a more substantial impact than bacterial infections (Thomas *et al.,* 2015; Mandakini *et al* 2014).Several risk factors for HIPIs in poor communities have been well documented. Among others, poverty-related factors (poor sanitation, scarcity of potable water, unsafe human waste disposal systems, and open-field defecation), conducive environmental conditions for the parasites, lack of adequate health services, and low level of awareness are the contributing factors for the high rate of HIPIs (Gebreyohanas *et al*.,2018).

The prevalence of IPIs is largely influenced by socioeconomic factors, with poorer sanitation, inadequate health facilities, and malnutrition significantly exacerbating the situation (Unasho *et al.,*2013).Several key factors contribute to the high prevalence of IPIs in tropical and subtropical regions, including increasing population density, poor sanitation conditions, lack of public health education, inadequate toilet facilities, and consumption of contaminated food and water (Tigabu *et al*.,2010; Gelawu *et al*.,2013).

A study by Bimerkas (2018) highlights that children aged 10-14 years, particularly males with poor hand washing practices, untreated water sources, and the use of pit latrines, are significantly more likely to contract IPIs. This underscores the role of behavioral practices in the transmission of these infections. In developing countries including Ethiopia, intestinal parasitic infection is one of the ten top major public health problems. The factors such as low living standards, poor environmental sanitation, and unsafe human waste disposal systems, inadequate and lack of safe water supply and low socio economic status results in high prevalence rate of IPIs in Ethiopia (Tilahun *et al.,* 2014).

The risk factors associated with IPIs are multifaceted, intertwining socioeconomic status, educational attainment, hygiene practices, and dietary habits (Feleke and *et al*., 2021) found a strong correlation between lower education levels and higher rates of infection, suggesting that individuals with limited knowledge about hygiene and sanitation are more likely to engage in behaviors that facilitate transmission. Moreover, households with lower income levels often lack access to clean water and adequate sanitation facilities, further exacerbating their risk of infections (Mekonnen *et al.,* 2020).For instance, in Ethiopia, a study indicated that individuals from low-income households were more than twice as likely to contract IPIs compared to those from higher-income backgrounds (Alemayehu *et al.,* 2017).

Hygiene practices are critical in preventing IPIs. Studies have demonstrated that poor hand washing significantly increases the likelihood of infection. Individuals who do not wash their hands after using the toilet exhibit much higher infection rates, highlighting the need for improved hygiene education and practices Additionally, dietary habits, such as the consumption of raw or undercooked food, have been linked to increased infection rates (Mulugeta *et al.,* 2020). The WHO estimates that approximately 800 million people lack access to safe drinking water, leading to 4.5 million deaths annually from preventable diseases (WHO, 2017). The interplay between these factors illustrates the complexity of addressing IPIs, as they are not merely health issues but also manifestations of broader socioeconomic disparities.

In Ethiopia, the prevalence of parasitic infections is alarming, with a considerable proportion of cases attributed to poor sanitation and hygiene practices. Prevalence of intestinal parasites in certain areas of Ethiopia was as high as 60%, with many localities still lacking comprehensive prevalence data (Firdu *et al.,* 2014). This highlights a critical gap in knowledge that impedes effective intervention strategies. A recent study indicated that WASH (Water, Sanitation, and Hygiene) promotion could significantly reduce the incidence of IPIs by improving community hygiene practices and access to clean water (Oswald *et al.,* 2017).

Implementing comprehensive WASH programs involves not only physical improvements to infrastructure but also community education on hygiene practices, which is crucial for sustainable health improvements. In conclusion, the multi-factorial nature of intestinal parasitic infections necessitates a holistic approach to understanding and addressing their prevalence. The relationship between socioeconomic factors, educational attainment, hygiene practices, and dietary habits emphasizes the need for targeted public health interventions. Strengthening WASH programs and improving health education in vulnerable communities can significantly mitigate the impact of IPIs, ultimately contributing to better health outcomes in these populations (Oswald *et al.,* 2017).

2.4.Prevention and controlling methods for intestinal parasite infections

A) Personal hygiene

The World Health Organization (WHO) defines hygiene as the conditions and practices that contribute to maintaining health and stopping the transmission of illnesses. Personal hygiene specifically refers to practices that focus on keeping the body clean. Essential activities within personal hygiene include regular hand washing, dental care, and bathing. According to Bloomfield *et al.* (2012), hygiene practices can be categorized into several types: home and everyday hygiene, personal hygiene, medical hygiene, sleep hygiene, and food hygiene.

Home and everyday hygiene involves maintaining cleanliness in domestic settings through practices such as hand washing, respiratory hygiene (covering the mouth when sneezing or coughing), kitchen hygiene, bathroom sanitation, and proper handling of laundry. Hand washing is particularly significant, as it is one of the most effective ways to prevent infections and the spread of pathogens. Food hygiene includes ensuring the cleanliness of food preparation areas and the proper handling, cooking, and storage of food to prevent food borne illnesses. Medical hygiene, both at home and in healthcare settings, involves practices like sterilization and the safe disposal of medical waste to avoid infection. Sleep hygiene, while often overlooked, refers to habits that promote quality sleep, which is crucial for maintaining mental and physical health (Bloomfield *et al*., 2012).

B) Appropriate Latrine facilities

Properly built and maintained pit latrines play a crucial role in reducing the spread of diseases by limiting the exposure of human feces in the environment, particularly in areas where open defecation is common. This reduction helps to minimize the transmission of pathogens from feces to food via flies, which are significant carriers of infectious diseases. These pathogens, including those causing infectious diarrhea and intestinal worm infections, are major public health concerns. Infectious diarrhea, for instance, accounted for about 700,000 deaths among children under five in 2011, and contributed to an estimated 250 million lost school days. Pit latrines, being a low-cost and effective sanitation solution, are a key method for separating human waste from people, thereby decreasing disease transmission (Oloruntoba *et al.,* 2019*)*.

C) Avoiding contamination of food

The spread of food borne diseases begins with the disease's characteristics, contaminating the food and posing a risk to both individual and public health. Safe food is defined as food that retains its nutritional value, is physically, chemically, and microbiologically cleans, and is fresh. Factors leading to food contamination can jeopardize its safe consumption, rendering it harmful to human health. Therefore, various resources must be employed to prevent contamination at every stage of the food chain, from harvest to consumption (Ucar *et al.,* 2016).

D) Purification of drinking water

Water purification can reduce the concentration of particulate matter including suspended particles, parasites, bacteria, algae and fungi, and as well as reduce the concentration of a range of dissolved and particulate matter (Treacy, 2019).

According to a 2007 (WHO) report, Approximately 1.1 billion people lack access to improved drinking water sources. Unsafe water, coupled with poor sanitation and hygiene, accounts for 88% of the 4 billion annual cases of diarrheal disease, resulting in 1.8 million deaths each year. According to the World Health Organization, 94% of these cases could be prevented through environmental improvements, including access to safe water. Simple home-based water treatment methods, such as chlorination, filtration, solar disinfection, and safe storage practices, have the potential to save a significant number of lives annually (Treacy, 2019).

E) Avoid eating raw fruits and vegetables

The consumption of unclean, raw, or undercooked fruits and vegetables is a key pathway for the spread of intestinal parasitic infections. These foods can act as carriers for parasites when contaminated at various stages of their journey, from planting and growth in the field to harvesting, transportation, storage, market handling, and even within the home (omowaye and Audu, 2012).

F) Public health education

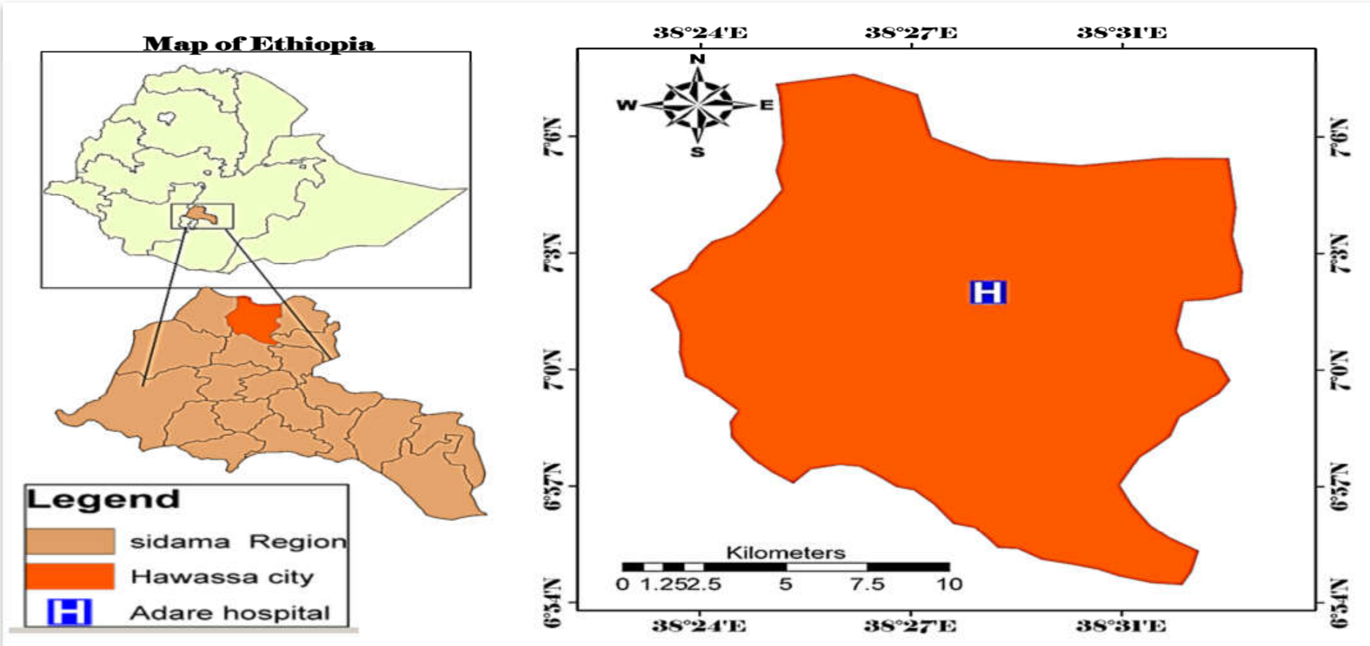
Many mass de-worming programs also combine their efforts with a public health education. These health education programs often stress important preventative techniques such as: washing your hands before eating, and staying away from water/areas contaminated by human feces. These programs may also stress that shoes must be worn; however, these come with their own -health risks and may not be effective (Howell, 2010).

3. MATERIALS AND METHODS

3.1 Description of Study Area

This study was conducted at Adare Hospital, located in Hawassa, the capital of the Sidama region, Ethiopia. Hawassa is situated approximately 275 kilometers south of Addis Ababa, the capital city of Ethiopia, and lies at an altitude of around 1,700 meters (5,577 feet) above sea level. The city's geographical coordinates are 7.0542° N latitude and 38.4783° E longitude. Hawassa is surrounded by scenic landscapes, including hills and mountains, with Mount Tabor rising to an elevation of 3,000 meters (9,843 feet) to the east of the city. The climate in Hawassa is generally mild, with average temperatures ranging from 15°C (59°F) to 25°C (77°F) throughout the year.

According to the 2007 Census conducted by the Central Statistical Agency of Ethiopia, the total population of Hawassa was 258,808, with 133,123 males and 125,685 females. The population density of the city was approximately 5,200 people per square kilometer. Adare Hospital in Hawassa is a well-equipped medical facility that serves the healthcare needs of the city and the surrounding areas. The hospital has several departments, including emergency care, general medicine, surgery, pediatrics, gynecology, and obstetrics. Overall, Adare Hospital provides quality healthcare services to the local population.



3.2. Study Design and period

A health facility-based cross-sectional study was conducted from April to June 2024. To assess the prevalence of intestinal parasitic infections, to identify the different species of intestinal parasites and identify associated risk factors among patients attending Adare Hospital in Hawassa Ethiopia. The study employed random sampling to select the study population, with stool samples collected from participants for parasite detection. Socio demographic, socioeconomic and practices concerning hygiene and sanitation data were gathered through interviews and questionnaires, Adare Hospital was chosen due to its extensive experience and high client volume compared to other public hospitals in the region.

3.3 Study Population

The study population includes patients who present to the hospital with intestinal parasitic symptoms. The study includes both adult and pediatric patients who are referred to the hospital for diagnostic testing and treatment of intestinal parasitic illnesses. Both males and females are included in the study. The patients come from diverse socio-economic backgrounds.

3.4 Inclusion criteria and Exclusion criteria

Inclusion criteria

In This study conducted at Adare Hospital on the prevalence and risk factors of intestinal parasitic infections included participants based on specific criteria. Patients of all ages were eligible if they were admitted to the hospital or attended outpatient clinics and exhibited symptoms of intestinal parasitic infections, such as diarrhea, abdominal pain, nausea, vomiting, or weight loss. Those who had not received antiparasitic treatment in the preceding three months were considered. Participation also required informed consent, willingness to provide stool samples for laboratory analysis, and completion of a questionnaire detailing demographic information, medical history, and potential risk factors for parasitic infections

Exclusion criteria

As exclusion criteria were, patients who received anti- parasitic medication for the last 3 months will excluded from the study.

3.5 Sample size calculation and Sampling Methods

3.5.1 Sample size calculation

The sample size was estimated using the single proportion formula(Charan and Biswas ,2013)

$$\mathbf{n} = \frac{\mathbf{Z2\ P(1-P)}}{\mathbf{d2}}.$$

Where **d** represents the margin of error (0.05), **p** denotes the population proportion (50%), and Zα/2is the critical value of the standard normal distribution at α/2 a 95% confidence interval, α=0.05, resulting in a critical value of 1.96. Additionally, a 10% non-response rate is accounted for in the sample size estimation.

$$\mathbf{n} = \frac{(\mathbf{1.96})\mathbf{2}\ \ \mathbf{0.5}(\mathbf{1}-\mathbf{0.5})}{(\mathbf{0.05})\mathbf{2}} = 384$$

Non-response rate: 384+10(384) =422

Thus, the sample size was estimated to be 422.

3.5.2 Sampling technique

Participants for the study were selected through a simple random sampling method, ensuring that every eligible individual had an equal and unbiased chance of being included. This approach involved assigning unique identification numbers to all eligible participants from the study population. A computer-generated randomization process or a lottery system was then used to select participants without any subjective influence. The sampling process was repeated until the required sample size was achieved, ensuring that the selected participants were representative of the study population. This method helped minimize selection bias and maintain the validity and reliability of the study findings.

3.6 Study variable

In this study, the prevalence of intestinal parasitic infections was the dependent variable, assessed through laboratory analysis of stool samples from participants. The independent variables included socio-demographic and socio-economic factors such as age, education level, residence, monthly income, and occupation. Additionally, potential risk factors such as hand washing practices, access to clean water, shoe-wearing habits, method of cleaning after toilet and consumption of unwashed fruits/vegetables/meat were considered.

3.7 Methods of data collection

3.7.1 Stool sample collection and Laboratory Procedures

Orientation was given to a representative sample of individuals on how to collect a sufficient amount of contamination-free stool specimens. Each study participant received a labeled disposable plastic cup and applicator stick to collect approximately 3–4 grams of stool. A unique code was assigned to each participant's cup, and the stool samples were then processed to identify parasite species.

Direct Microscopy (Wet Mount) Method

Approximately 2 milligrams of stool sample was mixed with a small volume of normal saline solution to form an emulsion. A drop of this mixture was then placed on a microscope slide, followed by the addition of iodine to enhance visibility. The preparation was covered with a cover slip. Each slide was first be examined under 10× magnification, followed by 40× magnification, for the precise identification of intestinal parasites, in accordance with the World Health Organization's 2003 guidelines, which were reviewed in 2020 (WHO, 2020).

Formal-Ether Concentration Method

To prepare the stool sample for examination, 1 gram of the specimen was mixed with 7 ml of 10% formalin in a centrifuge tube. The mixture was stirred thoroughly with an applicator stick. The suspension was then filtered through a sieve into a beaker, and the filtrate was poured back into the tube. Next, 3 ml of di-ethyl ether was added to the mixture, the tube was closed, and it was shaken vigorously. The tube was centrifuged at 1500 rpm for 2 minutes. After centrifugation, the supernatant (layers of ether, debris, and formalin) was discarded, and the sediment containing parasites at the bottom of the tube was re-suspended. Finally, the sediment was transferred to a slide using a Pasteur pipette and examined under 10× and 40×

magnification lenses for the presence of intestinal parasites according to the provided instructions (WHO 2020).

3.7.2 Data Collection by questionnaire.

We created a semi-structured questionnaire in English based on established and potential factors related to the study objectives. After reviewing relevant literature, the questionnaire was translated into the local Amharic language by two independent translators who were proficient in both languages and were health professionals. This process aimed to ensure clarity, consistency, and accuracy of the questions. Data on socio-demographic and related factors were gathered in alignment with local cultural norms.

3.8 Data quality assurance

The quality of data was assured by applying a properly designed and pre-tested questionnaire. The data tool was pre-tested on 5% of the sample size at Hawassa referral hospital before the actual data collection to establish its ability to elicit relevant information, and after the pretest, necessary corrections were made. In addition, categorization and coding of the questions were made. Regular supervision and follow-up were carried out by the principal investigator and supervisor. Additionally, regular check-ups for completeness and consistency of the data were made on a daily basis, and the consistency of the questionnaire was checked. Incomplete questionnaires were discarded and considered as non-response rate.

3.7 Data Analysis

The data collected from laboratory analysis and questionnaire surveys were entered into a database and analyzed using statistical software. The information was checked, coded, and inputted in to SPSS version 27 for further analysis. Prior to analysis, the data were reviewed for outliers, missing values, and cleaned. Descriptive statistics such as frequencies and proportions were used to characterize the study population based on relevant variables. Logistic regression was utilized to assess statistical associations through Odds ratios, with significance determined using a 95% confidence interval and a P-value of less than 0.05. Bivariate and Multivariate analyses were conducted to explore relationships between the outcome variable and selected independent variables. Results were presented through tables, figures, and text. Variables with a p-value less than 0.05 in the multivariate analysis were considered statistically significant.

3.8 Ethical considerations

Ethical approval was obtained from College of natural and computational science research ethics review committee (RERC) and permission was obtained from Adare Hospital Hawassa. The study adhered to ethical principles and guidelines for conducting research involving human subjects. Informed consent was obtained from all participants prior to their participation in the study. Participants were informed of the study's purpose, potential risks and benefits, and their right to withdraw from the study at any time. Confidentiality was maintained throughout the study, and all data collected were kept secure and only accessible to the research team.

4. RESULTS

4.1 Socio-demographic characteristics of Study participants

This study included 422 participants, achieved a 100% response rate in both completed questionnaires and provided stool samples. The study investigated the socio-demographic characteristics, hygiene practices, and prevalence of parasitic infections among 422 participants. Participants' ages ranged from 0 to over 60, the population is predominantly young, with 42.7% aged 30-59 years and 24.9% aged 16-30years, reflecting a significant portion in their working or schooling years. Females make up 53.8% of the population, slightly outnumbering males. Education levels vary, with 27.7% having completed Grade 7-12 and 19% having education beyond Grade 12, while 14.9% are unable to read or write.

A vast majority (96.2%) reside in Hawassa, with 53.4% living there since birth, indicating a stable population base. The most common family income range is 3001-7000 NTS (44.3%), suggesting a middle-income majority, while 7.3% live in poverty with incomes fewer than 1000 NTS. Households are typically medium-sized, with 53.8% having 4-6 members, and most homes have 4-5 rooms (54%). The population's occupational profile is diverse, with students comprising the largest group (26.5%), followed by daily laborers (19.4%) and the unemployed (15.2%)(Table1).

Table 1 Socio-demographic characteristics of the study participants (n=422) at adare hospital from April to June 2024

Variable	Categories	Number	Percent
Age	0-5	35	8.2
	6-15	35	8.2
	16-30	105	24.9
	31-59	180	42.7
	>60	67	15.9
Gender	Female	227	53.8
	Male	195	46.2
Level of education	Unable to read/write	65	15.35
	Able to read/write	65	15.35
	Grade 1-6	95	22.5
	Grade 7-12	117	27.7
	Beyond grade 12	80	19.0
Reside in Hawassa	Yes	406	96.2
	No	16	3.8
Duration of residence in Hawassa	Since Birth	225	53.4
	Few years ago	69	16.4
	Half of my life	128	30.2
Family income (NTS)	<1000	31	7.3

	1001-3000	144	34.1
	3001-7000	187	44.3
	> 7000	60	14.2
Household size	1-3	138	32.7
	4-6	227	53.8
	>7	57	13.5
Number of rooms in the home	1	38	9.0
	2	87	20.6
	3	52	12.3
	4	122	28.9
	5	106	25.1
	6	17	4.0
Occupation	Student	112	26.5
	Unemployed	64	15.2
	Daily labor	82	19.4
	Housewife	46	10.9
	Farmer	22	5.2
	Merchant	49	11.6
	Government employee	29	6.9
	Others	18	4.3

4.2 Behavioral and Sanitation related characteristics of the study participants

The data highlights a mix of hygiene and dietary practices among the population. While 40% wash their hands 3-5 times daily and 70.9% wash after using the toilet, 29.1% do not, indicating gaps in hygiene. Most use toilet paper (50.2%) or both toilet paper and water (26.5%) for self-cleaning, and 95.3% wear shoes in public restrooms, showing good public hygiene habits. However, 76.3% rarely have access to clean water, which affects personal hygiene. Dietary habits also pose risks, with 57.8% consuming raw or undercooked meat or fish, (38.4%) consumed raw/undercooked fruits and vegetables, which, if not properly washed, could harbor parasites, adding to infection risks. and 40% drinking untreated water, 38.4% consumed unpasteurized milk or dairy products. two-thirds (66.8%) reported eating food left out for extended periods Additionally, 76.1% have had parasitic infections. The overall picture suggests a population facing significant health risks due to inadequate hygiene practices, unsafe food consumption, and limited access to clean water (Table 2).

Table2 Behavioral and Sanitation related characteristics of the study participants at adare hospital from April to June 2024

Variables	**Categories**	**Number**	**Percent**
Number of times hands are washed daily	More than 10 times	52	12.3%
	6-10 times	105	24.9%
	3-5 times	169	40%
	Less than 3 times	96	22.7%
hand washing after toilet	No	123	29.1%
	Yes	299	70.9%
method of self-cleaning after toilet	Toilet paper	212	50.2%
	Water	98	23.2%
	Both	112	26.5%
Wearing shoes in public toilets or bathrooms	Always	402	95.3%
	Sometimes	16	3.8%
	Rarely	4	0.9%
Access to clean water for personal hygiene	Always	22	5.2%
	Sometimes	78	18.5%
	Rarely	322	76.3%
consuming raw (undercooked) meat or fish	Yes	244	57.8%
	No	178	42.2%
consuming raw (undercooked) fruits and vegetables	Yes	162	38.4%
	No	260	61.6%
Drinking untreated or un-boiled water from natural sources	Yes	169	40%
	No	253	60%
Habit of drinking unpasteurized milk or dairy products	Yes	162	38.4%
	No	260	61.6%
Eating food left at room temperature for more than two hours	Yes	282	66.8%
	No	140	33.2%
Diagnosed with a parasitic infection in the past	Yes	321	76.1%
	No	101	23.9%

4.3 Prevalence Of Intestinal Parasitic Infections

Of 422 stool specimens, 152(36.0%) were found to be positive for one or more parasite species.

Based on microscopic stool sample examinations, four species of intestinal parasites were identified from the respondents. The most prevalent parasite identified was *G. lamblia* 60(14.9%), *E. histolytica /dispar* 44(10.4%) followed by *A. lumbricoides* 32(7.6%). Less frequent identified intestinal parasite species was *H.nana* species. Among 152 positive Participant 16(3.8%) had double infections (figure 3).

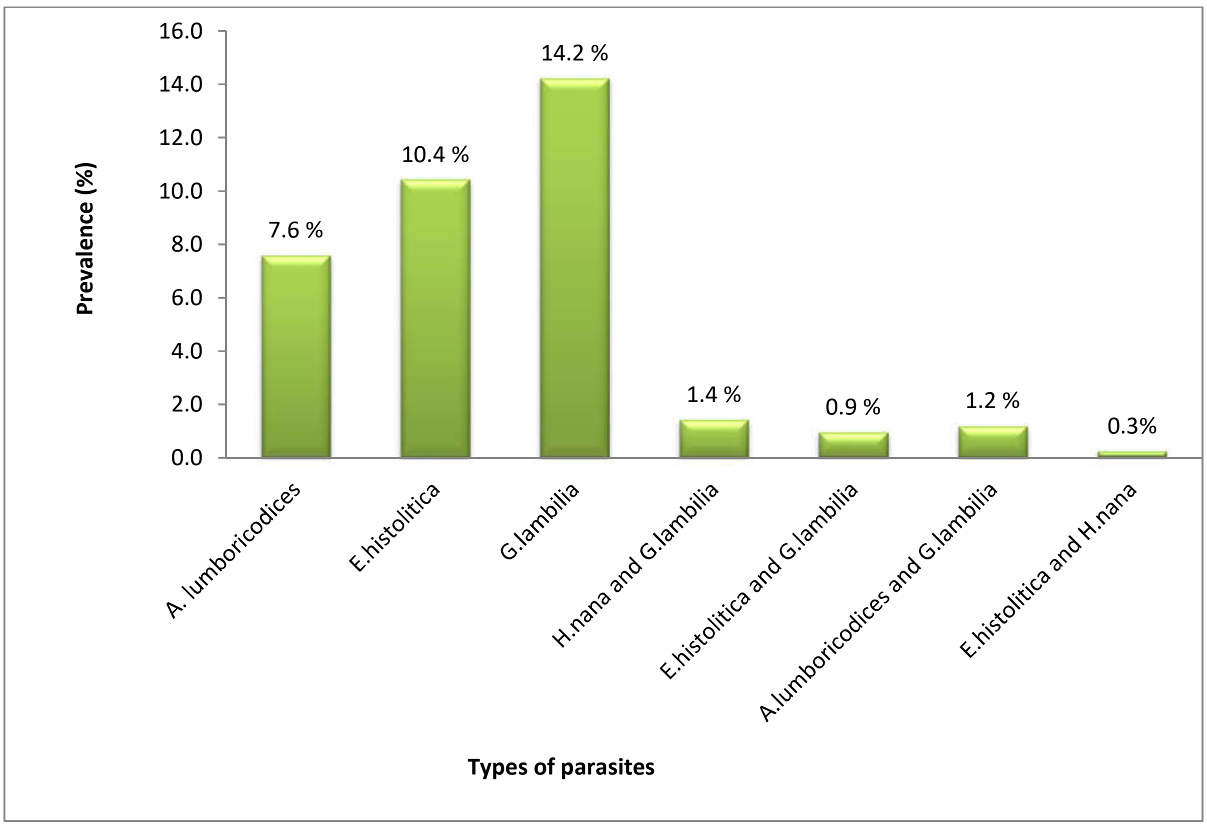


Figure3: Prevalence of parasitic infection in the study participants at Adare hospital from to April to June 2024.

The data collected from patients reveals the different stages of the parasite found in individuals seeking medical attention. Among the patients, 30 (19.7%) were identified to have the ova stage of the parasite, while 36(25.7%) had the cyst stage. The majority of patients, accounting for 77(50.7%), were diagnosed with the tropozoite stage of the parasite. Furthermore, a small percentage of patients, specifically 16(3.9 %,) were found to have both ova and tropozoite stages of the parasite. This data highlights the prevalence of the tropozoite stage among patients visiting the hospital, followed by the cyst and ova stages, with a minority showing a co-occurrence of ova and tropozoite stages(figure 4).

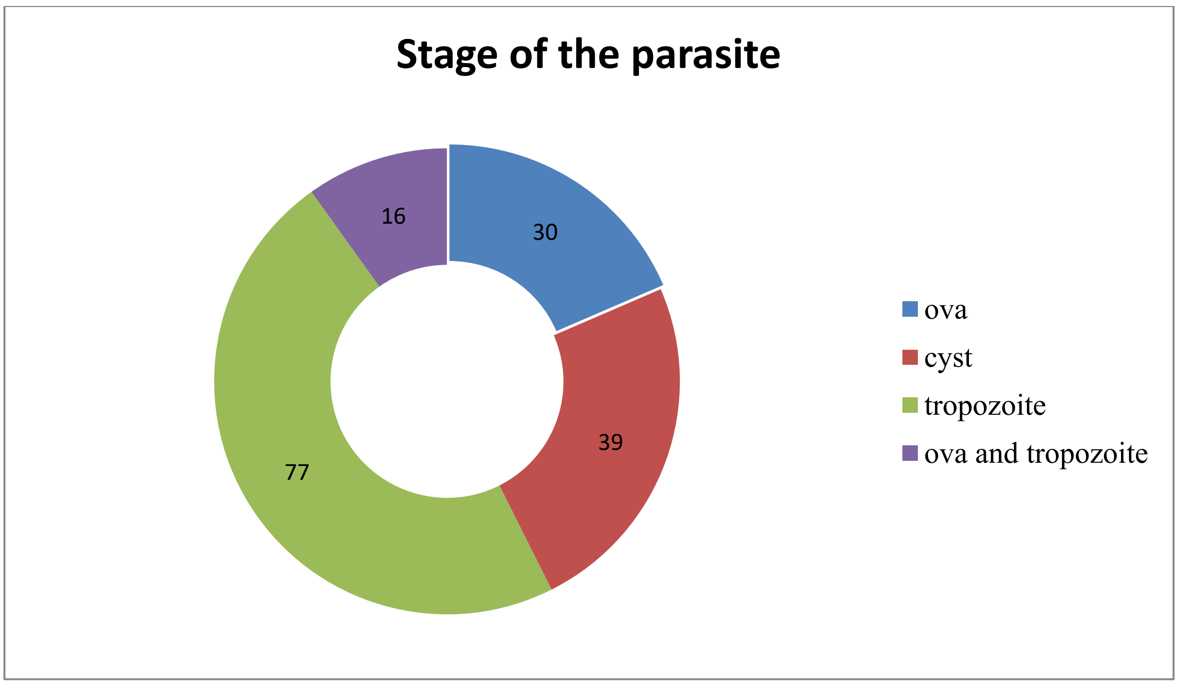


Figure4: Stage of the prevalent parasite detected in the study participants at Adare hospital from to April to June 2024.

4.4 Risk Factors Associated with Intestinal Parasitic Infection

4.4.1Bivariate analysis of different associated factors

We conducted a bi-variate analysis of various factors linked to parasitic infections within a population. Younger children (0–12 years) have the highest rate of parasitic infections (67.1%), followed by those aged 13–18 (34.3%). The lowest infection rates are observed in the age group 19-59 years) at 27.8%. This age-based difference in infection rates is statistically significant (p = 0.000). The occurrence of parasitic infections is slightly higher in females (55.9%) compared to males (44.1%), but this difference is not statistically significant (p = 0.510). There is a no significant correlation between education levels and higher rates of parasitic infections (p = 0.421). There is no significant difference in infection rates between those residing in Hawassa and those living elsewhere (p = 0.235). The duration of residence in Hawassa does not significantly affect the rate of parasitic infections (p = 0.180). Individuals from lower-income families (<1000 NTS) have a significantly higher rate of parasitic infections (51.6%) compared to those from higher-income families. This correlation is significant (p = 0.002). Household size does not significantly influence the rate of parasitic infections (p = 0.701). The number of rooms in the household does not significantly impact infection rates (p = 0.991). Students show the highest rate of parasitic infections (49%), followed by unemployed individuals (25%).The occupational difference is statistically significant (p = 0.001).Poor hand hygiene is strongly associated with higher rates of parasitic infections. Those who do not wash their hands with soap and water have significantly higher infection rates (61.3%) (p = 0.000).Similarly, individuals washing their hands less than 3 times daily have the highest infection rate (57.2%) (p = 0.604). A significant portion of individuals who do not wash their hands after using the toilet (45.1%) are more prone to parasitic infections (p = 0.000). Consuming raw or undercooked meat or fish, as well as unwashed fruits and vegetables, significantly increases the risk of parasitic infections (p = 0.006 and p = 0.000, respectively). Drinking untreated water (94.7%) and consuming unpasteurized dairy products (89.5%) are also strongly associated with higher infection rates (p = 0.000 for both). Leaving food at room temperature for more than two hours does not significantly affect the rate of parasitic infections (p = 0.395)(Table 3).

Table 3 Bivariate analysis of different associated factors of intestinal parasitic infections among patient visiting Adare hospital

Variable	**Categories**	**parasitic infection**		**Total no. (%)**	χ^2	**P-value**
		Positive no. (%)	**Negative no. (%)**			
Age	0-5	24(67.1%)	11(32.9%)	35(8.2)	1.172	0.000
	6-15	23(67%)	12(33%)	35(8.2)		
	16-30	36(34.3%)	69(65.7%)	105(24.9)		
	31-59	50(27.8%)	130(72.2%)	180(42.7)		
	>60	19(28.4%)	48(71.6%)	67(15.9)		
Gender	Female	85(55.9)	142(52.6)	227(53.8)	0.04	0.510
	Male	67(44.1)	128(47.4)	195(46.2)		
Level of education	Unable to read/write	48(30.3)	17(6.3)	65(14.9)	3.282	0.421
	Able to read/write	31(19.1)	34(12.3)	65(14.9)		
	Grade 1-6	47(30.9)	48(17.8)	95(22.5)		
	Grade 7-12	22(14.5)	95(35.2)	117(27.7)		
	Beyond grade 12	8(5.3)	72(26.7)	80(19.)		
Reside in Hawassa	Yes	144(94.7)	262(97.0)	406(96.2)	0.291	0.235
	No	8(5.2)	8(2.9)	16(3.7)		
Duration of residence in Hawassa	Since birth	85(56.3)	140(51.9)	225(53.4)	1.505	0.180
	Few years ago	18(11.9)	51(18.9)	69(16.4)		
	Half of my life	49(31.8)	79(29.3)	128(30.2)		
Family income (NTS)	<1000	16(51.6%)	15(48.4%)	31(7.3)	5.493	0.002
	1001-3000	56(38.9%)	88(61.1%)	144(34.1)		
	3001-7000	58(31%)	129(69%)	187(44.3)		

	>7000	22(36.7%)	38(63.3%)	60(14.2)		
Household size	1-3	66(43.4)	72(26.7)	138(32.7)	10.969	0.701
	4-6	66(43.4)	161(59.6)	227(53.8)		
	>7	20(13.2)	37(13.7)	57(13.5)		
Number of rooms in the home	1	34(22.4)	4(1.5)	38(9.0)	0.263	0.991
	2	49(32.2)	38(14.1)	87(20.6)		
	3	19(12.5)	33(12.2)	52(12.3)		
	4	30(19.7)	92(34.1)	122(28.9)		
	5	16(10.5)	90(33.3)	106(25.1)		
	6	4(2.6)	13(4.8)	17(4.0)		
Occupation	Student	50(49%)	52(51%)	112(26.5)	15.946	0.001
	Unemployed	15(25%)	45(75%)	64(15.2)		
	Farmer	27(32.9%)	43(67.1%)	82(19.4)		
	G. Employee	40(32%)	85(68%)	46(10.9)		
	Other	20(30.8%)	45(69.2%)	22(5.2)		
Habit of hand washing with soap and water	No	87(61.3%)	78(27.9%)	166(39.1)	43.136	0.000
	Yes	65(25.3%)	192(74.7%)	257(60.9)		
Number of times hands are washed daily	More than 10 times	4(2.6)	48(17.8)	52(12.3)	29.817	0.604
	6-10 times	8(5.3)	97(35.9)	105(24.9)		
	3-5 times	53(34.9)	116(43.0)	169(40.0)		
	Less than 3 times	87(57.2)	9(3.3)	96(22.7)		
hand washing after toilet	No	74(60.1%)	49(39.9%)	123(29.1)	26.227	0.000
	Yes	78(26.1%)	221(73.9%)	299(70.9)		
method of self-cleaning after toilet	Toilet paper	84(39.6%)	128(60.4%)	212(50.2)	0.439	0.048
	Water	33(33.7%)	65(66.3%)	98(23.2)		
	Both	35(31.3%)	77(68.7%)	112(26.5)		
Wearing shoes in public toilets or bathrooms	Always	144(94.7)	258(95.6)	402(95.3)	12.316	0.802
	Sometimes	8(5.3)	8(3.0)	16(3.8)		
	Rarely	0(0)	4(1.5)	4(0.9)		
Access to clean water for personal hygiene	Always	12(54.5%)	10(45.5%)	22(5.2)	22.01	0.033
	Sometimes	41(52.6%)	37(47.4%)	78(18.5)		
	Rarely	99(30.7%)	223(69.3%)	322(76.3)		
consuming raw (undercooked) meat or fish	Yes	79(32.4%)	165(67.6%)	244(57.8)	7.473	0.006
	No	73(41%)	105(59%)	178(42.2)		
consuming raw (undercooked) fruits and vegetables	Yes	124(81.6)	38(14.1)	162(38.4)	3.142	0.000
	No	28(18.4)	232(85.9)	260(61.6)		

Drinking untreated or un-boiled water from natural sources	Yes	144(94.7)	25(9.3)	169(40.0)	15.975	0.000
	No	8(5.3)	245(90.7)	253(60.0)		
Habit of drinking unpasteurized milk or dairy products	Yes	136(89.5)	26(9.6)	162(38.4)	16.893	0.000
	No	16(10.5)	244(90.4)	260(61.6)		
Eating food left at room temperature for more than two hours	Yes	101(35.8%)	181(64.2%)	282(66.8)	0.725	0.395
	No	51(36.4%)	89 (63.6%)	140(33.2)		
Diagnosed with a parasitic infection in the past	Yes	89(27.7%)	232(72.3%)	321(76.1)	21.078	0.000
	No	63(62.4%)	38(37.6%)	101(23.9)		

4.4.2 Multivariable analysis showing the associated factors of intestinal parasitic infections among patient who visit Adare hospital

Multivariable logistic analysis was conducted after adjusting variables which were statistically significant in binary logistic analysis and from the factors associated with intestinal parasites. (Table 4).

In terms of age, children aged 0-5 and 6-15 years have a higher risk of infection, as indicated by the adjusted odds ratio (AOR) of 1.509 (CI: 0.402-5.669, $p = 0.018$). This confirms a statistically significant association between this age group and higher IPI risk compared to the reference group (>60 years). The age groups 13-18 and 19-59 do not show significant associations with IPI risk. Household income also plays a notable role, with those earning below 1000 NTS having a greater likelihood of infection, shown by AOR (1.304, CI: 0.376-4.515, $p < 0.01$). This suggests that low-income households are at a heightened risk of IPIs, even when adjusted for other factors. Occupational status is significant as well. Students face an elevated risk of infection, with an AOR of 13.39 (CI: 3.77-47.495, p < 0.001), indicating a notably high infection risk among students compared to other occupations.

Hygiene practices, specifically hand washing with soap and water, show a protective effect against infection. The lack of hand washing significantly raises IPI risk, with AOR (0.188, CI: 0.053-0.665, p = 0.030), underscoring the importance of hygiene. Additionally, failing to wash hands after using the toilet correlates with higher infection rates, with an AOR of 0.663 (CI: 0.087-5.079, p = 0.021).Access to clean water emerges as another critical factor. Those with rare access to clean water have a significantly higher risk, indicated by AOR (3.436, CI: 2.639-6.777, p < 0.001), underscoring limited water access as a substantial risk factor for IPIs.

Dietary habits also affect infection likelihood. Individuals consuming raw meat or fish are at increased risk, with an AOR of 0.368 (CI: 0.117-0.440, p = 0.001), affirming this association even after adjustment. However, consuming raw fruits and vegetables does not show a significant association after adjustment, as reflected in an AOR of 1.096 (CI: 0.580-2.008, p = 0.811). Conversely, drinking untreated water is a significant predictor of IPIs, with an AOR of 0.205 (CI: 0.09-0.468, p < 0.001) confirming this association. (Table 4).

Table 4 Multivariable analysis showing the associated factors of intestinal parasitic infections at adare hospital Hawassa from april to June

Statistics							
Variables	**Categories**	**Positive**	**Negative**	**COR (CI 95%)**	**p-value.**	**AOR (CI 95%)**	**p-value.**
Age	0-5	24(67.1%)	11(32.9%)	0.809(0.390,1.676)	.000	1.509(0.402,5.669)	0.018
					.000.		
	6-15	23(67%)	12(33%)	0.808(0.391,1,66)	001	1;59(0.402,5,667)	0.017
	13-18	36(34.3%)	69(65.7%)		.055		
				0.759(0.389,1.4		0.208(0.065,0.6	0.00

				78)		61)	8
	19-59	50(27.8%)	130(72.2%)	0.717(0.389,1.324)		0.322(0.116,0.896)	0.030
	>60(ref)	19(28.4%)	48(71.6%)				
Family income (NTS)	<1000	16(51.6%)	15(48.4%)	2.272(1.035,4.991)	.041	1.304(0.376,4.515)	<0.00
	1001-3000	56(38.9%)	88(61.1%)	2.372(1.099,5.122)	.028	1.553(0.201,12.02)	0.02
	3001-7000	58(31%)	129(69%)	1.842(0.765,4.436)	.173	0.000	0.09
	>7000(ref)	22(36.7%)	38(63.3%)				
Occupation	Student	50(49%)	52(51%)	2.885(1.430,5.818)	.003	13.39(3.77,47.495)	0.000
	Unemployed	15(25%)	45(75%)	2.998(1.534,5.859)	.001	-	-
	Farmer	27(32.9%)	43(67.1%)	2.043(1.190,3.507)	.010	-	-
	G. Employee	40(32%)	85(68%)	2.163(1.125,4.162)	.021	-	-
	Other(ref)	20(30.8%)	45(69.2%)				
Habit of hand washing (soap and water)	No	87(61.3%)	78(27.9%)	0.248(0.162,0.381)	.000	0.188(0.053,0.665)	0.030
	Yes	65(25.3%)	192(74.7%)				
hand washing after toilet	No	74(60.1%)	49(39.9%)	0.325(0.210,0.504)	.000	0.663(0.087,5.079)	0.021
	Yes	78(26.1%)	221(73.9%)				
method of self-cleaning after toilet	Toilet paper	84(39.6%)	128(60.4%)	0.848(0.520,1.383)	.513	3.673(2.10,6.427)	<.001
	Water	33(33.7%)	65(66.3%)	0.895(0.502,1.597)	.708	1.509(0.339,6.710)	0.08
	Both(ref)	35(31.3%)	77(68.7%)				
Access to clean water	Rarely	12(54.5%)	10(45.5%)	1.083(0.419,2.799)	.000	3.436(2.639,6.777)	<.001
	Sometimes	41(52.6%)	37(47.4%)	3.142(1.311,7.529)	.010	0.000(0.000,0.000)	-
	Always(ref)	99(30.7%)	223(69.3%)				

consuming raw meat or fish	No	79(32.4%)	165(67.6%)	0.567(0.377,0.853)	.006	0.368(0.117,0.440)	0.001
	Yes	73(41%)	105(59%)				
consuming raw fruits &vegetables	Yes	124(81.6)	38(14.1)	0.669(0.429,1.045)	.030	1.096(0.580,2.008)	0.811
	No	28(18.4)	232(85.9)				
Drinking untreated water	No	144(94.7)	25(9.3)	0.244(0.117,0.510)	.000	0.205(0.09,0.468)	<.001
	Yes	8(5.3)	245(90.7)				
Habit of drinking unpasteurized milk	No	136(89.5)	26(9.6)	2.353(1.558,3.554)	.000	0.645(0.375,1.109)	0.113
	Yes	16(10.5)	244(90.4)0				
Eating food left at room for more than 2 hours	No	101(35.8%	181(64.2%)	0.831(0.543,1.272)	.002	1.265(0.771,2.075)	0.352
	Yes	51(36.4%)	89 (63.6%)				
Diagnosed parasitic infection in the past	No	89(27.7%)	232(72.3%)	0.347(0.219,0.551)	.000	0.827(0.413,1.657)	0.592
	Yes	63(62.4%)	38(37.6%)				

This analysis includes Crude Odds Ratios (COR), Adjusted Odds Ratios (AOR), Confidence Intervals (CI), and p-values to demonstrate the strength of associations between these factors and infection risk.

5. DISCUSSION

Assessing the magnitude of intestinal parasitic infections (IPIs) and identifying related risk factors is crucial for informing the development, implementation, and evaluation of effective prevention and control strategies (Beshir *et al.,* 2023). This study investigated the prevalence of IPIs and associated risk factors among patients attending Adare Hospital in Hawassa.

The findings of this study demonstrate a significant prevalence of intestinal parasitic infections (IPIs) in the population under investigation, with 36% of the stool samples testing positive for one or more species of intestinal parasites. Four species of intestinal parasites were identified two protozoan and two helminthes. The most prevalent parasite identified was G. lamblia 60(14.9%), *E. histolytica* /dispar 44(10.4%) followed by *A.lumbricoides* 32(7.6%). Less frequent identified intestinal parasite species Was *H.nana* species. Among 152 positive Participant 16(3.8%) had double infections. Single infections were more common, found in 32.2% of the patients, while 3.8% had double infections. Among the patients, 30 (19.7%) were identified to have the ova stage of the parasite, while 36(25.7%) had the cyst stage. The majority of patients, accounting for 77(50.7%), were diagnosed with the tropozoite stage of the parasite. Furthermore, a small percentage of patients, 16(3.9 %,) were found to have both ova and tropozoite stages of the parasite. This study highlights the prevalence of the tropozoite stage among patients visiting the hospital, followed by the cyst and ova stages, with a minority showing a co-occurrence of ova and tropozoite stages. And this study identifies age, income, and occupation, and hand hygiene, access to clean water and dietary habits as significant factors influencing the prevalence of parasitic infections. Younger children, low-income individuals, students, and those with poor hygiene practices or unsafe dietary habits are at higher risk.

This prevalence was comparable to findings of the study conducted in Debark (Alelign *et al*., 2024) and Gondar (Alemu *et al.,* 2021).which revealed overall prevalence of 33.64%, 34.2% respectively. Prevalence of the present study was lower than 44.6%, 89.7% Aksum north Ethiopia (Gebreslassie et al., 2015) And Wonji (Tadesse, 2020) respectively.In contrast, this finding is higher than the rates found Jimma Health Center 20.6 (Belete *et al*., 2021).This could be due to difference of time in conducting the survey, living condition of the study participants, level of environmental sanitation, access to clean water, life style of the study participants and geographical factors in the study areas, or sample population characteristics.

As compared to the findings of the study conducted across Africa, this finding results are in line with findings from other countries, A higher prevalence of intestinal parasitic infections has been reported from other African countries such as Nigeria 63.5% (Tyoalumun *et al*., 2016), Sudan 62.5% (Mohammed *et al.,*2018) And also some studies show lower rates. For example, in Ghana, reported a prevalence of just 17.33 %,(Mirisho *et al*., 2015).which is significantly lower than the rate observed. This difference could be due to improved sanitation and public health measures in certain areas of Ghana. Similarly, Nigeria shows a range of prevalence rates between 23% and 44% (Nmorsi *et al*., 2010), comparable to this finding. These African countries face similar challenges, including inadequate access to clean water, poor hygiene practices, and overcrowded living conditions, all of which contribute to higher rates of parasitic infections.

On a global scale, the prevalence of IPIs tends to be lower in many developed nations, where improved sanitation and healthcare infrastructure play a crucial role in controlling these infections. In Brazil, Faria *et al.* (2017) reported a prevalence of 17.5%, much lower than findings in Ethiopia. Despite the socioeconomic challenges Brazil faces, there have been considerable improvements in public health measures in recent decades, which may explain the lower prevalence rates. In India, the prevalence rates in rural areas range from 20% to

30% (Mandakini *et al.,* 2014), which is similar to some regions of Ethiopia but still lower than this finding of 36%. In developed countries like the United States, the prevalence is significantly lower, typically around 1-2%, largely due to better access to clean water, sanitation, and healthcare (CDC, 2019). The variability in prevalence rates, both within Ethiopia and internationally, can be explained by several factors. These include differences in water quality, awareness of hygiene practices, nutrition, and healthcare access.

The results of this study revealed that protozoan infections were more prevalent than intestinal helminth infections. *Giardia lamblia* was the most common intestinal parasitic infection at 14.9%, followed by *Entamoeba histolytica/dispar* at 10.4%. This high prevalence of *G. intestinalis* and *E. histolytica/dispar* aligns with a World Health Organization (WHO) report identifying these two parasites as significant causes of intestinal infections across Ethiopia (WHO, 1987). The elevated rates of these protozoan infections may be attributed to their fecal-oral transmission route and their ability to reproduce and persist effectively in both the environment and the host (WHO, 2002).The lower helminth prevalence could be due to a de-worming program against helminths particularly soil-transmitted helminths and schistosomiasis in Ethiopia(MoH,2016).

The prevalence of *G. intestinalis/lamblia* in the present study was (14.9%), closer with a study in done at Felege Hiwot referral hospital 13.3% (Derso *et al*.,2016) and with Tseda health center North-west Ethiopia 12.4% (Abate *et al.,*2013) but Lower than North-West Ethiopia reported a prevalence of 19.95%(Beshir*et al*., 2023)and higher than the 6.5%,7%,8.5% reported in Mojo, Hawassa, Debark (chala,2013);(Mulatu *et al.,* 2015);(Alelign *et al.,*2024) respectively.

The second most prevalent parasite in this study was *Entamoeba histolytica/dispar* (10.4%), which aligns closely with a study in Gondar North-West Ethiopia 9.2% prevalence of

Entamoeba histolytica/dispar (Alemu *et al.*, 2022).The result was found to be higher than previous reports 8.2 %, and 5.5 % from Addis Ababa and Gorgora, North West Ethiopia by (Banchiamlak *et al.,* 2014; Ayalew*et al*., 2015) respectively. And lower than previous report 17.3 %, from Axum town Northern Ethiopia (Gebreslassie *et al*., 2015).

The third most prevalent parasite in the present study was *Ascaris lumbricoides* (7.6%), The prevalence rate of the present study was much lower than prevalence observed in Dawro zone Southern Ethiopia (47.3%), (Bereket and Tomass, 2015).lower than that reported in Jimma 14.6% (Tadesse *et al*,2013) .This difference might be due to the better availability of tap water for drinking and hand washing habit before eating food in the present study. but higher than5.9% reported in Gondar (Mulugeta *et al.,* 2023).

Hymenolepis nana was detected with a relatively low prevalence, which aligns with findings from other studies in Ethiopia that generally report lower rates of this parasite compared to *Giardia lamblia* or *Ascaris lumbricoides*. For instance, a study in Gondar reported a prevalence of 5.9% among schoolchildren, and another study found it to be around 4% (Mulugeta *et al.,* 2023; Alemu *et al*., 2022), (4.4%) bale (Tulu *et al* .,2014). 5.3% prevalence reported in Tigray by Regassa *et al*. (2021). However, our findings are notably lower than the prevalence reported in an earlier study in Gondar, where it reached 13.8% (Gelawu *et al*., 2013),.The variation in *H. nana* prevalence rates may be attributed to differences in local sanitation practices, hygiene awareness, and access to clean water, which are critical factors in transmission control. *H. nana*, often spread through the fecal-oral route and direct human contact, tends to have lower prevalence rates in settings with improved sanitation.

These consistent results across different regions of Ethiopia highlight the widespread nature of these parasites, often linked to poor sanitation and hygiene practices. The persistence of these infections, particularly among school-age children, underscores the urgent need for comprehensive public health interventions targeting water sanitation, hygiene education, and routine de-worming programs. Such efforts are crucial in reducing the burden of parasitic infections and improving overall public health outcomes.

The findings of risk factors in this study align closely with the risk factors identified in previous research by (Begna *et al.,* 2014) and (Alelign *et al.* ,2024), underscoring the multifaceted nature of intestinal parasitic infections (IPIs) and the importance of factors such as age, socioeconomic status, hygiene practices, and dietary habits. current study revealed that children aged 0-12 years face a notably higher risk of IPI, with an adjusted odds ratio (AOR) of 1.509 ($p = 0.018$), a finding that is consistent with Alelign *et al.* (2024), who also identified that younger children are significantly more vulnerable to IPIs compared to older age groups(Alelign *et al.*,2024). This increased risk can likely be attributed to age-related behaviors, such as outdoor play and reduced awareness of hygiene practices Young children have a less developed immune system, poor personal hygiene, and the habit of playing on contaminated soil (Ihejirika *et al.,* 2019). Additionally, in terms of income, both present study and study conducted in Debark by Alelign *et al* highlight the association between low-income status and heightened IPI risk. Specifically, Alelign *et al.* found that individuals in households earning less than 1000 ETB per month were more likely to have IPIs (AOR = 6.66, CI = 1.87–23.70) (Alelign *et al* 2024).Similarly, this study found that participants with a household income below 1000 NTS had a higher risk (AOR = 1.304, $p < 0.01$), emphasizing the impact of financial constraints on access to resources and hygiene measures. Hygiene practices, particularly hand washing, emerge as a critical factor in IPI prevention in our study. Similarly in Begna *et al.* (2014), knowledge of hand washing before meals was significantly associated with lower IPI prevalence ($p < 0.001$), (Begna *et al.* 2014) reinforcing the importance of regular hand washing in reducing infection risks. Alelign *et al.* in the same way found that participants who washed their hands after using the toilet were significantly less likely to contract IPIs (AOR = 0.05, CI = 0.13–0.22). this study supports these findings, with hand washing with soap and after using the toilet associated with reduced IPI risk (AOR 0.188, p = 0.030), thereby confirming that consistent hand hygiene plays a crucial role in minimizing IPI risk.

Dietary habits were also significant across studies, with Begna *et al*. (2014) and Alelign *et al*. (2024) both finding that consuming raw or unwashed vegetables was strongly associated with higher odds of IPIs. Alelign *et al*. reported a particularly high risk (AOR = 9.98, CI = 2.68–37.14) among individuals consuming unwashed vegetables. While with this finding that consuming raw meat or fish increases infection risk (AOR = 0.368, p = 0.001).For instance, consuming undercooked meat, or drinking untreated water were strongly associated with higher IPI rates in our study. These findings align with studies from other countries, like Kenya, where similar dietary practices led to IPI prevalence rates between 29.2% and 52.3% (Aloo *et al.,* 2021).

In sum, the alignment of these findings with those of Begna *et al.* and Alelign *et al.* highlights shared risk factors for IPIs across different regions and populations in Ethiopia. The studies collectively emphasize the role of age, income, hygiene practices, and dietary habits as key contributors to IPI prevalence. Addressing these through targeted interventions such as improving access to clean water, promoting regular hand washing, and educating about safe dietary practices could reduce IPI risks, particularly among vulnerable groups like children and low-income households.

6. CONCLUSION AND RECOMMANDIATION

6.1 Conclusion

Overall, the study found a 36% prevalence of parasitic infections among the participants, with four species of intestinal parasites identified. Factors such as age, income, occupation, hand washing with soap, hand washing after using the toilet, access to clean water, consuming raw meat or fish, and drinking untreated water were identified as significant factors. These findings highlight the importance of targeted interventions to improve hygiene practices and access to clean water to reduce the burden of parasitic infections in the study population.

6.2 Recommendation

Based on these study findings on prevalence of Intestinal Parasitic Infection and associated risk factors among patients attending Adare Hospital, Hawassa Ethiopia, I would like to recommend the following points:

- **Improvement of Water Access :** Access to clean water is essential for the prevention of IPIs. Ensuring that households, especially those in low-income neighborhoods, have access to safe drinking water will significantly reduce the transmission of parasitic infections.
- **Hygiene Education Programs:** Public health authorities should implement community-wide hygiene education programs that emphasize the importance of hand washing with soap, proper food handling.
- **Sustained Mass Drug Administration (MDA) Programs:** While MDA programs have been effective in temporarily reducing the prevalence of soil-transmitted helminths, their long-term success depends on addressing the root causes of re-

infection. Regular de-worming campaigns should be continued, but they must be integrated with efforts to improve sanitation and hygiene in the communities to prevent re-infection.

- **Further Research:** Future studies should focus on understanding the specific barriers to accessing clean water and sanitation in Hawassa and surrounding area.

REFERENCES

Abate, A., Kibret, B., Bekalu, E., Abera, S., Teklu, T., Yalew, A., Endris, M., Worku, L. and Tekeste, Z., 2013. Cross-Sectional Study on the Prevalence of Intestinal Parasites and Associated Risk Factors in Teda Health Centre, Northwest Ethiopia. *International Scholarly Research Notices*, *2013*(1), p.757451.

Abossie Ashenafi, and Mohammed Seid.2014. Assessment of the prevalence of intestinal parasitosis and associated risk factors among primary school children in Chencha town, Southern Ethiopia. *BMC public health* 14(1): 1-8.

Adam, R. D. 2021. Giardia duodenalis: biology and pathogenesis. *Clinical Microbiology Reviews,* 34(4):e00024-19.

Admasu Haile, Temesgen Abera and Daniel Dana 2017.The prevalence of intestinal infection and associated factors among primary school children in Gurage Zone, South Ethiopia.*Journal of Pharmacy and alternative Medicine* .15.

Al Saqur, I. M., H. S. Al-Warid and H. S Albahadely. 2017. The prevalence of Giardia lamblia and Entamoebahistolytica/dispar among Iraqi provinces. *Karbala International Journal of Modern Science*3(2):93-96

Al-Daoody, A.A.K., Younes, M.R., Ali, W.R. and Hamad, K.M., 2017.Prevalence of Hymenolepis nana in Erbil City-North of Iraq. *methods*, *8*, p.9.

Alelign Amir, NigusMulualem and Zinaye Tekeste. 2024. Prevalence of intestinal parasitic infections and associated risk factors among patients attending Debarq Primary Hospital, northwest Ethiopia. *PLoS ONE* 19(3): e0298767

Alemayehu, B., Tomass, Z., Wadilo, F., Leja, D., Liang, S. and Erko, B., 2017. Epidemiology of intestinal helminthiasis among school children with emphasis on Schistosoma mansoni infection in Wolaita zone, Southern Ethiopia. *BMC public health*, *17*, pp.1-10.

Alemu Anteneh, Shiferaw,Yared, & Tesfaye,Ayele.2021. Intestinal parasitic infections and associated risk factors among schoolchildren in Ethiopia: A systematic review and meta-analysis. *PLoS One*, 16(8), e0256089.

Alemu Aschale Shimeles, AdhanomGebreegziabherBaraki, Mekuriaw Alemayehu and Melaku KindieYenit. 2019. The prevalence of intestinal parasite infection and associated factors among food handlers in eating and drinkingestablishments in Chagni Town, Northwest Ethiopia. *BMC research notes,* 12(1):1-6.

Alemu Getaneh, MezgebuNega and Megbaru Alemu. 2020. Parasitic contamination of fruits and vegetables collected from local markets of Bahir Dar City, northwest Ethiopia. *Research and Reports in Tropical Medicine* 11:2

Alemu Yirgalem, Asrat Mulugeta and Tadesse Berhanu. 2022. Intestinal Parasitic Infections in Gondar, Ethiopia: Prevalence and Associated Risk Factors. *Journal of Parasitology Research,* 18(3): 125-132.

Aloo, P. A., Karanja, S. M., Nganga, J. K., &Njagi, J. M. 2021. Epidemiology and risk factors of intestinal parasitic infections among school-aged children in Kenya: A systematic review. *BMC Infectious Diseases*, 21(1), 250.

Alum, A., J.Rubino and M.K. Rand Ijaz. 2010. "The global war against intestinal parasitesshould we use a holistic approach?" *International Journal of Infectious Diseases*, 14(9):e732–e738

AyalewJejaw, Ahmed Zeynudin, EndalewZemene and Tariku Belay.2014.Status of intestinal parasitic infections among residents of Jimma Town, Ethiopia. BMC research notes, 7(1):502

Banchiamlak Mekonnen, Berhanu Erko and MengsituLegesse, 2014.Prevalence of intestinal parasitic infections and related risk factors among street dwellers in Addis Ababa, Ethiopia.*Journal of Tropical Diseases* 2(132).

Begna Tulu, Solomon Taye and Eden Amsalu (2014). Prevalence and its associated risk factors of intestinal parasitsic infections among Yadot Primary School children of South Eastern Ethiopia: a cross-sectional study. BMC Research Notes 7 (848).

Belete Yohannes Alemu, Tilahun Yemane Kassa and MinaleFekadie Baye.2021. Prevalence of intestinal parasite infections and associated risk factors among patients of Jimma health center requested for stool examination, Jimma, Ethiopia. *PLoS One*. 16(2):e0247063.

Berek*et al*emayehu and Zewdneh Tomass.2015. Prevalence of intestinal Helminthiasis and associated risk factors among school children in Dawro zone, Southern Ethiopia. *Journal Biology, Agriculture and Healthcare* 15 (11).

Beshir Rahmeto, Alemu Yirgalem and Asrat Mulugeta.2023. Prevalence of Intestinal Parasitic Infections and Associated Risk Factors in North-West Ethiopia: A Cross-Sectional Study. BMC Public Health 23(1):789.

Beyene Abebe, Tamene Hailu, Kebede Faris and Helmut Kloos. 2015. Current state and trends of access to sanitation in Ethiopiaand the need to revise indicators to monitor progress in the post-2015 era. *BMC Public Health*.15(1):1–8.

Bimerkas, M. 2018.Prevalence and risk factors of intestinal parasitic infections among school-age children in a rural area of Ethiopia.*Journal of Parasitology Research*, 2018; 1-8.

Bloomfield, S. F., M. Exner, C. Signorelli, K. J.Nath and E. A. Scott.2012.The chain of infection transmission in the home and everyday life settings, and the role of hygiene in reducing the risk of infection.In *International scientific forum on home hygiene*.

Cappello, M. 2004.Global health impact of soil-transmitted nematodes. *The Pediatric infectious disease journal,* 23(7): 663-664.

Castellanos-Gonzalez, A., A.White, P Jr. Melbyand B. Travi 2018.Molecular diagnosis of protozoan parasites by Recombinase Polymerase Amplification.*Actatropica*. 182:4–11.

Centers for Disease Control and Prevention. (2019).report Retrieved from https://www.cdc.gov/.

Chala, B. 2013. Prevalence of intestinal parasitic infections in Mojo Health Center, Eastern Ethiopia: a 6-year (2005–2010) retrospective Study. *Epidemiol* 3(119):2161–1165.

Charan J, T.Biswas. 2013. How to calculate sample size for different study designs in medical research? Indian J PsycholMed.35(2):121–6

Charles Patrick Davis.2021. Definition of intestinal parasite.University of Texas.Reviewedon 3/29/2021

Davis, A. N., R Haque and W. A. Petri Jr.2002. Update on protozoan parasites of thentestine. *Current opinion in gastroenterology* 18(1):10-14.

Deribe Kebede, KaduMeribo, Teshome Gebre, Asrat Hailu, Ahmed Ali, Abraham Aseffa and Gail Davey .2012.The burden of neglected tropical diseases in Ethiopia, and opportunities for integrated control and elimination. *Parasites and Vectors* 5(1):1–5.

DersoAdane, EndalkachewNibret and AbainehMunshea. 2016. A: Prevalence of intestinal parasitic infections and associated risk factors among pregnant women attending antenatal care center at FelegeHiwot Referral Hospital, northwest Ethiopia. BMC infectious diseases 16(1):530

Dixon, B. R. 2021. Giardia duodenalis in humans and animals–Transmission anddisease.*Research in veterinary science*, 135, 283-289.

Faria C.P, G.M.Zanini, G.S Dias, S. da Silvade, M.B Freitas and R.Almendra.2017.Geospatial distribution of intestinal parasitic infections in Rio de Janeiro (Brazil) and its association with social determinants. *PLoS neglected tropical diseases* 11(3):e0005445

Federal Ministry of Health Ethiopia. 2016. Second Edition of National Neglected Tropical Diseases Master Plan. Addis Ababa

Feleke, D.G., Alemu, Y., Bisetegn, H., Mekonnen, M. and Yemanebrhane, N., 2021. Intestinal parasitic infections and associated factors among street dwellers and prison inmates: A systematic review and meta-analysis. *PLoS One*, *16*(8).e0255641.

Firdu Teshome, FufaAbunna and Mekonnen Girma. 2014. Intestinal protozoal parasites in diarrheal children and associated risk factors at Yirgalem Hospital, Ethiopia: a case-control study.*International Scholarly Research Notices* 357:126–8.

GebremichaelGebretsadik (2016). Prevalence of intestinal parasites and associated risk factors among school children of Homesha District (Woreda) in Benishangul-Gumuz

Regional State, Western Ethiopia. Journal of Family Medicine and Health Care 2 (4):57-64.

GebreyohannsAlganesh, Melese Hailu Legese, MistireWolde, GemechuLeta and GeremewTasew..2018. "Prevalence of intestinal parasites versus knowledge, attitude and practices (KAPs) with special emphasis to Schistosomamansoni among individuals who have river water contact in Addiremets town, Western Tigray, Ethiopia," *PloS One*, 13(9):e0204259.

GelawAschalew, Belay Anagaw, Bethel Nigussie, BetrearonSilesh, AtnadYirga, Meser*et al*em, Mengistu Endris, and BayeGelaw. 2013.Prevalence of intestinal parasitic infections and risk factors among schoolchildren at the University of Gondar Community School, Northwest Ethiopia: a cross-sectional study. *BMC public health* 13(1):1-7.

Ghosh, S., Padalia, J. andMoonah, S. (2019). Tissue Destruction Caused by Entamoeba histolytica Parasite: CellDeath, Inflammation, Invasion, and the gut microbiome. *Current Clinical Microbiology Reports,* 6(1), 51-57

Girma Abayeneh and AlekaAemiro. 2022. Prevalence and Associated Risk Factors of Intestinal Parasites and Enteric Bacterial Infections among Selected Region Food Handlers of Ethiopia during 2014–2022: A Systematic Review and Meta-Analysis. *The Scientific World Journal*

Hadush, A. and Pal, M., 2016. Ascariasis: Public health importance and its status in Ethiopia. Air Water Borne Diseases, 5(1), p.126.

Hailu GedamuGebreamlak and EsubalewTesfahun Ayele. 2021. Assessment of the prevalence of intestinal parasitic infections and associated habit and culturerelated risk factors among primary schoolchildren in DebreBerhan town, Northeast Ethiopia. *BMC public health* 21(1):1-12.

Hajare, S. T., Chekol, Y. and Chauhan, N. M.(2022). Assessment of prevalence of Giardia lamblia infection and its associated factors among government elementary school children from Sidama zone, SNNPR, Ethiopia.*Plos one*, 17(3), e0264812

Haque, R. 2007.Human intestinal parasites. Journal of Health, Population and Nutrition25(4):387-91.

Hotez, P.J., 2014. Ten global "hotspots" for the neglected tropical diseases. *PLoS Neglected Tropical Diseases*, *8*(5), p.e2496.

Hotez, P.J., 2021. *Forgotten people, forgotten diseases: the neglected tropical diseases and their impact on global health and development*.John Wiley & Sons.

Hotez, P.J., Brindley, P.J., Bethony, J.M., King, C.H., Pearce, E.J. and Jacobson, J., 2008. Helminth infections: the great neglected tropical diseases. *The Journal of clinical investigation*, *118*(4), pp.1311-1321.

Howell, L. D. 2010. The Barefoot Book: 50 Great Reasons to Kick Off Your Shoes. Hunter House.

Ihejirika, O. C., Nwaorgu, O. C., Ebirim, C. I., &Nwokeji, C. M. 2019.Effects of intestinal parasitic infections on nutritional status of primary children in Imo State Nigeria. *The Pan African Medical Journal,* 33.

KamadeE, L. Muthami andJ.Ouma.2015. Prevalence and intensity of intestinal parasitic infections and factors associated with transmission among school going children. East African *MedJ*. 92(6):264–9

Kassai, Z., Phuong, P. L., &Tuyen, H. D. 2021. Post-MDA reinfection rates of intestinal helminths in rural Cambodia: The need for integrated approaches. *Tropical Medicine and Infectious Disease*, 6(4), 178.

Kiani, H., Haghighi, A., Salehi, R. and Azargashb, E. 2016. Distribution and risk factors associated with intestinal parasite infections among children with gastrointestinal disorders. Gastroenterology and hepatology from bed to bench, 9(Suppl1), S80.

Mandakini M. P, R.P Prashant, G.Bhavna, M.Jigna. And P Suresh. 2014. Prevalence of intestinal parasites infestation in Surat City Of South Gujarat. Natl J CommunMed.5(3):273.

Mascarini-Serra, L. 2011."Prevention of soil-transmitted helminth infection," *Journal of Global Infectious Diseases*3(3):175–182.

Mbuh V, NNtonifor and T. Ojong. 2010.The incidence, intensity and host morbidity of human parasitic protozoan infections in gastrointestinal disorder outpatients in Buea Sub Division, *Cameroon. J Infec Developing Countries* 4: 38-43.

Mekonnen, Z., Sime, H., Legesse, M., & Belay, T. (2021).Re-infection of soil-transmitted helminths after mass drug administration in southwestern Ethiopia.*Infectious Diseases of Poverty*, 10(3):1-8.

MenjettaTadesse., Simion, T., Anjulo, W., Ayele, K., Haile, M., Tafesse, T. andAsnake, S. (2019).Prevalence of intestinal parasitic infections in Hawassa University students' clinic, Southern Ethiopia: a 10-year retrospective study. *BMC Research Notes*, 12(1):1-5.

Mirisho., R. 2015. Intestinal Helminths Infestation in Children Attending Princess Marie Louise Children's Hospital. University of Ghana.

Mohammed, H. M. N., H.S, M. Siddig, A. E. Mohammed, H. H.Ahmed, H. F. Abdalgadir, N. F. Alameen and M. I.Mahmoud. 2018.Prevalence of intestinal parasitic infections among patients attended to Alribat University hospital, Khartoum State, Sudan.

Muehlenbachs, A., Bhatnagar, J., Agudelo, C. A., Hidron, A., Eberhard, M. L., Mathison, B. A. and Zaki, S. R. (2015).Malignant transformation of Hymenolepis nana in a human host. *New England Journal of Medicine,* 373(19), 1845-1852.

Mulatu Getamesay, Ahmed Zeynudin, EndalewZemene, SerkadisDebalke and Getenet Beyene.2015.Intestinal parasitic infections among children under five years of age presenting with diarrhoeal diseases to two public health facilities in Hawassa, South Ethiopia. Infectious diseases of poverty 4(1):49

Mulugeta Asrat, Berhanu Tadesse and Fekadu Alemayehu.2023. Distribution and Risk Factors of Intestinal Helminths in Gondar, Ethiopia.*Ethiopian Journal of Health Development*37(2):112-118.

Nash, T., Moore, S., & Harvey, S. A. 2022. Global patterns of helminth infection and disease burden: insights from a systematic review. *The Lancet Global Health*, 10(2), e43-e52.

Nayyef, H. J., Abo-Alhur, F. J., Mohammed, S. W., Taqi, E. A. and Kahdim, S. S. 2022.Prevalence of Entamoeba histolytica among enteric infection in Al-Furat general hospital Baghdad/Iraq.*In AIP Conference Proceedings* (Vol. 2386, No. 1, p. 020011).

Ngowi, HA. 2020. Prevalence and pattern of waterborne parasitic infections in eastern Africa: Asystematic scoping review. *Food and waterborne parasitology*, 20:e00089.

Ojha, S.C., C.Jaide, N.Jinawath, P.Rotjanapan and P. Baral.2014.Geohelminths: public .health significance. The Journal of Infection in Developing Countries 8(01): 005-016.

Oloruntoba, E. O., O. E.,Amubieya, M.Adejumo and M. K. C Sridhar.2019. Status of sanitation facilities and factors influencing faecal disposal practices in selected low-income communities in Ibadan, Nigeria. *Journal of Environment Pollution and Human Health* 7(2): 62-72.

Omowaye, O. S. and P. A. Audu.2012.Parasites contamination and distribution on fruits and vegetables in Kogi, Nigeria*.* *CibtechJournal of Bio-Protocols*, 1(1):44-47.

Organization WH. Guidelines for drinking-water quality: World Health Organization; 2002. Available from: https://www.who.int/publications/i/item/9789241549950.

Organization; 1987. Available from: https://www.who.int/publications/i/item/WHO-TRS-749

Oswald,W.E., A.E. Stewart, M.R. Kramer, T.Endeshaw, M.Zerihun, B.Melak,E.Sata, D., Gessese, T.Teferi and Z.Tadesse. 2017. Association of community sanitation usage with soil-transmitted helminth infections among school-aged children in Amhara Region, Ethiopia.Parasitic Vectors. 10(1):91.

Palmeirim,M.S.,M.Ouattara,C.Essé,V.A.Koffi,R.K.Assaré,E.Hürlimann,J.T.Coulibaly,N.RDiakité.2018. Are schoolchildren less infected if they have good knowledge about parasitic worms? A case study from rural Côte d'Ivoire. BMC Public Health 18(1):1-11

Rawat, A., Singh, P., Jyoti, A., Kaushik, S. and Srivastava, V.K., 2020.Averting transmission: A pivotal target to manage amoebiasis. *Chemical Biology & Drug Design*, *96*(2), pp.731-744.

Regassa, K., Tedla, K., Bugssa, G., Gebrekirstos, G., Gebreyesus, H.andShfare, M. T. 2021. Prevalence and factors associated with intestinal parasites among food handlers in Medebay Zana District, north West Tigray, northern Ethiopia. *Tropical diseases, travel medicine and vaccines,* 7(1): 1-6.

Sackev, M. 2001. Intestinal Factors and Parasite Infections: Prevalence, Risk Factors and Consequences for Child Growth, Iron Status and Development in Rural Ecuador, Virginia Polytechnic and State University, Ecuador

Savioli, L.and M.Albonico.2004. Focus: Soil-transmitted helminthiasis. *Nature Reviews Microbiology* 2(8):618-619.

Schmidt, M. A., Valverde, P., & Gutiérrez, R. M. 2020. Environmental determinants of soil-transmitted helminths: a global analysis. *Infectious Diseases and Poverty*, 9(1), 1-12.

Scholtyseck, E. 2012. *Fine structure of parasitic protozoa: an atlas of micrographs, drawings and diagrams.*Springer Science & Business Media.

Shiferaw Kefale, Teklemichael Tesfay, GirmayKalayu and GebrehiwotKiros. 2021. Prevalence and risk factors of intestinal parasitic infections in children attending hospitals in southern Ethiopia. *BMC Infectious Diseases* 21(1): 1-7.

Shiferaw MelashuBalew, AmtatachewMogesZegeye and AgmasDessalegn Mengistu. 2017.Helminth infections and practice of prevention and control measures among pregnant women attending antenatal care at Anbesame health center, Northwest Ethiopia. *BMC research notes* 10(1):1-5.

SitotawBaye and Wakgari Shiferaw. 2020. “Prevalence of intestinal parasitic infections and associated risk factors among the first-cycle primary schoolchildren in Sasiga district, Southwest Ethiopia,” *Journal of Parasitology Research* 8681247:13.

Squire,S. and U.Ryan.2017. Cryptosporidium and Giardia in Africa: current and future challenges. *Parasites &vectors*10(1):1–32.

Tadesse G, Zeynudin A, Mekonnen Z, Taha M, Adamu H, Kebede A: Intestinal Parasitosis among HIV Sero Positive in Jimma, Ethiopia. J Trop Dis 2013, 1(122):2.

Tadesse Hailu, BayehAbera, WondemagegnMulu,SimachewKassa,AshenafiGenanew and Arancha Amor. 2020.Journal of *Parasitology Research* 8855362: 6

TadesseDuguma,TeshaleWorku, Samuel Sahile and Daniel Asmelash. 2023.Journal of *Tropical Medicine Volume* 2268554: 8

TadesseGizeshwork. 2020. Prevalence and risk factors of intestinal parasitic infections in rural Ethiopian communities: A systematic review. *BMC Public Health* 20(1):1-14.

TegenDires, DestawDamtie, and TamiratHailegebriel. 2020. Prevalence and Associated Risk Factors of Human Intestinal Protozoan Parasitic Infections in Ethiopia: A Systematic Review and Meta-analysis. *Journal of parasitology research*,.

Thomas, K., L. Fomefret and E. Emmanuel. 2015. Prevalence and risk factors of intestinal helminths and protozoa infections.America*Journal of Epidemiology of Infectious Disease*3(2):36–44.

Tigabu, A., Taye, S., Aynalem, M. and Adane, K., 2019.Prevalence and associated factors of intestinal parasitic infections among patients attending Shahura Health Center, Northwest Ethiopia. *BMC research notes*, 12:1-8.

Tilahun Workneh, Ahmed Esmael and MekonenAyichiluhm 2014.Prevalence of intestinal parasitic infections and associated factors among Debre Elias Primary School children, East Gojjam Zone, Amhara Region, North West Ethiopia.Journal of Bacteriology and Parasitology 5 (181).

Treacy, J. 2019. Drinking water treatment and challenges in developing countries. *The relevance of hygiene to health in developing countries* 55-77.

Tyoalumun K, S.Abubakarand N.Christopher.2016. Prevalence of Intestinal Parasitic Infections and their Association with Nutritional Status of Rural and Urban Pre-School Children in Benue State, Nigeria.*Int J MCH AIDS*5 (2):146–52.

Uçar,A.,M.V.YilmazandF.P.Çakiroglu.2016.Foodsafety–problemsandsolutions. *Significance,Prevention and Control of Food Related Diseases*, 3.

Unasho, A. 2013.An investigation of intestinal parasitic infections among the asymptomatic children in, Southern Ethiopia.*InternationalJournal of Child Health and Nutrition.*2:212–22.

WHO (World Health Organization). 2010. *Working to Overcome the Global Impact of Neglected Tropical Diseases: First WHO Report on Neglected Tropical Diseases*,

WHO.2015 (World Health Organization report).

WHO. 2017. Guideline, Preventive Chemotherapy to Control Soil-Transmitted Helminth Infections in At-Risk Population Groups, World Health Organization, Geneva, Switzerland, Licence: CC BY-NC-SA 3.0 IGO.

World Health Organization. 2020. Bench Aids for the Diagnosis of Intestinal Parasites (Second Edition)**.**World Health Organization.

WHO (World Health Organization). 2020 "Soil-transmitted helminth infections,"

WHO (World Health Organization).2021."Soil-transmitted helminth infections,"

WHO. 2022.Soil-transmitted helminth infections, January, Geneva

World Health Organization (WHO**)**. 2022. *Intestinal Parasitic Infections: Key Facts and Public Health Significance*. WHO. Retrieved from https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections

Workineh Lemma, Andargachew Almaw and Tahir Eyayu. 2022. Trend Analysis of Intestinal Parasitic Infections at Debre Tabor Comprehensive Specialized Hospital, Northwest Ethiopia from 2017 to 2021: A Five-Year Retrospective Study. *Infection and Drug Resistance* 15:1009.

ZemeneTelanesh and MelashuBalew Shiferaw. 2018. Prevalence of intestinal parasitic infections in children under the age of 5 years attending the DebreBirhan referral hospital, North Shewa, Ethiopia. *BMC Research Notes* 11(1):58.

APPENDEXES

APPENDEX I: Questionnaire for risk factors of intestinal parasitic infections

Questionnaire is prepared for individuals who are willing to participate this Semi-structured questionnaire prepared after reviewing different literatures for interview.

Name of interviewers ______________ signature _______________

English Version Questionnaire

Dear Study Participants, My name is _______________ and I am conducting a study to investigate the prevalence of intestinal parasitic infections and their associated risk factors in Hawassa town, Sidama region, Ethiopia. Your participation in this study is greatly appreciated. Please be assured that all information provided will be kept strictly confidential and used solely for research purposes. Your cooperation in providing accurate information is essential for the success of this study.

If you are willing to participate, we will ask you. A. Yes, I agree B. I do not agree

Participant identification: Code No ________________ Serial No _______________

Section 1: Demographic Information

1.1 personal Information

1.1.1 What is your age a) 0-12 b) 13-18 c) 19-59 D) >60

1.1.2. What is your gender? a) Female b) male

1.1.3. What is your level of education) Unable to read /write b) Able to read /write

c) Grade 1-6 d) Grade 7-12 e) Beyond grade 12 f) other /specify

1.2 Residential Details

1.2.1 Do you live in Hawassa A) yes B) no?

1.2.1 For how long do reside in Hawassa

A) Since birth B) few years ago c) half of my life

1.3 Family income (NTS)

A, <1000 c, 3000-7000 E,Others

B, 1000 -3000 d >7000

Section 2: Personal Hygiene Practices

2.1. Do you wash your hands regularly with soap and water?

a) Always b) Sometimes c) Rarely d) Never

2.2. How often do you wash your hands in a day?

a) More than 10 times b) 6-10 times c) 3-5 times d) Less than 3 times

2.3. Do you wash your hands after using the toilet?

a) Always b) Sometimes c) Rarely d) Never

2.4. Do you use toilet paper or water to clean yourself after using the toilet?

a) Toilet paper b) Water c) Both d) Other

2.5. Do you wear shoes when using public toilets or bathrooms?

a) Always b) Sometimes c) Rarely d) Never

2.6. Do you have access to clean water for personal hygiene?

a) Always b) Sometimes c) Rarely d) Never

Section 3: Food and Water Consumption

3.1. Do you consume raw or undercooked meat or fish?

a) Yes b) No

3.2. Do you consume raw fruits and vegetables without washing them?

a) Yes b) No

3.3. Do you drink untreated or un-boiled water from natural sources?

a) Yes b) No

3.4. Do you drink unpasteurized milk or dairy products?

a) Yes b) No

3.5. Do you eat food that has been left at room temperature for more than two hours?

a) Yes b) No

Section 4: Medical History

4.1. Have you been diagnosed with a parasitic infection in the past?

a) Yes b) No

Thank you for participating in this questionnaire. Your responses will help us understand the risk factors associated with intestinal parasitic infections and develop strategies to prevent their spread.

APPENDEX II: Information sheet

Dear participant:

1. Title: prevalence of intestinal parasitic infection and associated risk factors among patients who visit Adare Hospital Hawassa Sidama Ethiopia

2. Background &aim of the study: I would like to conduct a cross sectional study on the prevalence intestinal parasitic infections and associated risk factors among patients who visit Adare hospital "Intestinal parasitic infections (IPIs) impose a significant health burden, affecting approximately 1.5 billion people globally, constituting around 24% of the world's population, as reported by the World Health Organization (WHO). The prevalence of these infections in tropical and subtropical regions is attributed to multiple factors, including rising population density, inadequate sanitation, poor health practices, contaminated food and water sources, malnutrition, low host resistance, and environmental changes. Thus, research on these issues is very important to control and prevent IPIs.

3. Objectives of the study:

3.1. General Objectives: The General objective of this research proposal is to investigate the prevalence of intestinal parasitic infections and the associated risk factors in a study population.

4.Procedure: On the basis of the established inclusion criteria, the research participants will been rolled following signed permission **.**Have the symptoms of intestinal parasitic diseases and take the treatment in this hospital and participate in this study; you will be asked some questions on socio-demographic characteristics, medical history in addition to clinical examination. Then you will provide 3-4gram of stool sample. The sample used for testing the presence of IPIs species.

5. Risks: Procedures used for IPIs diagnosis do not cause any harm. But we may take your time to answer the questioners

6. Benefits: Participating in this research will benefit your neighbourhood and you. A teach session long the way of your medical care, you will be able to determine how well you are doing in terms of your health**.** You will also learn how to prevent intestinal parasitic infections from your doctor, in addition to receiving further information on how to improve your health. However, you have the absolute right to decline taking part in this study.

7. Confidentiality: We will keep all i n formation we learn about you for this research strictly private. Your identity related data will been coded and stored in a safe location. If it becomes essential to identify you in order to help you medically, only the lead investigators will be allowed to doso. However, the researchers may examine all of the clinical data, which is anonymous to you. Your interview responses will be recorded n the form of a questionnaire. No report will include a reference of your name. Your entire response history and outcomes will be kept private. Your data will only be used for the mentioned purposes**.**

8. Sharing the results: We will publish a report detailing the study's findings at its conclusion or use another method. You won't find any information about you in the reports (such your name or identify).We guarantee the privacy of such information. As a result, we also require your consent before using the test findings to create report.

9. Rights to refuse or withdraw:-You have the ability to decline or withdraw from the research at anytime because participation is completely voluntary. We will delete any stored information we received from you before this date if you decide to revoke your permission later. You will still be able to get care at this facility in accordance with the customary level of care even if you decide not to participate in this research and you won't lose any advantages.

Do you understand what has been said to you? If you have any question you have the right to get proper explanation.

Contact Address: If you have any further question and incase of urgency you can contact at anytime using the following address:-

1.BontuDesu,Address:HawassaUniversity,Faculty ofNaturalandcomputationalScience,BiologyDepartmentinBiomedicalprogramunit.HawassaEthiopiaTelephone(mobile):0913389359E-mail:bonidesu@gmail.com.;

2,**Dr.MeleseBirmeka**,BiologySchool, University of Hawassa, Ethiopia. Tel: +251911702057

Email;-Melesebirmeka@yahoo.com

Thank you for your kind cooperation and participation in this study!

APPENDEX III;Informed consent form

Name: ---Age: -----------------------Sex: ----------------

IdentificationNo:_________________________HRHNo:_________________________

Adress:______________________________________Date:________________________________

I have been well informed, would like to carry out a collaborative study on prevalence of intestinal parasitic infections and associated risk factors **.**I am aware of how crucialitis to appropriately reactt o the pre-made questionnaires andc linical exams.The study also informs stool sample will be needed. Furthermore,I consent to providing these samples while acknowledging my right tolater change my mind about participating in the study**.**

Please read and tick off each of the boxes and sign the form if you agree to take part in this study.

1. I understand what this study is about and know how to contact the investigators if I want to. ☐

2. I understand apportion of the sample used for this study only. If there i s left over after the completion of the study, it will be discarded safely. ☐

3 I understand that all the information given to the investigators and all test results will be kept private and confidential. ☐

☐

4. I understand that I am free to with draw myself from this study if I want to. ☐

5. I understand that if I refuse to take part in this study, that my care will not be affected. ☐

I have been given enough time to think over before I signed this informed consent.Itis,therefore,with full understanding of the situation that I gave my informed consent to participate in this study.

The information was explained to me by:____

Name of participant:__________________________________Signature:-__________________

Nameofthephysician:______________________________Signature:-__________________

Witness:__________________________Date:__________________________