ASSESSMENT OF INTESTINAL PARASITIC INFECTION AND NUTRITIONAL STATUS ON UNDER-FIVE CHILDREN VISITING ASSELA REFERRAL HOSPITAL

MSc THESIS

BY

TILAHUN ENDALE

NOVEMBER 2024

HAWASSA, ETHIOPIA

ASSESSMENT OF INTESTINAL PARASITIC INFECTION AND NUTRITIONAL STATUS ON UNDER-FIVE CHILDREN VISITING ASSELA REFERRAL HOSPITAL

BY: TILAHUN ENDALE

ID; GPBiSc /0009/15

A THESIS SUBMITTED TO HAWASSA UNIVERSITY SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF BIOMEDICAL SCIENCES

PRINCIPAL ADVISOR: MELESE BIRMEKA (PhD)

HAWASSA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

DEPARTEMENT BIOLOGY

NOVEMBER 2024

HAWASSA, ETHIOPIA

HAWASSA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

ADVISORS' APPROVAL SHEET

The student known as Tilahun Endale has produced MSc thesis proposal entitled "**Assessment of intestinal parasitic infection and nutritional status in Under-five children visiting Asella referral hospital**" has ended all the comments given on the Thesis; Therefore, I recommend that the student has fulfilled the requirements and hence here by can submit the thesis to the department.

____________________________	______________________	________________
ADVISOR'S NAME	SIGNATURE	DATE

HAWASSA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
EXAMINERS' APPROVAL SHEET

We the undersigned, members of the Board of Examiners of the final open defense by Tilahun Endale have read and evaluated his/her thesis entitled: "**Assessment of intestinal parasitic infection and nutritional status in Under-five children visiting Asella referral hospital**", and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree Masters in Biomedical science.

Name of the Chairperson	Signature	Date
______________________	____________	____________
Name of Major Advisor	Signature	Date
______________________	____________	____________
Name of internal examiner	Signature	Date
______________________	____________	____________
Name of External examiner	Signature	Date
______________________	____________	____________

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the School of Graduate Studies (SGS) through the Department/School Graduate committee (DGC/SGC) of the candidate's major department/School.

Thesis approved by

______________________	______________________
SCG Approval Signature	Date

ACKNOWLEDGEMENT

This study was not the result of an individual effort. It was accomplished with the assistance of many people, to whom I am very grateful. My next gratitude goes directly to Melese Birmeka (PhD), who gave me his priceless comments, advice, and constructive critiques. Indeed, he played a great role, starting from title selection up to analytical thinking for the successful completion of my thesis. My straight appreciations also extend to the Assela referral hospital, where the chief laboratory director, Dr. Dejene Negasa, and parasitological laboratory director, Mr. Sultan, were the most appreciable people for the provision of laboratory facilities and material support. Laboratory technicians in the Assela referral hospital, mainly in pediatrics, are also greatly acknowledged for helping and facilitating the collection and examination of stool samples during laboratory work.

Finally, thanks to those who are involved directly or indirectly in this work, whose names I have not mentioned here.

DEDICATION

To my father, Mr. Endale W/Tsadik, who was optimistic in his idea, and also to all my family, who were supporting me in any situation and provided their love and support always until I finished my work.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS/ACRONYMS

AOR…………………....Adjusted Odd Ratio

BF………………………Breast Feeding

COR……………………Crude Odd Ratio

HIPI …………………...Human Intestinal Parasite Infection

HIPs…………………….Helminthic Intestinal Parasites

IHs……………………...Intestinal Helminths

IPs………………………Intestinal Parasites

IPIs …………………....Intestinal Parasitic Infections

IPPs…………………... Intestinal Protozoan Parasites

MUAC…………………Mid-Upper Arm Circumference

NTDs ………………….Neglected Tropical Diseases

SPSS…………………..Statistical Package for Social Science

STH …………………...Soil Transmitted Helminths

UNICEF ……………....United Nation International Children Emergency Fund

WASH ………………..Water Sanitation and Hygiene

WHO …………………World Health Organization

ABSTRACT

Intestinal parasitic infections (IPIs) and undernutrition in under-five children are of significant public health concern in low- and middle-income countries and contribute significantly to childhood morbidity and disability. Unfortunately, under-five children are more susceptible to infection. However, information is scarce in the study area. Therefore, this study investigated the relationship between intestinal parasites and the anthropometric status of outpatients under five children in Assela referral hospital, east Arsi zone, Ethiopia. An institutional-based cross-sectional study was conducted at Assela referral hospital from February 15 to March 15, 2024. Stool samples were collected from 227 children and examined using direct wet mount and formal ether concentration techniques. Children's weight, height, and Z scores were measured using a digital balance scale and a wooden board, with mothers or caregivers deducted from weight. The data were entered into Excel and analyzed using WHO-Anthro Plus software version v3.2.2 and SPSS v24 statistical software, respectively. An AOR analysis was done to test the association between intestinal parasites and nutritional status. The prevalence of stunting, underweight, and wasting was 38 (16.7%), 64 (28.2%), and 59 (26%), respectively. The total prevalence of parasitosis was 19.4% of children infected with at least one type of intestinal parasite. The most common intestinal parasitic infections detected in the study were E. histolytica (8.4%), E.Vermicularis (4.4%), and Giardia lamblia (3.5%). Residence (P: <0.001), deworming (P: 0.009), toilet (P: 0.034), and others like: fingernail cleanness, water source and parental education levels were the predictor variables for the prevalence of IPIs. Protozoan parasites are the most common cause of disease in under-five children in the area. Public health interventions for intestinal parasitic infections include targeted deworming programs, health education campaigns, sanitation improvements, routine screening, nutritional support, community-based interventions, and comprehensive health policies.

Key words: *IPI, under-five children, parasites, undernutrition*

1. INTRODUCTION

1.1. Background of the study

Intestinal parasitic infections (IPIs) are a major public health problem affecting susceptible populations in low- and middle-income countries (UNICEF, 2013). Intestinal parasites affect about 25% of the global population, with poorer nations having the highest prevalence. According to Zemene and Shiferaw (2018), intestinal parasitic infections are among the most prevalent infections, affecting about 3.5 billion people and resulting in over 450 million health issues each year, including diarrhoea, abdominal pain, undernutrition, general malaise and weakness, and impaired growth and physical development.

The prevalence of IPIs varies from country to country. Due to various geographical, social, and environmental factors, they are the most prevalent diseases in developing countries, particularly in sub-Saharan Africa, Asia, Latin America, and the Caribbean (Kamau *et al*., 2012). The main reasons for the high prevalence of IPIs in developing countries are poor sanitation conditions, increasing population density, poor personal hygiene, inadequate toilet facilities, inadequate water sanitation, contaminated food and water, and malnutrition as a consequence of poverty (Kamau *et al*., 2012; Sitotaw *et al*., 2019).

Amebic dysentery (caused by Entamoeba histolytical) and giardiasis (caused by Giardia lamblia) are the two most prevalent protozoan infections, infecting about 500 million and 200 million people, respectively (Barry *et al*., 2013). With respect to helminthic infections, Ascaris lumbricoides, Trichuris trichiura, and hookworms are the most predominant causes and have been estimated to affect more than two billion people in the world.

This infections are prevalent in all stages of human development; so far, children are the worst affected (Bdir and Adwan, 2010, cited in Melese *et al*., 2018). This age group is predisposed to heavy infection with intestinal parasites because children have not fully developed immune systems and due to their habits related to playing with soil, which may be faecal-contaminated (Alsubaie *et al*., 2016). Hence, these effects can lead to or aggravate protein-energy malnutrition, and serious complications of IPIs in children can include malabsorption, dyspepsia, iron deficiency anaemia, growth retardation, vitamin A deficiency, weight loss, poor educational performance, and other physical and mental consequences (Paniker, 2018).

Child undernutrition is refers to not consuming enough calories, protein, or micronutrients to maintain good health and it is a major public health problem, especially in many low- and middle-income countries (UNICEF, 2013). Worldwide, the prevalence of undernutrition is great. According to the World Health Organisation (WHO) report, it was estimated that 178 million children were undernourished, 20 million children were suffering from the most severe form of undernutrition, and 3.5–5 million annual deaths occurred among children aged 6–59 months (WHO, 2016). Malnourished children are vulnerable to IPI suffering. In contrast, IPI-related chronic infections can contribute considerably to the evolution of undernutrition in the paediatric population, thus creating a potentially lethal cycle or vicious cycle of worsening illness and deteriorating nutritional status (Ajjampur and Tan, 2016). This combination is a significant reason for high under-five mortality in developing and populous nations like Ethiopia.

Intestinal parasitic infections (IPIs) and undernutrition in under-five children are of significant public health concern in low- and middle-income countries and contribute significantly to childhood morbidity and disability (Calegar *et al*., 2021). IPI, along with soil-transmitted Helminths (STHs), are neglected tropical diseases (NTDs) and constitute one of the most important causal agents of intestinal parasitic infections. The STHs of major concern to humans are *Ascaris lumbricoides, Trichuris trichiura, Ankylostoma duodenale,* and *Necator americanus*, which are the most common parasitic infections in developing countries.

Ethiopia as a nation is still dealing with a number of underlying vulnerabilities for childhood malnutrition, including food insecurity (Yirga *et al*., 2019; Adam & Bitew, 2021), caused by multifactorial determinants such as prolonged drought and famine, poverty, and civil unrest. So the risk of IPI and the resultant possibility of forming a vicious cycle (undernutrition and IPI) make this situation very complex from the family medicine practice perspective (Hooshyar *et al*., 2019). It is crucial to ascertain the frequency of IPI in children under five and to contrast it with their nutritional status.

1.2. Statement of the problem

The relationship between IPI and undernutrition is complex and bidirectional. Parasitic infections can impair nutrient absorption, reduce appetite, and lead to gastrointestinal symptoms such as diarrhea, which exacerbate malnutrition. Conversely, undernourished children are more susceptible to infections due to weakened immune defenses. Despite the evident interplay between these two conditions, there is a need for comprehensive research to better understand their epidemiology, the extent of their overlap, and the mechanisms through which they influence each other.

In Assela, Ethiopia, Assela referral Hospital serves as a primary Weight and height measurements was taken using a digital balance scale and a wooden measuring board, respectively. Children willing to stand alone will stand in the middle of the scale, while those not willing to stand alone was measured by their mother or caregiver. The weight of the mother or caregiver alone was deducted from the child's weight. Children was weighted without shoes, and the accuracy of the weighing scale was monitored daily. The height of the child was also measured by wooden measuring board. Z scores for weight-for-age (WAZ), weight-for-height (WHZ), and height-for-age (HAZ) was calculated using WHO Anthro plus software v3.2.2 Stunting, underweight, and wasting are defined as HAZ, WAZ, and WHZ, <-2 standard deviations, respectively. Primary healthcare facility for the region, including a pediatric ward that caters to a large number of under-five children. Preliminary observations suggest a high prevalence of both IPIs and undernutrition among these children, in Ethiopia raising significant concerns about their health and development. However, there is limited empirical data specifically addressing the situation in this hospital's pediatric class, making it challenging to design and implement effective interventions.

Understanding the prevalence, risk factors, and impact of IPIs on nutritional status in young children within the context of Assela referral Hospital is crucial for developing targeted public health strategies. Unfortunately, under-five children are more susceptible to infection. However, information is scarce in the study area. Therefore this research aims to investigate the prevalence of intestinal parasitic infections and their association with undernutrition among children under-five years old attending the pediatric ward of Assela referral Hospital.

1.3. Objective

1.3.1. General Objective

Evaluate the Assessment of intestinal parasitic infection and nutritional status in Under-five children visiting Asella referral hospital.

1.3.2. Specific Objectives

- To identify the intestinal parasites found on under-five children in the study area.
- To assess the total prevalence of nutritional status in the under-five children visiting Assela referral hospitals.
- To determine the prevalence of undernutrition between separate sex groups.
- To identify the association between the IPI and undernutrition.

1.4. Significance of the study

The study provides information on the prevalence of intestinal parasitic infections and their association with malnourished children among patients visiting Assela Referral Hospital. It also provides valuable information for public health planning, guiding the development of targeted interventions to prevent and control both conditions. The study can inform the development of preventive strategies, such as educational programs and nutritional interventions, to reduce the incidence of both IPI and undernutrition.

1.5. Scope of the study

It is vital to specify the study's boundaries in order to make it manageable. The study's delimitation must be established in order to make it manageable. The study was confined in terms of topic, methodology, time, and geography. The influence of intestinal parasite infection on the nutritional status of under-five children in Assela town, east Assela Oromia area, is the conceptual focus of this study. The sample population was chosen to study IPI's prevalence and the continued undernourishment in our country and in the study area. The time scope of the study was conducted from January 2024 to march 2024 G.C.

2. LITERATURE REVIEW

2.1. Over view of IPI and undernutrition

Intestinal parasites include both Helminths and protozoa. Helminths are worms such as Tapeworms, pinworms, and roundworms. All of these worms can live but typically do not reproduce inside the human intestine. In contrast to worms, which are composed of many cells, protozoa are single-celled organisms that can multiply inside the body (Charles, 2021). UNICEF identifies undernutrition as a group of disorders like stunting, wasting, and undernutrition that result from insufficient diet, infections, poor breastfeeding practices, delayed complementary food introduction, and inadequate protein, while malnutrition can result from neglect, abnormal mealtimes, and insufficient food quantities (Ansuya *et al*., 2018).

Studies shows a significant link between IPI and undernutrition, particularly in Ethiopia, a sub-Saharan African country with a high prevalence of intestinal parasitic infections and undernutrition, potentially affecting growth and development. Example According to the Alemneh *et al*. (2017) study report, there are different IPIs in children with high prevalence of undernutrition. This high prevalence of IPI is due to habits, poor water supply, and a lack of environmental sanitation, especially where children eat, drink, exercise, develop activities, and play (Francis *et al*., 2014, as cited by Alemneh *et al*., 2017). The prevalence of undernutrition was alarmingly high among children identified with other parasitic infections. The prevalence of stunting among children infected with intestinal parasitic infections (59.4%) was considerably greater than the prevalence in non-infected children (20.6%) ($P < 0.001$).

2.2. Common Intestinal Parasitic Infections in Children

Human intestinal parasitic infections (HIPIs) have been a worldwide public health threat. Such infectious diseases are already identified as neglected tropical diseases (NTDs) and have received attention very recently (Ojha *et al*., 2014). Total control of the transmission of HIPIs and the reduction of possible aggravating factors are among the components of the sustainable development goals of the United Nations. Despite the efforts, intestinal parasites remain a public health burden, specifically in tropical and subtropical regions (Hotez *et al*., 2014). HIPIs, as in many developing countries, are common and cause serious public health problems such as malnutrition, anemia, and growth retardation, as well as a higher susceptibility to other infections (G/hiwot *et al*., 2014).

The main clinical manifestation of infections with IPs is diarrhea, with abdominal cramping, vomiting, flatulence, and weight loss also being common symptoms. The symptoms can be severe in younger children, as well as in undernourished and immune-compromised patients. Besides protozoan parasites, intestinal helminthic infections are also a huge burden in developing countries, including Ethiopia (Abera and Nibret, 2014; Mathewos *et al*., 2014). Ethiopia is a developing country in sub-Saharan Africa, where diarrhea is a significant health problem in children under 5 years of age. In a national survey conducted in 2011, 13% of Ethiopian children under 5 experienced diarrhea within two weeks, with variations across regions. Common causes include *Salmonella, Shigella, Campylobacter* and *E. histolytica and G. duodenalis* (Mulatu *et al*., 2014).

2.2.1. Helminthic IPs

Soil-transmitted Helminths infection are among the most common infections worldwide and affect the poorest and most deprived communities. They are transmitted by eggs present in human feces which in turn contaminate soil in areas where sanitation is poor. There is no direct person-to-person transmission, or infection from fresh feces, because eggs passed in feces need about 3 weeks to mature in the soil before they become infective. The high burden of helminthic infections leads to undernutrition through reduced food intake, malabsorption, endogenous nutrient loss, and anemia-related nutritional problems via excessive blood cell destruction. The presence of *hook worm, Schistosoma mansoni, Trichuris trichiura,* and *Ascaris lumbricoides* infection in particular are associated with undernutrition (Mekonnen *et al*., 2014).

2.2.1.1. *Ascaris lumbricoides*

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

The prevalence is greatest in children younger than 5 years of age. The average cure rate with anthelminthic treatment is over 95%. Unfortunately, most treated patients in endemic areas become re-infected within months (Leung *et al*., 2020). Eating habits like unwashed raw vegetables, absence of toilets, children who defecate in open fields, drinking unprotected water, toilets without cover, and a lack of hand washing before meals and after defecation were the key factors significantly associated with *A. lumbricoides* infection (Hajare *et al*., 2022).

2.2.1.2. *Trichuris trichiura*

Trichuris trichiura, also known as the human whipworm, is a roundworm that causes *trichuriasis* in humans. The eggs are deposited in soil from human feces. After 14 to 21 days, the eggs mature and enter an infective stage. If humans ingest the embryonated eggs, the eggs start to hatch in the human small intestine and utilize the intestinal micro flora and nutrients to multiply and grow. The majority of larvae move to the cecum, penetrate the mucosa, and mature into adulthood. Infections involving a high worm burden will typically involve distal parts of the large intestine (Viswanath *et al*., 2023). The worm is acquired through fecal-oral transmission. A human host consumes infected eggs, typically while eating and drinking contaminated food or water. Once the embryonated eggs are ingested, the larvae hatch in the small intestine.

2.2.2. Protozoan IPs

Infections caused by intestinal protozoan parasites (IPPs) are among the most prevalent human diseases that affect a large section of poor communities particularly in developing countries (Castellanos *et al.,* 2018).There is a high global burden of protozoan intestinal parasites. For instance, *E. histolytica* infected some 48 million individuals. In the same way, there was a high global prevalence of giardiasis. Besides, parasitic worms such as roundworm, hookworm, and whipworm have been among the most common parasites affecting communities in low-income countries (Mascarini, 2011). Intestinal parasitic infections (IPIs) are the most common infections among children in developing countries. *Giardia duodenalis (G. duodenalis), Cryptosporidium parvum (C. parvum),* and *Entamoeba histolytica (E. histolytica*) are the most common protozoan parasites that cause acute diarrheal illnesses in children (WGO, 2012).

2.2.2.1. *Entamoeba histolytica*

Entamoeba histolytica is the protozoan that causes extra intestinal symptoms and intestinal amebiasis. It is still a major global health concern and the third most common cause of death from 121parasitic infections (Ghosh *et al*., 2019). Despite the fact that 90% of *E. histolytica* infections are asymptomatic, up to 100,000 people die from the infection each year, and about 50 million individuals develop symptoms. The majority of Entamoeba-infected individuals are colonized by either *E. dispar* or *histolytica*. The pathogenic type of *E. histolytica* is capable of causing extra intestinal amebiasis and amoebic colitis. According to Ghosh *et al*. (2019), *E. dispar* is regarded as nonpathogenic and doesn't produce any symptoms of illness. Globally, infections happen, although they are more common in nations with low socioeconomic standing and inadequate public health systems.

2.2.2.2. *Giardia lamblia*

Giardia lamblia is a flagellate parasite that is a major cause of epidemic or sporadic diarrhea worldwide. The giardia infection rate can be as high as 30% in developing countries and 7% in developed countries (Minetti *et al*., 2016). *Giardia lamblia* has two morphological forms: cyst and trophozoite. Trophozoites are pear-shaped, bi-nucleate, multi-flagellated parasite forms capable of division by asexual binary fission. This is the active, motile feeding stage that caused the pathology in the small intestine. The cyst forms are non-motile, resistant, and stable stages that don't adhere to the mucosal surface (William *et al*., 2010).

The parasite is associated with poverty, poor sanitation, a lack of clean and safe drinking water supply, and poor personal hygiene (Hajare *et al*., 2022). Giardiasis prevalence rates have been reported consistently as high among young children from developing countries, with high rates of repeated infection even within the first year of life. However, many developed countries have many regions with endemic giardiasis or regular outbreaks. In these countries, giardiasis outbreaks are particularly common during the summer months (likely due to recreational swimming exposure) or throughout the year around daycares and nurseries, infecting children under 5 years old—and their caregivers—the most (Pijnacker *et al*., 2016).

2.3. Undernutrition in Under-five Children

According to the United Nations Children Fund (UNICEF), undernutrition is the outcome of insufficient food intake and recurrent infectious diseases. Undernutrition is a group of disorders that includes stunting, wasting, and being underweight. There is strong evidence that undernutrition is associated with slowed growth, delayed mental development, and reduced intellectual capacity. They can also no longer sustain natural bodily capacities, such as resisting infections and improving from disease (Shrimpton *et al*., 2001, cited in Ahmed A. *et al*., 2017).

Child undernutrition is a global problem with several concerns about survival, the incidence of acute and chronic diseases, healthy development, and the economic productivity of individuals and society (WHO, 2014). Child undernutrition is a major public health problem, especially in many low- and middle-income countries (UNICEF, 2013). For children below 5 years of age, undernutrition can be compounded by severe or repeated infections, with intergenerational influences and consequences (Prendergast and Humphrey, 2014).

A cross-sectional study done by Ma'alin (2016) in Shinile Woreda from February to March 2014 reported that the overall prevalence of undernutrition expressed by stunting, underweight, and wasting was 33.4%, 24.5%, and 20%, respectively. Child undernutrition continues to be a key public health problem in developing countries, including Ethiopia. Ethiopia has demonstrated promising progress in reducing levels of undernutrition over the past decade. However, the baseline levels of undernutrition remain so high that the country still needs to continue substantial investment in nutrition (NNP, 2013).

Nutritional status is measured by Wasting, stunting, and underweight; they are among those anthropometric indicators commonly used to measure under nutrition in a population of under-five children (Zemenu *et al*., 2017).

2.3.1. Stunting

According to a 2015 survey by the World Bank, 23 percent of children under 5 worldwide are shorter than the average height for that age. So, while it is normal for children, especially toddlers, to lose weight as they become more active, consistently low weight and a height growth of less than 2 inches, or none at all, in a year may serve as a harbinger for stunted growth and numerous possible mental and physical health issues. Globally, more than one in four children under the age of 5 years is stunted, and Sub-Saharan Africa and South Asia suffer the heaviest burden (De Silva *et al*., 2013). Stunting is one of the most common indicators of long-lasting undernutrition, which is a true growth failure or inability to reach potential height for a particular age.

Africa and Asia continents are the most highly affected regions by child undernutrition mainly stunting and it accounts for more than nine out of ten of all stunted children globally (DI, 2018). In Ethiopia, stunting remains a major public health problem (EPHI, 2019). The same survey reported the national prevalence of stunting among under-five children as 37%, out of which 17% were below 6 months of age (Ahmed *et al*., 2021). Other studies noted that nearly half of the children were stunted in the Northwest, Southern, and Eastern parts of Ethiopia (EPHI, 2019). It is believed that evidence of stunting at birth is quite crucial to reaching the global target of reducing stunting by 40% by 2025 and also relevant to playing a role in the plan of the government of Ethiopia to end stunting (FDRE, 2016).

The proportion of stunted under-five children with intestinal parasitic infections (69%) was higher than the proportion of under-five children without parasitic infections (61.2%). Under-five children who were infected with intestinal parasites and classified as underweight were also proportionally higher (70.5%) as compared to those without intestinal parasitic infections (54.1%). The proportion of intestinal parasitic infection was also higher among wasted (74%) under-five children than non-wasted (52.2%) (Alemneh *et al*., 2017).

2.3.2. Wasting

Wasting can be caused by an extremely low energy intake (e.g., caused by famine), nutrient losses due to infection, or a combination of low intake and high loss. Infections and conditions associated with wasting include tuberculosis, chronic diarrhea, AIDS, and superior mesenteric artery syndrome. The mechanism may involve cachectic, also called tumor necrosis factor, a macrophage-secreted cytokine. Caretakers and health providers can sometimes contribute to wasting if the patient is placed on an improper diet. Voluntary weight loss and eating disorders are excluded as causes of wasting. An estimated 45 million children under 5 years of age (or 6.7%)

were wasted in 2021 (WHO, 2021). Body Mass Index (BMI) is the quotient between weight and height squared (kg/m2). An individual with a BMI < 18.5 is regarded as wasting.

2.3.3. Under weight

If a person is underweight, their body may not be getting the nutrients it needs to build healthy bones, skin, and hair. Related symptoms or signs can include osteoporosis, anemia, feeling tired, and more.

2.4. Association between Intestinal Parasitic Infection and Undernutrition

Malnourished children are vulnerable to IPI suffering. In contrast, IPI-related chronic infections can contribute considerably to the evolution of undernutrition in the pediatric population, thus creating a potentially lethal cycle or vicious cycle of worsening illness and deteriorating nutritional status (Ajjampur and Tan, 2016). This combination is a significant reason for high under-five mortality in developing and populous nations like Ethiopia. Undernutrition claims nearly half of all deaths in under-five children (WHO, 2020).

The risk of IPI and the resultant possibility of forming a vicious cycle (undernutrition and IPI) make this situation very complex from the family medicine practice perspective (Hooshyar *et al*., 2019). According to WHO, anthropometric indices are used to check the magnitude of undernutrition in terms of stunting, wasting, and underweight.

In low- and middle-income countries, undernutrition often co-exists with STH infections in children (Mekonnen *et al*., 2020). The cause-and-effect relationship between undernutrition and STH infections is reciprocal in that undernutrition may be a predisposing factor for STH infections and several communicable and non-communicable diseases as it affects the physical fitness of the host, including their immune status. On the contrary, STH infections may result in undernutrition by consuming nutrients from the host and/or adversely affecting nutrient absorption.

Vast numbers of under-five children in developing countries face major health and nutrition problems that adversely affect their ability to take advantage of the limited educational opportunities available to them. Because proper nutritional intake increases brain cell development and improves the cognitive performance of the child, undernutrition also decreases the hemoglobin level of children by 0.1 mg/dL. This is due to the fact that undernourished children will not take enough quantity of iron per their demand (Berhanu, 2016). Many of these under-five children have a history of protein-energy malnutrition (PEM) as well as current nutritional deficiencies, including deficits in body stores of iodine, vitamin A, and iron due to IPIs. These conditions are exacerbated by helminthic infections, which are highly prevalent among under-five children and particularly inimical to their healthy growth, development, and educational progress (Gilavand and Hosseinpour, 2016, as cited in Haratipour *et al*., 2016).

There are multiple published studies on malnutrition and IPI in the pediatric age group. But the association between stunting, wasting, and IPI is still controversial. But there is no heterogeneity in the association between underweight and IPI prevalence. All study reports agree that children affected by IPs have low weight because they consume nutrients from the body (Hegazy *et al*., 2014; Haratipour *et al*., 2016; Alemneh *et al*., 2017).

According to deka study done in India, the overall prevalence of stunting and wasting of IPIs was 60.2% and 36.6%, respectively. The most occurred IPs were soil-transmitted Helminths that are *Ascaris lumbricoides*: 21.1%; *Trichuris trichiura*: 13.0%; and *hookworms*: 8.1%), followed by the intestinal protozoa (*Enterobius vermicularis*: 7.3; *Giardia lamblia*: 6.5; and *Cryptosporidium spp*: 2.4%). IPIs were present in 47.2%, and 11.4% showed poly parasitism. The prevalence of IPI was significantly associated with stunting and wasting. Individually, *Ascaris* and *hookworms* contributed significantly to stunting and *Cryptosporidium spp*. to wasting. The association of IPI with stunting (chronic malnutrition) and wasting (acute chronic malnutrition) suggests that intestinal parasites could be an initial step in the evolution of malnutrition (Sangeeta *et al*., 2022).

On the other hand, according to Ihejirika report, the total prevalence rate of IPI was 16.6% recorded in the study areas, with *Ascaris lumbricoides* (4.0%), *Trichuris trichiura* (0.6%), *Hookworm* (1.0%), *Taenia sp*. (0.3%), *Entaomeba histolytica* (5.3%), *Entamoeba coli* (2.7%), and *Giardia lamblia* (2.7%). Anthropometric study results showed that 79 (31.3%) of the children were malnourished. The prevalence of stunting, underweight, and wasting were higher in uninfected children (86.1%, 90.0%, and 10%), respectively, than in infected children (13.9%, 10.0%, and 0.0%), respectively, although not significant at $p = 0.857$, 0.587, and 0.368, respectively (Ihejirika *et al*., 2019).

Undernutrition among under-five children is also a prevalent public health concern in the study area. Significant proportions of under-five children were found to be stunted, wasted, and underweight. *A. lumbricoides* was associated with the three (underweight, wasting, and stunting) forms of nutritional status assessed. *Hookworm* was associated with wasting (weight for height status). G. lamblia was associated with stunting (height for age status) and being underweight (weight for age). *E. histolytica* was associated with height for age, and *T. trichiura* was found to be associated with weight for height. Intestinal parasitic infections were more common among children with low height for age Z-score compared to those with low weight for age Z-score and low weight for height Z-score (Jimenez *et al*., 2009, as cited in Alemneh *et al*., 2017).

The association between IPI and undernutrition is polygonal and indicated by different ways: That were Nutrient absorption impairment, weakened immune system, Appetite suppression, reduced food intake and Increased nutrient requirements.

2.5. Risk Factors for the Prevalence of IPI and Under Nutrition

Poor communities face high rates of HIPIs due to poverty-related factors such as poor sanitation, scarcity of potable water, unsafe waste disposal, open-field defecation, conducive environmental conditions, lack of health services, and low awareness. (Gebreyohanns *et al*., 2018). School and under-five children are highly susceptible to HIPIs due to exposure to the parasites as a result of their behaviors. Thus, urgent treatment and preventive interventions are required (Palmeirim *et al*., 2018). Parasitic infections are more prevalent in children from low socioeconomic backgrounds due to lack of nutritious food, lack of knowledge about childcare, inadequate sanitation facilities, and healthcare access. Intestinal parasitic infections are linked to personal hygiene, with fecal-oral routes being the most common (Fauziah *et al*., 2022). Rural areas lack separate housing for animals, leading to soil contamination. Children's hand-to-mouth behavior and exploratory behavior increase infection risk. Overcrowding in homes increases intra-family transmission, including infant feeding and bathing, from close family members (Forson *et al*., 2018; Thurstans *et al*., 2021). Interestingly, the presence of siblings under-five years old is also a risk factor.

According to Yosef and Beyene (2020) Consuming raw vegetables and fruits has a higher risk of infection in children who consume uncooked vegetables and fruits. On the other way according to Gutierrez *et al.* (2019), IPIs were found in children in rural areas, with no infections in urban children. There is a complete absence of potable water; students obtain their water from nearby streams that might have been contaminated with fecal matter (Opara *et al*., 2012). Factors like ignorance, unhealthy practices, and lack of public amenities, poor sanitation, poverty, and healthcare access were major predisposing factors.

2.6. Implications and Intervention of IPI Method and Under Nutrition

2.6.1. Implication of IPI and undernutrition

Based on its aetiology, Undernutrition in children can be acute or chronic. Primary acute undernutrition occurs due to insufficient food intake, while secondary acute undernutrition is caused by abnormal nutrient loss, increased energy expenditure, or decreased food intake. This condition often occurs with underlying chronic diseases. Acute undernutrition is primarily indicated by wasting (WHO, 2020), while chronic undernutrition occurs due to specific nutrients lacking during early childhood, affecting physical and cognitive growth (Bouma, 2016; Elia, 2017; Cederholm *et al*., 2017; DiPasquale *et al*., 2020).

Undernourishment increases the likelihood of infection and its severity while also slowing recovery (Dobner and Kaser, 2017; UNICEF, 2021). There is a relationship between undernutrition and the immune system, where undernutrition can lead to fatal disruptions in immune system development and vice versa. Immune system disruption increases a child's vulnerability to parasitic infection. Repeated gut infections, on the other hand, may compromise epithelial integrity and reduce nutrition absorption. Thus, these two conditions form a vicious cycles (Simon *et al*., 2015).

2.6.2. Intervention method of IPI and under nutrition

IPIs with respect to Undernutrition in under-five children is a severe issue globally, and effective management can improve or cure malnutrition faster than nutritional support alone. Understanding the prevalence and pattern of IPI in a specific area can help formulate control policies for undernutrition management at primary care level. However, geographical variance and the identification of new, lesser-known parasites complicate the situation (Shrestha *et al*., 2018).

Starving children are vulnerable to IPI suffering. Chronic infections related to IPI can significantly contribute to undernutrition in pediatrics, potentially leading to a vicious cycle of worsening illness and deteriorating nutritional status (Ajjampur and Tan, 2016). Studies show a link between undernutrition and unspecified parasitic infections, with mixed infections potentially contributing more. Education on hygiene, caregiving, deworming, nutrient supplements, and regular evaluation could control parasite infections and improve growth (Fauziah *et al*., 2022).

2.6.2.1. Anti- parasitic Treatment

Administering medications to eliminate the parasites is a crucial step in improving the nutritional status of affected children. Broad-spectrum benzimidazoles (such as albendazole and mebendazole) are the first-line treatment for intestinal roundworm and Tapeworm infections. Macrocyclic lactones (such as Ivermectin) are effective against adult and migrating larval stages of nematodes. Praziquantel is the drug of choice for schistosomiasis, taeniasis, and most types of food-borne trematodiases. Oxamniquine is also widely used in mass deworming programs. Pyrantel is commonly used for veterinary nematodiasis (Al-Wasidi *et al*., 2021). Artemisinins and derivatives are proving to be candidates as drugs of choice for trematodiasis (Perez *et al*., 2012).

2.6.2.2. Nutritional Support

Following parasitic infections, children can experience nutrient malabsorption and depletion and become underweight. Undernourishment can also be caused by a lack of high-quality food. Chronic malnutrition and recurrent infection force the body to break down fat and muscle in order to provide adequate energy and achieve functionality. This condition causes linear growth failure (stunting and wasting), anemia, impaired immunity, and impaired healing, creating a vicious cycle of increased risk of reinfection and severity (Fauziah et al., 2022). Providing nutritional interventions, including supplementation and dietary improvements, is essential to address existing deficiencies and support the recovery of undernourished children. Also breastfeeding practices can reduce the risk of intestinal parasite infection in children under 5 years old, especially those over 12 months old.

2.6.2.3. Hygiene and Sanitation

IPI transmission mainly occurs through fecal contamination due to poor sanitation practices. Unacceptable quality of water, poor personal hygiene, low parental literacy, lack of awareness on hygienic practices, etc., are found to have bearing on the prevalence of IPIs. In Ethiopia, 60 to 80 percent of infectious diseases are due to limited access to potable water, inadequate sanitation and hygiene services (Beyene *et al*., 2015). The absence of sanitation facility in households was positively associated with intestinal parasitic infections.

In addition, an estimated 50 percent of the consequences of under nutrition are caused by socioeconomic factors like poor hygiene and lack of access to water supply and sanitation. There is strong relationship between sanitation and stunting, whereas, open defecation can lead to fecal-oral diseases such as diarrhea which is a one of major cause of malnutrition (Beyene *et al*., 2015). Improving hygiene practices and ensuring access to clean water helps prevent the spread of parasitic infections and reduces the risk of reinfection (Calegar *et al*., 2021).

3. MATERIAL AND METHODS

3.1.Study area and population

The study was conducted at Assela Referral Teaching Hospital, which is in Arsi Zone, in the south-eastern part of Ethiopia. Assela is the capital town of East Arsi Zone located in the Arsi Zone of the Oromia Region 175 km south from Addis Ababa, this town has a latitude and longitude of (7°57′N39°7′E), with an elevation of 2,430 meters. Assela Town, with a population of 94,500 and Arsi Zone has 3.5 million as of the CSA projection (CSA, 2013), serves over 3.6 million people, including neighboring zones. The town has one public university, one public referral hospital, two private general hospitals, two health centers, and ten private clinics. Assela Hospital is one of the teaching hospitals in Ethiopia, and it has different departments: gynecology and obstetrics, surgery, internal medicine, pediatrics, neonatal intensive care unit, and ophthalmology. More than 5,000 deliveries are conducted in the hospital annually.

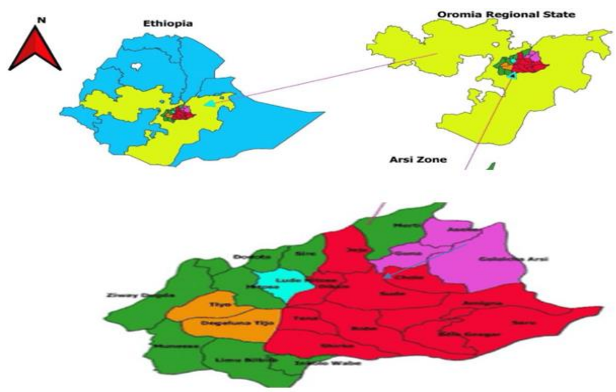

Figure: 1 map of the study area

3.1.1. Eligibility criteria

Inclusion criteria: Under-5-year-old children who were attending the pediatric clinic of the hospital was the study subjects, and those children who can provide stool samples and whose parent or guardian can give consent to be included in the study was eligible.

Exclusion criteria: Any children who are taking anti-parasitic treatment within the last 2 weeks and children less than six month are not part of our study. Because infants aged under 6 months are often excluded from nutrition surveys and marginalized in malnutrition treatment programs.

3.2.Study design and period

A hospital-based cross-sectional study was conducted between February 15 and March 15, 2024.

3.3. Sample Size Determination and Sampling technique

3.3.1. Sample Size Determination

The required sample size was calculated using the single population proportion formula (n = [(Zα/ 2) 2×P (1-P)]/d2), where n is the required sample size, Zα/ 2 is the level of confidence, P is the estimated prevalence of the IPI, and d is the tolerated margin of error. The following assumptions were used to determine sample size: 95% level of confidence, 5% margin of error, 18% prevalence of IPI among under-5 years' children in a recent study in Ethiopia (Eyayu *et al*., 2021), and a 10% non-response rate. Hence, a total of 249 study participants was included in this study.

$n = [(Z\alpha/2)^2 \times P(1-P)]/d^2$ where $d=0.05$ and $Z\alpha/2=1.96$

$$n = \left[\frac{(1.96)^2 \times 0.18(1-0.18)}{(0.05)^2}\right] \qquad n = 3.84(0.1476)/0.0025$$

n=227+10% non-response rate, then the total sample size was n=249

3.3.2. Sampling technique

A systematic random sampling technique was used to select participants. Every child attending the pediatric outpatient class was enlisted until the desired sample size was achieved. According to the hospital data, 300 under-five children come to the hospital in one week, but the researcher planned for one month, so the number of children that come to the hospital was approximately 1,280, then 1280/249 = 5. Finally, the study children were selected using a systematic sampling strategy with a sampling interval of 5. The first child was selected by using a simple random sampling technique. Then, consecutive children were selected at a regular interval of the 5th children until the needed sample size obtained.

3.4. Data Collection Procedure

3.4.1. Interview

Data was collected using a semi-structured questionnaire through face-to-face interviews with the parents or guardians of the children. The questionnaire was developed after reviewing relevant literature. The outcome variables were categorical for nutritional status (stunting, wasting, and underweight), whereas they were binary for IPIs status (positive or negative) for any species. In addition, the potential predictors used was socio-demographic (mothers and children's age, parity, education level, marital status, household size, monthly income, water source, and type of toilet), health status (deworming status), as well as feeding and hygiene habits (feeding habits, meal frequency). During the interview, the cleanliness, fingernail status, and shoe-wearing habits of the child was collected through direct observations of the study participants.

3.4.2. Stool Sample Collection and Laboratory Analysis

First, a clear orientation was given to each child's parent or guardian on how to collect sufficient and appropriate specimens. After that, a clean, dry, leak-proof plastic container was labelled with a unique ID number was given to each parent or guardian of the children to collect the sample. A 5 g stool specimen was collected from each study participant, and all specimens was examined by the direct wet mount method within 30 minutes. The remaining sample was preserved with 10% formalin and processed by the formol-ether concentration method as per the standard operating procedures. All specimen processing and examination takes place at the Assela referral hospital laboratory. After the researcher's observation, the two medical laboratory technologists check the reality and perform both wet mount and concentration techniques for the identification of IP through a light microscope. All standard procedures was strictly followed, from specimen collection up to the reporting and recording of results.

3.4.2.1. Direct microscopic examination using normal saline and iodine preparation

About 1 to 2 mg of stool was emulsified in 1 to 2 drops of 0.85% normal saline or Lugol's iodine solution. A cover slip was placed, and the slide was scanned under the 10× and 40× objectives of a light microscope. Saline wet mount smear preparation was done to detect protozoal trophozoites and helminthic eggs or larvae. Iodine direct smear allows the examination of the characteristic features of the protozoa and the identification of the E. histolytica*/dispar* cyst from the commensal E. coli. In the iodine mount, the cytoplasm of the cyst will stain yellow or light brown, and the nuclei will stain dark brown (WHO, 1991; Cheesbrough, 2009).

3.4.2.2. Formol–ether concentration technique

It is the most frequently used technique to concentrate a wide range of parasites with minimum damage to their morphology, and it is important to increase the chance of detecting parasites. One gram of each sample was emulsified in 7 ml of 10% formalin solution in a centrifuge tube. Filter the emulsified feces and collect them in a test tube. Add 3 to 4 ml of diethyl ether and mix for 1 minute. Then it was centrifuged immediately at 750 to 1000*g* (3000 rpm) for 1 minute. After centrifuging, the parasites will sediment to the bottom of the tube. The centrifuged tube was inverted to decant off the supernatant and allow a few drops of the deposit to remain. Then, after mixing, the sediment will transfer to a slide and be covered with a cover slip. Finally, the preparation was examined under the 10× and 40× objectives of a light microscope (WHO, 1991; Cheesbrough, 2009).

3.5.Anthropometry measurements

Weight and height measurements was taken using a digital balance scale and a wooden measuring board, respectively. Children willing to stand alone will stand in the middle of the scale, while those not willing to stand alone was measured by their mother or caregiver. The weight of the mother or caregiver alone was deducted from the child's weight. Children was weighted without shoes, and the accuracy of the weighing scale was monitored daily. The height of the child was also measured by wooden measuring board. Z scores for weight-for-age (WAZ), weight-for-height (WHZ), and height-for-age (HAZ) was calculated using WHO Anthro plus software v3.2.2 Stunting, underweight, and wasting are defined as HAZ, WAZ, and WHZ, <-2 standard deviations, respectively.

3.6.Data quality control

Primarily, the data collection tool was prepared in the English language. Then, it was translated into the local (Afan Oromo) language. Lastly, it was retranslated back to English to maintain its accuracy and consistency. It is also pre-tested at a nearby hospital (Assela Referral Hospital) on 5% of the calculated samples for the study to improve the quality of the data collection tool. After the pretest, the tool is modified for proper utilization. After the reading of the slide, laboratory technologists read the slides independently to make sure the identification of the IPI and their readings was compared with those of the researcher. Discordant/conflicting is immediately fixed by cross-checking the slide by a senior medical parasitologist. Furthermore, all standard operating procedures are strictly followed during stool sample examination to ensure the quality and sensitivity of the test result. Data quality was checked, entered into Microsoft Excel, exported to SPSS version 24 software, and analyzed.

3.7. Data management and analysis

Before the data analysis, we re-coded some continuous variables. To this end, children's ages are classified into 6 to 11, 12 to 23, 24 to 35, 36 to 47 and 48 to 59 months, whereas less than 21, 21 to 30, 31 to 40, and greater than 41 years are for mothers' ages. Likewise, the household size was re-coded into three levels: from 1 to 3, from 4 to 6, and at least 7 individuals. Entire data was checked for completeness, coded, entered into SPSS version 24 for windows. Anthropometric data was exported from Excel to WHO Anthro plus software v3.2.2 for windows and standard Z-scores was generated for nutritional status: weight-for-height (WHZ), height-for-age (HAZ), and weight-for-age (WAZ). Children below 2 standard deviations (−2SD) of the WHO median for WHZ, HAZ, and WAZ are considered wasted, stunted, or underweight, respectively. Descriptive statistics like frequencies and proportions was calculated. AOR analysis was done to determine the association between specific intestinal parasites and the nutritional status (stunting, underweight, and wasting) of under-five children. Ps less than 0.05 was considered statistically significant.

3.8. Ethical considerations

The study received ethical approval from Hawassa University's research Ethical Review committee and permission from District health offices that is Assela referral hospital. Parents and guardians of the children was provided written and oral consent before stool specimen collection. The study's objectives was explained to the parents, and all data and information was kept confidential.

4. RESULT

4.1. Socio-demographic and economic characteristics of the children and guardian of the children.

Out of the total 249 under-five children invited in the study, 22 (8.8%) under-five children were excluded from the analysis due to dropout, incomplete information or insufficient stool sample size. The proportion of male and female was 55.5% and 44.5% respectively. As shown in **Table 1**, all of the sociodemographic characteristics (variables) of the children and guardian of the children were recorded.

Table 1: Socio-demographic and socio-economic characteristics of the guardian and under-five children in Assela referral hospital, East Arsi zone, Ethiopia, 2024 (N = 227).

Variables	Category	Frequency	Proportion (%)
Sex of the child	Male	126	55.5
	Female	101	44.5
Residence	Rural	95	41.9
	urban/town	132	58.1
Age of the child	6-11 months	7	3.1
	12-23 months	37	16.3
	24-35 months	37	16.3
	36-47 months	92	40.5
	48-59 months	54	23.8
Fingernail cleanness and status	clean and climbed	68	30.0
	clean and unclimbed	31	13.7
	not clean and also unclimbed	78	34.4
	climbed but not clean	50	22.0
Meal frequency	less than three times per day	122	53.7
	greater than or equal to three times per day	105	46.3

4.2. Prevalence of the Intestinal Parasitic Infection

4.2.1. Determinant factors for the prevalence of the IPI in outpatient under-five children in Assela hospital.

Table 2: Analysis by **a logistic regression model** with intestinal parasitic infection (yes or no) as the outcome revealed the following, as shown in (**Table 2)**. Residence, fingernail cleanliness, education level of parents, deworming, water source, toilet and lack of treatment of IPI in their area are the most commonly associated factors of IPI in the area, with household size, household income and others like marital status, age, meal frequency are being negatively associated with intestinal parasite infection at the 5% significant level.

Table 2: Determinants of intestinal parasitic infection, that are significantly associated with the IPI as an outcome variable among children 6–59 months old.

Variable	Category	N (%)	IPI "yes"	IPI "no"	OR (95%CI)	P
Residence	Rural	95 (41.9)	29	66	3.42 (1.71-6.85)	**<0.001**
	urban/town	132 (58.1)	15	117		
Finger-nail status	clean and climbed	68 (30.0)	71	61	1	1
	clean and unclimbed	31 (13.7)	12	19	1.79 (0.44-7.327)	0.413
	not clean and also unclimbed	78 (34.4)	22	56	1.18 (1.06-2.527)	**0.002**
	climbed but not clean	50 (22.0)	3	47	1.29 (1.116-3.74)	**0.009**
Education	unable to read and write	20 (8.8)	8	12	7.56 (1.72-33.3)	**0.007**
	able to read and write	22 (9.7)	7	15	3.86 (1.337-11.2)	**0.013**
	grade 1-6	30 (13.2)	8	22	3.16 (0.78-12.86)	0.107
	grade 7-12	37 (16.3)	3	34	1.43 (0.40-5.017)	0.581
	beyond grade 12	118 (52)	18	100	1.83 (0.55-6.125)	0.325
Deworming	not dewormed at all	45 (25.6)	14	31	3.80 (1.39-10.41)	**0.009**
	once a year	49 (19.8)	9	40	1.71 (0.721-4.05)	0.223
	twice a year dewormed	133 (51.1)	21	112	2.007 (0.77-5.24)	0.155
	Tap water	138 (60.8)	19	119	1	1

Water source	from protected spring	11 (4.8)	2	9	0.254 (0.06-1.03)	0.054
	from un protected spring	20 (8.8)	6	14	1.237 (1.07-2.58)	**0.022**
	from river or stream	58 (25.6)	17	41	1.245 (1.09-4.64)	**0.004**
Toilet	Yes	181 (79.7)	30	151	1	
	No	46 (20.3)	14	32	0.454 (0.22-0.95)	**0.034**

4.3. Prevalence of undernutrition in under-five children

Figure 2: The total prevalence of the undernourishment was 70.9% and the left 29.1% of under-five children was normal. The prevalence of stunting, wasting, and underweight was 16.7%, 26% and 28.2%, respectively. Among these, 13.1%, 17.8% and 5.3% of the children were severely stunted, wasted, and underweighted, respectively.

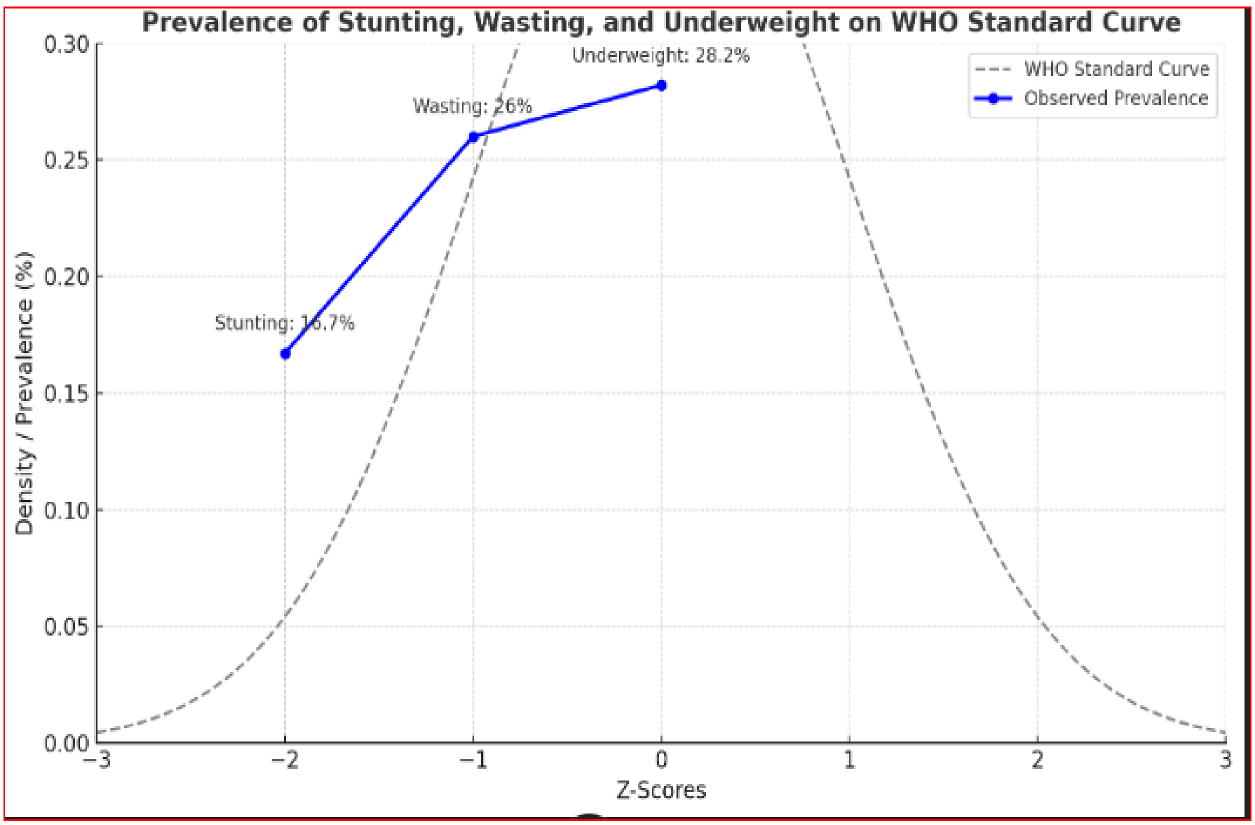

Figure 2: prevalence of stunting, wasting and underweight in percent

4.4. Predictor factors for the prevalence of magnitudes of the undernutrition

Presents results after performing multinomial logistic regression with nutritional status as the outcome and socio-demographic factors as predictors. It was noticed that gender, monthly income, and meal frequency had no significant effect on nutritional status.

4.4.1. Factor associated with stunting

Among the total number of children who participated in the study, 38 (16.7%) were stunted (HAZ<-2SD). Age of the children, meal frequency, monthly income and breast feeding practice were strongly associated with increased odds of being stunted (**Table 3**). The house hold size, age of the care giver and sex of the children were not associated with stunting in this study.

Table 3: multinomial logistic regression analysis of stunting as the outcome and socio-demographic factors as predictors in under-five children.

Variables	Categories	No.	No. of stunted	COR (95%CI)	P	AOR (95%CI)	P
			Stunting (n=38)				
Sex of the child	Male	105	21				
	Female	84	17	1.124 (0.55-2.274)	0.746	1.705 (0.626-4.64)	0.296
Meal frequency	less than three times per day	92	28	0.37 (0.331-0.81)	0.01	0.472 (0.58-0.92)	**0.030**
	greater than or equal to three times per day	88	10				
Age of the child	6-11 months	2	5	1	1	1	1
	12-23 months	16	21	10.7 (1.71-67.1)	**0.011**	5.7 (4.417-32.8)	**0.001**
	24-35 months	31	6	35.8 (5.709-224.9)	**<0.001**	7.8 (1.9-19.0)	**<0.001**
	36-47 months	86	6	4.03 (0.000- _	0.997	2.69 (0.000- _	0.996
	48-59 months	54	0	1	1	1	1
Income	<1000 ETB per month	27	5	2.5 (2.03-2.11)	0.030	4.61 (4.1-4.65)	**0.038**
	1001-3000 ETB per month	84	11	2.1 (1.96-2.60)	0.032	2.61 (2.09-4.19)	**0.045**
	3001-5000 ETB per month	37	11	2.6 (1.65-2.84)	0.022	1.5 (1.60-3.032)	**0.002**
	5001-7000 ETB per month	22	7	0.69 (0.15-0.55)	0.031	0.63 (0.06-0.88)	**0.049**
	>7001 ETB per month	19	4	1	1	1	1
	1-3 children	75	15	1	1	1	1

House hold size	4-6 children	90	16	0.741 (0.273-2.02)	0.558	0.883 (0.191-4.087)	0.874
	>7 children	24	7	1.312 (0.608-2.83)	0.489	3.49 (0.99-12.30)	0.052
age of the care-giver	<21 years	16	3	0.58 (0.123-2.753)	0.494	2.234 (0.294-16.96)	0.437
	21-30 years	84	17	1.076 (0.205-5.65)	0.931	1.965 (0.249-15.52)	0.522
	31-40 years	65	6	0.235 (0.047-1.19)	0.080	0.204 (0.025-1.648)	0.136
	≥41 years	24	12	1	1	1	1
Breast feeding habit	Exclusive BF	27	8	1	1	1	1
	Complementary BF	78	10	0.848 (0.277-2.59)	0.773	1.171 (1.32-2.903)	**0.037**
	Predominant BF	43	9	1.26 (0.425-3.733)	0.676	2.167 (1.32-2.878)	**0.035**
	Mixed/Partial BF	51	11	0.887 (0.266-2.95)	0.845	4.071 (1.211-5.451)	**0.005**

4.3.2. Factor associated with wasting

Of the total participants, 59 (26%) showed the problem of wasting (**Table 4**). The meal frequency, income of the family, house hold size, age of the care giver and breast feeding practices are the common predictor factors that are significantly affect the children but, only age and sex of the children are not significant.

Table 4: multinomial logistic regression analysis of wasting as the outcome and socio-demographic factors as predictors on under-five children.

Variables	**Categories**	**No**	**No. of wasted**	**COR (95%CI)**	**P**	**AOR (95%CI)**	**P**
		Wasting (n=59)					
Sex of the child	Male	89	37	1.49 (0.812-2.743)	0.196	1.19 (0.580-2.440)	0.636
	Female	79	22				
Meal frequency	less than three times per day	103	19	3.33 (1.77-6.25)	0.009	2.49 (1.21-3.73)	**0.010**
	greater than or equal to three times per day	65	40				
Age of the child	6-11 months	7	0	0.000 (0.000- _	0.999	0.000 (0.000- _	0.999
	12-23 months	35	2	0.000 (0.000- _	0.999	0.000 (0.000- _	0.999
	24-35 months	29	8	0.000 (0.000- _	0.999	0.000 (0.000- _	0.999
	36-47 months	63	29	0.000 (0.000- _	0.999	0.000 (0.000- _	0.999
	48-59 months	34	20	0.000 (0.000- _	-	0.000 (0.000- _	-
Income	<1000 ETB per month	23	9	2.15 (0.733-6.320)	0.057	5.639 (1.43-22.23)	**0.026**

	1001-3000 ETB per month	44	8	1.115 (0.44-2.809)	0.320	2.24 (0.411-12.172)	0.173
	3001-5000 ETB per month	57	20	0.678 (0.25-1.842)	0.642	1.85 (0.238-14.401)	0.525
	5001-7000 ETB per month	26	15	1.006 (0.314-3.23)	0.096	3.378 (0.343-33.23)	0.349
	>7001 ETB per month	18	7	1	1	1	1
House hold size	1-3 children	70	20	1	1	1	1
	4-6 children	75	31	0.82 (0.319-2.115)	0.683	0.578 (0.161-2.074)	0.087
	>7 children	23	8	0.69 (0.361-1.324)	0.265	1.437 (1.16-2.901)	**0.049**
age of the care-giver	<21 years	11	8	2.77 (0.989-7.758)	0.052	5.307 (1.517-18.57)	**0.015**
	21-30 years	80	21	1.338 (0.476-3.76)	0.580	2.765 (0.826-9.253)	0.054
	31-40 years	46	25	4.509 (1.21-16.74)	0.024	9.99 (2.104-47.477)	0.321
	≥41 years	31	5	1	1	1	1
Breast feeding habit	Exclusive BF	27	8	1	1	1	1
	Complementary BF	59	29	1.057 (0.406-2.75)	0.909	1.609 (0.49-5.227)	0.604
	Predominant BF	39	13	1.018 (0.42-2.464)	0.968	2.75 (0.06-9.425)	0.056
	Mixed/Partial BF	43	9	1.714 (0.57-5.161)	0.338	1.28 (0.64-2.558)	**0.030**

4.3.3. Factor associated with underweight

A total of 227 children's were used to assess the prevalence of underweight. 64 (28.2%) were underweight (WAZ<-2SD). The binary logistic regression model showed that underweight was strongly associated with breast feeding practice (P: 0.026 OR=1.289 CI (1.097-3.861)) and also meal frequency (P: 0.021; OR= 0.456 CI (0.341-0.890)). (**Table 5**).

Table 5: multinomial logistic regression analysis of underweight as the outcome and socio-demographic factors as predictors on under-five children.

Variables	**Categories**	**No.**	**No. of Underweight Underweight (n=64)**	**COR (95%CI)**	**P**	**AOR (95%CI)**	**P**
Sex of the child	Male	88	38	1.246 (0.693-2.24)	0.463	1.363 (0.708-2.625)	0.354
	Female	75	26				

Meal frequency	less than three times per day	78	44	0.417 (0.23-0.77)	0.017	0.456 (0.341-0.890)	**0.021**
	greater than or equal to three times per day	85	20				
Age of the child	6-11 months	5	2	1	1	1	1
	12-23 months	20	17	1.45 (0.236-8.923)	0.689	2.204 (0.319-15.24)	0.423
	24-35 months	29	8	0.914 (0.167-4.99)	0.918	1.527 (0.245-9.502)	0.650
	36-47 months	64	28	2.00 (0.336-11.97)	0.448	2.967 (0.443-19.85)	0.262
	48-59 months	45	9	0.47 (0.081-2.743)	0.402	0.604 (0.093-3.939)	0.598
Income	<1000 ETB per month	23	9	0.89 (0.367-2.159)	0.798	0.634 (0.223-1.806)	0.394
	1001-3000 ETB per month	36	16	0.950 (0.353-2.59)	0.920	0.614 (0.194-1.942)	0.406
	3001-5000 ETB per month	53	24	1.027(0.335-3.15)	0.963	0.548 (0.146-2.146)	0.388
	5001-7000 ETB per month	31	10	1.859 (0.49-6.995)	0.359	0.996 (0.216-4.599)	0.996
	>7001 ETB per month	20	5	1	1	1	1
House hold size	1-3 children	61	29	1	1	1	1
	4-6 children	78	28	1.63 (0.63-4.219)	0.314	1.877 (0.627-5.623)	0.261
	>7 children	24	7	1.324 (0.714-2.46)	0.373	1.326 (0.621-2.833)	0.466
age of the care-giver	<21 years	12	7	1.77 (0.629-4.197)	0.278	1.796 (0.542-5.949)	0.338
	21-30 years	76	25	1.488 (0.512-4.32)	0.465	1.388 (0.412-4.678)	0.597
	31-40 years	51	20	1.167 (0.36-3.727)	0.795	1.068 (0.279-4.085)	0.924
	≥41 years	24	12	1	1	1	1
Breast feeding habit	Exclusive BF	26	9	1	1	1	1
	Complementary BF	68	20	1.419 (0.509-3.96)	0.504	1.026 (0.338-3.114)	0.965
	Predominant BF	39	13	1.154 (0.46-2.904)	0.761	0.714 (0.251-2.031)	0.528
	Mixed/Partial BF	30	22	0.407 (0.15-1.103)	0.047	1.289 (1.097-3.861)	**0.026**

4.5. Prevalence of the nutritional status in under-five children by the gender

From the total number of the participants 161 (70.9%) undernourished under-five children's 92 (89.4%) were males and 69 (71.6%) were females. From 66 (29.1%) normal under-five children's 34 (36.6%) were males and 32 (29.4%) were females.

Table 6. The prevalence of the undernutrition in relation with the sex difference.

Category	Male	Female	Total
Stunting	21 (16.7%)	17 (16.8%)	38 (16.7%
Wasting	37 (29.4%)	22 (21.8%)	59 (26.0%)
Underweight	38 (30.2%)	26 (25.7%)	64 (28.2%)
Undernutrition	96 (76.3%)	65 (64.3%)	70.1%

4.6. Association of Intestinal Parasitic infection and undernutrition

The researcher observed that 19.4% of malnourished under-five children had IPI. The association of IPIs with undernutrition (P: 0.424) hints that the intestinal parasites do not have any association with malnutrition. In this study we did not find any association between IPI and stunting (P: 0.539; AOR=0.745 CI (0.291-1.911)), but we got positive association with wasting (P: 0.033; AOR=2.114 CI (1.052-4.247)). Underweight also does not have an association with malnutrition (P: 0.824; AOR=1.085 CI (0.526-2.238).

Table 7: Association of nutritional status and intestinal parasites and their cross-tabulation results, in under-five children.

Variables	Categories	N (%)	Undernourished	Normal	X^2	OR	P
Prevalence of IPIs	*E. Histolytica*	20 (8.8)	14	6			
	Giardia lamblia	8 (3.5)	7	1			
	A. lumbricoides	7 (3.1)	6	1	0.639	0.737 (0.348-1.561)	0.424
	E. Vermicularis	10 (4.4)	7	3			
	No O/P seen	182 (80.2)	125	57			
		Stunted	**Non stunted**				
Presence of parasitic infection	Yes	6 (15.8%)	38 (20.1%)				
	No	32 (84.2%)	151 (79.9%)		0.372	0.745 (0.291-1.911)	0.539
	Total	38 (100%)	189 (100%)				
		Wasted	**Non wasted**				
Presence of parasitic infection	Yes	17 (28.8%)	27 (16%)				
	No	42 (71.2%)	141 (84%)		4.537	2.114 (1.052-4.247)	**0.033**
	Total	59 (100%)	168 (100%)				
		Underweight	**normal**				
Presence of parasitic infection	Yes	13 (20.3%)	31 (19%)		0.049	1.085 (0.526-2.238)	0.824
	No	51 (79.7%)	132 (81%)				
	Total	64 (100%)	163 (100%)				

5. DISCUSSION

From the total number of participants, 161 (70.9%) undernourished under-five children’s 92 (89.4%) were males and 69 (71.6%) were females. Of the 66 (29.1%) normal under-five children's, 34 (36.6%) were males and 32 (29.4%) were females. Undernutrition has been reported to be associated with multiple factors; one of those is the sex or gender of the child (Asfaw *et al*., 2015; Roba *et al*., 2021; Birhan and Belay, 2021), which is significantly associated with the nutritional status, but in our case there is no significant association between the gender of the child and undernutrition (P = 0.438; AOR = 0.797 CI (0.448-1.416)).

A descriptive analysis of differences in proportions between groups. A univariate analysis of the different IP infections in children was carried out at Assela Hospital. Among the 227 children who participated in the study, 44 (19.4%) were positive for intestinal parasites. The most common intestinal parasitic infections detected in the study were *E. histolytica* (8.4%), *Enterobius/Vermicularis* (4.4%), and *Giardia lamblia* (3.5%). Analysis according to gender did not reveal gender-related differences with respect to infection. In our study, protozoans were the predominant parasites in malnourished under-five children, in accordance with many other studies (Yosef and Beyene, 2020; Habib *et al*., 2021; Osman *et al*., 2021; Ihejirika *et al*., 2021). Amoeba was the first predominant parasite, affecting a small part of the study population (8.8%) this is approximately related with the studies in Mekane Eyesus (8.1%) and Hawassa (11.4%), followed by Giardia lamblia, the third predominant protozoan parasite, which was (3.5%) prevalent in under-five children in the Assela referral hospital and it is related with research that is done in Mekane Eyesus.

While STH parasites (*E. Vermicularis* and *A. Lumbricoides*) were found only in 4.4% and 3.1% of prevalent Helminths, respectively, a fact with potential impact on primary care practice for the management of such cases, Few other studies elsewhere reported the predominance of STHs in malnourished children (Shrestha *et al*., 2018; Jayaram et al., 2021). The most common intestinal parasitic infections detected in the study were *E. histolytica* (8.4%), *E. vermicularis* (4.4%), and *Giardia lamblia* (3.5%). Poor parental education level, a lower number of dewormed houses, not washing hands before eating (dirty hands, uncleaned and unclimbed fingernails), and a lack of potable drinking water could have exposed children to the infection of IPIs. These were the most significant predictor variables.

The presence of rural land respondents and the lack of health facilities around their area lead to a lack of treatments like albendazole and mebendazole, which are the most significant factors that are associated with IPIs. Children are in the habit of eating whatever they come across while crawling, and this exposes them to *E. histolytica*. The presence of access to treatment (P: 0.049; OR=0.068 CI (0.005-0.986)) this means the children which have an access of IPI treatment decreases the chance of infecting by *E. histolytica* by 6.8%, sex of the children's (P: 0.018; OR=4.064 CI (1.271-12.06)) males are more vulnerable than women, and source of drinking water (P: 0.043; OR=1.23 CI (0.003-0.912)) is directly associated with the infection of *E. histolytica*. So, children who don’t have access to clear water were 1.2 times more vulnerable to IPIs. The risk and severity of *E. histolytica* infection in children are strongly influenced by the quality of drinking water and the availability of treatment. Access to clean water and prompt treatment are crucial in preventing and managing the disease. While there may be some differences in infection rates or disease outcomes between male and female children, these differences are likely influenced by a combination of biological, cultural, and social factors.

Ascaris is a parasitic infection with a significant association with lack of treatment of IPI (P: 0.005; OR=2.231 CI (0.024-0.673)) without proper treatment, an Ascaris infection can lead to a high worm burden. Untreated individuals continue to pass Ascaris eggs in their feces, contributing to environmental contamination and increasing the risk of spreading the infection to others, especially in communities with poor sanitation and the other one is finger cleanliness and status (P: 0.080; OR=0.140 CI (0.026-0.741)), this means the children which have clean finger nail can decrease the IPIs infection by 14%. Fingernails can harbor dirt and microorganisms, including Ascaris eggs. If an individual with poor fingernail hygiene handles contaminated soil or food, the eggs can stick to their nails. When they touch their mouth or handle food, the eggs can be ingested, leading to infection. E. Vermicularis does not show any significant association with the predictor factors.

Analysis by a logistic regression model with intestinal parasitic infection (yes or no) as the outcome revealed the following: - Residence, fingernail cleanliness, education level of parents, deworming, water source are toilet are the most commonly associated factors of IPI in the area, but household size, household income, and others like marital status, age, and meal frequency are being negatively associated with intestinal parasite infection at the 5% significant level. Household size is not associated with IPIs in this research area, but according to Yosef and Beyene, 2020, they observed that IPIs were 2.7 times higher in children living in large families, and Feleke B, 2016 reported a 2.06 times higher chance of IPIs in families with > 4 members, but similar to Mulatu *et al*., 2015, we did not find any significant relationship between family size and IPIs. Household income also has a negative relationship with IPI.

Those whose fingernails were unclean and not climbed and children's that were climbed but unclean were 18% and 29%, respectively, more likely to be infected with at least one species of IPs compared to those with clean fingernails. Those whose residence is rural were 3.42 times more affected than urban children. This is similar with opara *et al*. (2012) that he states the rural children's are more prone to the IPIs than the urban children's. This may be due to the rural children's do not have an access for the clean water, there is no awareness about the disease and others (Fauziah *et al*., 2022), but chalkeba *et al*. (2020) says there is no difference in the residence for the susceptibility of the IPIs.

IPI transmission mainly occurs through faecal contamination due to poor sanitation practices, which is the source of the water (P: 0.022; OR=1.237 CI (1.069–2.580) was for the family that uses unprotected spring water, and (P: 0.004; OR=1.245 CI (1.09–4.64) was for the family that uses river and spring water. This indicates the family that uses unprotected spring and river water was the predictors and 1.2times causes for IPI disease. So that the family that uses unprotected spring and river water was the most susceptible to the prevalence of the intestinal parasitic infection disease. Unacceptable quality of water, poor personal hygiene, low parental literacy, a lack of awareness of hygienic practices, etc. are found to have a bearing on the prevalence of IPIs (Okyay *et al*., 2004; Zonta *et al*., 2019; Yosef and Beyene, 2020; and Deka *et al*., 2021).

Paternal education level was also significantly linked to IPIs (P: 0.007; OR = 7.56 CI (1.72–33.3) and P: 0.013; OR = 3.86 CI (1.337–11.7)), which was the result of the family's uneducated parents being unaware of clean and safe hygienic practices. This indicates that the family that was unable to read and write is 7.56 times more vulnerable, and the family that is educated from grades 1-6 is 3.86 times more vulnerable to the parasitic infection. According to Zonta *et al*., 2019 also observed that 63.7% of infected children had mothers educated up to the primary level. In contrast, Okyay *et al*. (2004) reported that 42.6% of children with IPIs had illiterate parents. H/Gabriel T. (2018) reported that the risk of IPI doubles when a child is born to illiterate parents. So, similar to the above findings, our finding also indicates that children with illiterate parents are exposed to parasitic infection.

The children that have a family that does not deworm their house are 3.8 times more susceptible to the IPIs (P: 0.009; OR = 3.80 (1.39–10.41). Similarly, families that have toilets (P: 0.034; OR = 0.454 CI (0.22-0.95)). So families with access to a toilet have a lower risk of contracting IPI, with the odds reduced by about 54.6% compared to families without toilets, and IPI treatment in their area (P: <0.001; OR = 0.199 CI (0.10-0.40)) that means The odds of having IPI are reduced by approximately 80.1% in areas with treatment access, as compared to those without. This finding is highly statistically significant and indicates that access to treatment is an important factor in preventing IPI in the population. This is similar with Gebreyohanns *et al*. (2018) says lack of health care service causes IPIs.

The prevalence of IPI in malnourished children has been found to vary depending on the geographic location, sampling population, study design, and sensitivity of the laboratory methods used. There are multiple published studies on malnutrition and IPI in the paediatric age group. However, to the best of our knowledge, this is the first study from east Arsi Zone Assela Hospital to assess the nutritional status of under-five children and correlate intestinal parasites in them. We observed that 19.4% of malnourished under-five children had IPI. This was relatively similar to the findings of other studies, viz., Awasthi *et al*., 1997, with 17.5% from Lucknow, India; Ihejirika *et al*., 2019 with 16.6% from Nigeria; Amare *et al*., 2013 (22.7%) from northwest Ethiopia; Eyayu T, 2021 (18%) from Mekane Eyesus; Mekonnen H; and Ekubagewargies D, 2019 with 18.7% from Woreta, etc.

But a higher rate, comparable to our finding, was reported by many studies conducted elsewhere (Hailegebriel T., 2018; Elfu F., 2016; Habib *et al*., 2021; Osman *et al*., 2020; Yosef and Beyene, 2020; Deka *et al*., 2023, etc.). This may be due to the fact that most of the children have access to IPI treatment in their area; most are urban children, so there is access to clear water; there is sanitation; most are government employee children’s, so this means there is information about the disease. The detection of malnourishment in nearly half of the population (under-five age group) was a significant finding from the general practice (family medicine) perspective.

The prevalence of stunting, underweight, and wasting was 16.7%, 28.2%, and 26%, respectively. Among these, 13.1%, 5.3%, and 17.8% of the children were severely stunted, underweighted, and wasted, respectively. The nutritional assessment using anthropometric indices revealed that 16.7% were stunted, 26% were wasted, and 28.2% were underweight. The prevalence of stunting was found to be lower than statistical reports of studies from, Hidabu Abote district-Ethiopia (Mengistu *et al*., 2013), Hawassa-Ethiopia (Wolde *et al*., 2014), Alemneh *et al*., 2017, Hawassa, Osman *et al*., 2019-Somali, and Deka Sangeeta, 2023, but the prevalence of wasting and underweight is higher than the Ethiopian mini-Demographic and Health Survey report but lower than (Osman *et al*., 2019 and Deka *et al*., 2023).

The observed difference might be because of variations in the study period, setting, season, and social attitude towards the case. Stunting is a better report than in another place, which may be the time period the research is done, and the geographical area also has an effect. But because of the area is not too cold the prevalence is not too high in relation to other studies. Cold weather conditions can affect the prevalence of stunting, primarily by exacerbating food insecurity, increasing energy and nutrient demands, raising the risk of infections, and influencing feeding practices (Hongoli J & Hahn Y 2023). As compared to studies conducted in Gumbrit-Ethiopia (34% stunting) (Melkie, 2007), Nigeria (39.2% stunting) and Gambia (31.2% stunting) (CSA, 2019), the prevalence of stunting in the study area was lower than the Ethiopian mini-demographic and health survey reports. However, the proportion of wasting (26%) on under-five children was higher than that of the countrywide figure of 9% of wasting (EmDHS, 2014), but lower than the research done in Somalia by Osman *et al*., 2019 reports, and 34% of under-five children were wasted, according to Deka *et al*. (2022).

According to the present study results, the age of the child was significantly associated with stunting. Stunting is mainly associated with the age of the children, who were 12-23 and 24-35 months old; that was (P: 0.001; OR=7.8) and (P: <0.001; OR 5.7), respectively. The children aged 12-23 months are 5.7 times and 24-35 months 7.8 times more prone to being stunted. As their age become increases the chance becoming stunted also increase. The reason is that one nutritional need means this period is crucial for growth and development. Inadequate intake of essential nutrients, such as protein, vitamins, and minerals, can impede growth. Transition to solid food, increased nutritional demand, frequent illnesses, and socioeconomic factors are the reasons that the children aged 12-35 are more prone to being stunted than others. Meal frequency was also another predictor factor for stunting (P = 0.030; OR = 0.472). The OR of 0.472 suggests that children who have a higher meal frequency are less likely to be stunted compared to those with a lower meal frequency. Specifically, the odds of stunting in children with higher meal frequency are about 47.2% of the odds in the reference group (likely children with lower meal frequency.

Another predictor variable was the monthly income of the family; the family that has an income of <1000 ETB as monthly income is 4.61 times more vulnerable than others, and family income that has 1001-3000 ETB is 2.61 times more stunted than others. This indicates that as the income of the family increases, the chance of the children being stunted will decrease. Breastfeeding practice was also another main predictor variable for stunting. Except the children that were Exclusively BF, other children who were Complementary BF, Predominant BF, and Mixed/Partial BF were significantly associated with the stunting (P: 0.037; OR=1.171; P: 0.035; OR=2.167; and P: 0.005; OR=4.071, respectively). This suggests that children receiving complementary feeding were 17.1% more likely to be stunted, children who were predominantly breastfed were more than twice as likely to be stunted and children who were mixed or partially breastfed were over four times more likely to be stunted compared to exclusively breastfed children. Due to the fact that stunting is a chronic disease that lasts a long time, addressing this issue requires a multifaceted approach that includes improving household income, promoting and supporting optimal breastfeeding practices, and ensuring regular, nutritious meals for children.

Wasting was significantly associated with meal frequency (P= 0.010; OR=2.49), family income (P: 0.026; OR = 5.639). This implies that families with income <1000 per month are 5.639 times more vulnerable than others to wasting. This may be due to wasting is occur shortly, the weight of the children may decrease and cause weight loss. This is similar to the study done by Sharkey *et al*. (2011), which says poor economic status may limit families' access to food and health services. But according to Asa *et al*. (2022) income, household size, and age of the care-givers do not have any significant effect on nutritional status except the household size with wasting, but three of them are significant in our case.

Household size (P: 0.049; OR=1.437) families that have many children were 43.7% more wasted than others; children who were their families are younger than 21 years old (P: 0.015; OR=5.307) were 5.307 times more wasted; and children who practiced a mixed/partial breast feeding habit (P: 0.030; OR=1.280) were 1.28 times more wasted. On the other hand, gender and age of the child had no significant effect on wasting. The age of the child shows a constant effect that has the same result on values. This may be due to the fact that the variable has the same odds ratio for different categories or levels, which may suggest that the effect of the variable is consistent across these categories. This could happen if the variable is coded in a way that doesn't differentiate between categories effectively or if the categories inherently have the same impact on the outcome.

Underweight was directly significantly associated with meal frequency and breast feeding practice (P: 0.026), and children with Mixed/Partial BF were 28.9% more vulnerable than the others. Factors like sex and age of the child, age of the care-giver and income of the family are not significantly associated with underweight. Since breast-feeding practice is the common predictor factor for all three undernutrition predictors, there must be criticism. If complementary feeding or Mixed/Partial BF is introduced too early, it is not possible for the child to absorb the necessary nutrients, and if it is introduced too late, the mother’s milk will not be able to supply the nutrients required for optimal continued growth. It is therefore recommended by the World Health Organisation (WHO, 2000) that complementary feeding be introduced at approximately 6 months of age. In contrast, research in Senegal reported that “no correlation was found between breastfeeding and the nutritional status of children (Gupta *et al*., 2007).” Studies in Ethiopia and Botswana showed that breastfeeding reduced the odds of a child being underweight and wasted (Fekadu *et al*., 2015). The results of this study conflict with the results of the longitudinal study conducted by Fawzi and colleagues, which showed that prolonged breastfed children from poorer families had a higher risk of being undernourished.

Similarly, stunting, wasting, and underweight also don’t have any association with the gender (sex) of the under-five children in our study (P: 0.745; OR=1.124 CI (0.555–2.274), P: 0.195; OR=1.493 CI (0.812–2.743), and P: 0.462; OR=1.246 CI (0.693–2.239), respectively). But a pooled analysis of 35 longitudinal cohorts from 15 LMICs showed male sex to be a predictor of both wasting and stunting (Mertens *et al*., 2020). Several studies exploring concurrent wasting and stunting have also shown that, overall, boys are more likely to be affected than girls; these include population-level data (Khara *et al*., 2017; Myatt et al., 2018; Obeng *et al*., 2020; Garenne *et al*., 2021). But in our study, this difference is not visible, there is no significant association between undernutrition and sex. This suggests that undernutrition affects individuals regardless of their gender. The prevalence or severity of undernutrition is not influenced by whether a person is male or female. Instead, access to resources, income, or breastfeeding practices may be more significant in determining the risk of undernutrition.

Different studies shows that there is a strong relationship between intestinal parasitic infection and undernutrition (Hegazy *et al*., 2014; Ahmed *et al*., 2015; and Melese and Beyene, 2017); on the other hand, there are studies that show that there is no association between IPI and undernutrition in children. An example study carried out in Adama, Ethiopia (Reji *et al*., 2011) shows no relationship between IPI and undernutrition. Similarly, our study observed that there is no overall significant association between intestinal parasitic infections (IPI) and undernutrition in under-five outpatient children when considering undernutrition as a single entity (P = 0.424; AOR = 0.737 CI (0.348–1.561)). However, when the three magnitudes of malnutrition (stunting, wasting, and underweight) were analysed individually, a significant association was found between IPI and wasting. This was similar to research done by deka sangeeta and kabeta. This nuanced and complicated finding highlights the complex relationship between IPI and different forms of undernutrition.

6. CONCLUSSION AND RECOMMENDATION

6.1. CONCLUSSION

This study showed that 19.4% of the children in Assela referral hospital have an intestinal parasitic infection, and 16.7%, 28.2%, and 26% were stunted, underweighted, and wasted, respectively. The most prevalent species of intestinal parasitic infections were E. histolytica. No mixed infections with polyparasites were identified. Furthermore, it was observed that there is no overall significant association between intestinal parasitic infections (IPI) and undernutrition in under-five outpatient children when considering undernutrition as a single. However, when the three magnitudes of malnutrition (stunting, wasting, and underweight) were analyzed individually, a significant association was found between IPI and wasting. Residence, fingernail cleanliness, education level of parents, deworming, water source and toilet are the most commonly associated factors of IPI in the area.

The age of the child, meal frequency, family income and breast feeding practice were the significant predictor factors for stunting, and also meal frequency and breast feeding practices were the significant factors for underweight. The meal frequency, age of the care-givers, household size, family income, and breast-feeding habits were the predictor factors for wasting. The findings suggest a multifaceted approach is necessary to tackle both intestinal parasitic infections and undernutrition, specifically wasting, in under-five children. By addressing the associated factors through targeted interventions, education, improved sanitation, and routine healthcare services, significant improvements in the health and nutritional status of children can be achieved. These recommendations aim to guide policymakers, healthcare providers, and community leaders in implementing effective strategies to combat these interrelated health issues.

6.2. RECOMMENDATIONS

Based on the findings of the study, the researcher identified specific factors associated with intestinal parasitic infections (IPI) and undernutrition, particularly wasting:

Public health interventions for intestinal parasitic infections (IPIs) include targeted deworming programs for under-five children, health education campaigns, sanitation infrastructure improvements, routine screening and treatment and health checks, nutritional support programs, community-based interventions, and comprehensive health policies.

- Integrated deworming programs are implemented, with priority given to under-five children identified as wasted.
- Health education campaigns emphasize hygiene practices and community outreach. Regular screening programs are implemented, with under-five children identified as wasted being systematically checked for IPIs.
- Supplementary feeding programs and breastfeeding support are also implemented.
- Community-based interventions involve local leaders and healthcare workers in spreading awareness and implementing hygiene practices.
- Further Research and Surveillance: Longitudinal Studies: - Encourage further research to explore the long-term effects of IPIs on child growth and development, and the effectiveness of various intervention strategies.

7. RERERENCES

Abera A and Nibret E (2014). Prevalence of gastrointestinal helminthic infections and associated risk factors among schoolchildren in Tilili town, northwest Ethiopia. *Asian Pac J Trop Med*; **7**, 525–30.

Adam B and Bitew, B (2021). Associated risk factors of underweight among under-five children in Ethiopia using multilevel ordinal logistic regression model. *Afr. Health Sci;* **21**(1), 362–372.

Afridi MF, Farhat K, Ali S, Qaisrani MN, Ahmed Z (2021). Prevalence of intestinal parasitic infestations in relation to wasting among children less than 5 years of age in Skardu, Pakistan: A cross sectional observational study. *Isra Med. J*; **13**, 130–133.

Ahmed MS, Sahrin S, Yunus FM (2021). Association between maternal antenatal care visits and newborn low birth weight in Bangladesh: *a national representative*; **10**, 935.

Ahmed A, Sakineh S, Shahabeddin R, Kurosh D (2017). Nutritional Status of Under-five Children in Ethiopia*: Ethiop J Health Sci*. **27**(2).

Ahmed A, Al-Mekhlafi H, Al-Adhroey A, Ithoi I, Abdulsalam A, and Surin J (2012). The nutritional impacts of soil-transmitted helminths infections among Orang Asli school children in rural Malaysia. Parasites Vectors; **5**:119.

Ajjampur SS and Tan KS (2016). Pathogenic mechanisms in Blastocystis spp. interpreting results from in vitro and in vivo studies. *Parasitol Int*; **65**(6), 772–779.

Alemneh K, Sintayehu A, Dejene H, Getenesh B (2017). Intestinal parasitic infections and nutritional status of under-five children in Hawassa Zuria District, South Ethiopia. *African Journal of Microbiology Research*; **11**(31), 1243-1251

Alsubaie A, Azazy A, Omer E, Al-shibani L, Al-Mekhlafi A, Al-Khawlani F (2016). Pattern of parasitic infections as public health problem among school children: a comparative study between rural and urban areas. *Journal Taibah Univ Med*; **11**(1), 13–18.

Al-Wasidi AS, Refat MS, Naglah AM, Elhenawy AA (2021). Different potential biological activities of benzimidazole derivatives. *Egyptian Journal of Chemistry*. **64**(5), 2431-46

Amare B, Ali J, Moges B, Yismaw G, Belyhun Y, Gebretsadik S, Woldeyohannes D *et al.,(*2013). Nutritional status, intestinal parasite infection and allergy among school children in northwest Ethiopia. BMC Pediatric; **13**:7.

Ansuya, Nayak B, Unnikrishnan B, George A, Shashidhara YN, Mundkur S, Guddattu V (2018). Risk factors for malnutrition among preschool children in rural Karnataka: a case-control study. *BMC Public Health;* **18**(1), 283

Asa BF, Shintouo CM, Shey RA, Afoumbom MT, Siekeh N, Yoah A, Kah E *et al*. (2022) , correlates of undernutrition and intestinal parasitic infection among children below 5 years living in the forest community of Ndelele, East Region of Cameroon: A cross-sectional assessment. *PLoS ONE*; **17**(12), e0278333.

Asfaw M, Wondaferash M, Taha M and Dube L (2015). Prevalence of undernutrition and associated factors among children aged between six to fifty nine months in Bule Hora district, South Ethiopia. *BMC Public Health*; **15**(1): 41.

Awasthi S, Pande VK (1997). Prevalence of malnutrition and intestinal parasites in preschool slum children in Lucknow. *Indian Pediatric*; **34**:599-605.

Berhanu E (2016). Nutritional Status and Intestinal Parasite in School Age Children: A Comparative Cross-Sectional Study. *International Journal of Pediatrics*.1962128

Beyene A, Hailu T, Faris K, Kloos H (2015) Current state and trends of access to sanitation in Ethiopia and the need to revise indicators to monitor progress in the post2015 era. *BMC Public Health*; **15**(1), 1–8.

Birhan N and Belay D (2021). Associated risk factors of underweight among under-five children in Ethiopia using multilevel ordinal logistic regression model. *Afr. Health Sci*; **21**(1): 362–372.

Bolka G and Philipos K (2021). Prevalence of Intestinal Parasite Infection and its Association with Anemia among Children Aged 6 to 59 Months in Sidama National Regional State, Southern Ethiopia. *Clinical Medicine Insights: Pediatrics;* **15**, 1–6

Bouma S (2016). Diagnosing Pediatric Malnutrition. *Nutr. Clin. Pract*; **32**, 52–67.

Calegar DA, Bacelar PA, Monteiro KJL, Dos Santos JP, Gonçalves AB, Boia MN (2021). A community-based, cross-sectional study to assess interactions between income, nutritional status and enteric parasitism in two Brazilian cities: Are we moving positively towards 2030? *J Health Popul Nutrition*; **40** (26).

Castellanos G, White A, Melby P, Travi, B (2018). Molecular diagnosis of protozoan parasites by Recombinase Polymerase Amplification. *Acta tropica*; **182**, 4–11.

Cederholm T, Barazzoni R, Austin P, Ballmer P, Biolo G, Bischoff S, Compher C, *et al* (2017). ESPEN guidelines on definitions and terminology of clinical nutrition. *Clin. Nutr*; **36**, 49.

Charles Patrick Davis (2021). Definition of intestinal parasite. University of Texas.

Cheesbrough M (2009). *District Laboratory Practice in Tropical Countries, Part I*. Cambridge University Press.

Chelkeba L, Mekonnen Z, Alemu Z, Emana D (2020). Epidemiology of intestinal parasitic infections in preschool and school-aged Ethiopian children: a systematic review and meta-analysis. *BMC Public Health*; **20**, 117

CSA (2016). Ethiopia Demographic and Health Survey, Addis Ababa, Ethiopia.

CSA (2013). Ethiopia Demographic and Health Survey 2011. Addis Ababa, Ethiopia Elizabeth M. Ward: Maternal Nutrition.

Derso T, Tariku A, Biks G, & Wassie, M (2017). Stunting, wasting and associated factors among children aged 6–24 months in Dabat health and demographic surveillance system site: A community based cross-sectional study in Ethiopia. BMC *Pediatric*. **17**(1), 96.

De Silva MJ, Cooper S, Li HL, Lund C, Patel V (2024). Effect of psychosocial interventions on social functioning in depression and schizophrenia: meta-analysis. *Br J Psychiatry*. 2013 Apr; 253-60.

Development Initiatives (2018). Global Nutrition Report: Shining a Light to Spur Action on Nutrition. Bristol, UK: Development Initiatives.

DiPasquale V, Cucinotta U, Romano C (2020). Acute Malnutrition in Children: Pathophysiology, Clinical Effects and Treatment. *Nutrients*; **12**, 2413.

Dobner J and Kaser S (2017). Body mass index and the risk of infection-from underweight to obesity. *Clin. Microbiol. Infect*; **24**:26–28.

Elia M (2017). Defining, Recognizing, and Reporting Malnutrition. *Int. J. Low. Extremity Wounds*; **16**, 230–237.

Ethiopia Demographic and health Survey (2011). Central Statistical Agency, Addis Ababa, Ethiopia, ICF International Calverton, Maryland, USA 2012.

Ethiopian Public Health Institute (EPHI) Ethiopia and ICF (2019). Mini Demographic and Health Survey 2019. Key Indicators. Rockville, Maryland, USA: EPHI.

Eyayu T, Wubie A, Kiros T, Tiruneh T, Damtie S, Sema M, Abebaw A, *et al*. (2021). Prevalence of Intestinal Parasitosis and Its Associated Factors Among Children Aged 6 to 59months

Attending Mekane Eyesus Primary Hospital, Northcentral Ethiopia. *Global Pediatric Health*; **8**, 1–10

FDRE (2016) Implementation Plan of the Seqota Declaration. The Federal Democratic Republic.

Fekadu Y, Mesfin A, Haile D, Stoecker BJ (2015). Factors associated with nutritional status of infants and young children in Somali Region, Ethiopia: A cross-sectional study. BMC Public Health; **15**, 846.

Feleke BE (2016). Nutritional status and intestinal parasite in school age children: A comparative cross-sectional study. Int J Pediatr; 1962128

Forson AO, Arthur I, Ayeh-Kumi PF (2018). The role of family size, employment and education of parents in the prevalence of intestinal parasitic infections in school children in Accra. *PLoS ONE*; **13**, e0192303.

Forson AO, Arthur I, Olu-Taiwo M, Glover KK, Pappoe-Ashong PJ, Ayeh-Kumi PF (2017). Intestinal parasitic infections and risk factors: a cross-sectional survey of some school children in a suburb in Accra, Ghana. *BMC Res Notes*; **10**(1), 485.

G/hiwot Y, Degarege A, Erko B (2014).Prevalence of Intestinal Parasitic Infections among Children under-five Years of Age with Emphasis on Schistosoma mansoni in Wonji Shoa Sugar Estate, Ethiopia. *Journal Articles: Epidemiology;* **132**.

Garenne M, Thurstans S, Briend A, Dolan C, Khara T, Myatt M, Seal A *et al*., (2021). Changing sex differences in undernutrition of African children: Findings from Demographic and Health Surveys. *Journal of Biosoc*; 1–11.

Gebreyohanns A, Legese MH, Wolde M, Leta G, Tasew G (2018) "Prevalence of intestinal parasites versus knowledge, attitude and practices (KAPs) with special emphasis to Schistosoma mansoni among individuals who have river water contact in Addiremets town, Western Tigray, Ethiopia," *PloS One*; **13** (9).

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

Gilbert H (2014). Determinants of malnutrition among under-five children in Nakaseke and Nakasongola Woredas of Central Uganda.

Golden M (2000). Comment on: Including infants in nutrition surveys. Experiences of ACF in Kabul city. Field Exchange; **9**:16.

Gupta N, Gehri M, Stettler N (2007). Early introduction of water and complementary feeding and nutritional status of children in northern Senegal. *Pub Health Nutrition*; **10**:1299–30.

Gutiérrez J, Luna LM, Cruz LM, De Aquino JA, Sandoval D, León AT, Hernández JA, *et al.* (2019). Children from a rural region in The Chiapas Highlands, Mexico, show an increased risk of stunting and intestinal parasitoses when compared with urban children. *Bol. Med. Hosp. Infant Mex*; **76**

Habib A, Andrianonimiadana L, Rakotondrainipiana M, Andriantsalama P, Randriamparany R, Randremanana RV, Womas V *et al*., (2021). High prevalence of intestinal parasite infestations among stunted and control children aged 2 to 5 years old in two neighborhoods of Antananarivo, Madagascar. *PLoSNegl Trop Dis*; **15**:e0009333.

Hadush A and Pal M (2016). Ascariasis: Public Health Importance and its Status in Ethiopia. *Air Water Borne Diseases*; **5**(1), 124.

Hailegebriel T (2018). Undernutrition, intestinal parasitic infection and associated risk factors among selected primary school children in Bahir Dar, Ethiopia. *BMC Infect Dis*; **18**:394.

Haratipour H, Sohrabi MB, Zolfaghari P, Nezakati E, Yahyaei E, Rezvani S (2016). The Relationship between Malnutrition and Intestinal Parasitic Infections among Preschool Children in East Area of Iran. *Int J Pediatric*; **4**(6), 2011-18.

Hegazy AM, Tawakol N, Aminou H, Badr AM (2014). Prevalence of intestinal parasites and its impact on nutritional status among preschool children living in Damanhur City El-Behera Governorate, Egypt. *J. Egypt Soc. Parasitology*; **44**, 517–524.

Hogenauer C and Hammer H (2016). Maldigestion and Malabsorption. *Sleisenger and Fordtran's Gastrointestinal and Liver Disease.* 10th ed. Saunders; Philadelphia, PA, USA: pp. 1788–1825.

Hongoli J & Hahn Y (2023). Early life exposure to cold weather shocks and growth stunting: Evidence from Tanzania. *Health Economics*, ***32***(12), 2855-2879.

Hooshyar H, Rostamkhani P, Arbabi M, Delavari M (2019). Giardia lamblia infection: review of current diagnostic strategies. *Gastroenterol Hepatol Bed Bench*; **12**(1), 3–12.

Hotez PJ, Alvarado M, Basáñez MJ (2014). The global burden of disease study: interpretation and implications for the neglected tropical diseases," *PLoS Neglected Tropical Diseases*; **8** (7).

Ihejirika OC, Nwaorgu OC, Ebirim CI, Nwokeji CM (2019). Effects of intestinal parasitic infections on nutritional status of primary children in Imo State Nigeria. *Pan African Med Journal*; 33-34.

Jayaram S, Saya GK, Rajkumari N, Ulaganeethi R, Roy PK, Mathavaswami V (2021). Prevalence of intestinal parasitic infection and its associated factors among children in Puducherry, South India: Acommunity-based study. *J Parasit Dis*; **45**:597-902.

Kamau P, Aloo-Obudho P, Kabiru E, Ombacho K, Langat B, Mucheru O, Ireri L (2012). Prevalence of intestinal parasitic infections in certified food-handlers working in food establishments in the City of Nairobi, Kenya. *J Biomed Res*; **24**(2), 84–89.

Khara T, Mwangome M, Ngari M, Dolan C (2017). Children concurrently wasted and stunted: A meta-analysis of prevalence data of children 6–59 months from 84 countries. *Matern. Child Nutr*; **14**, e12516.

Kiani H, Haghighi A, Salehi R, Azargashb E (2016). Distribution and risk factors associated with intestinal parasite infections among children with gastrointestinal disorders. *Gastroenterol Hepatol Bed Bench*; **9**(Suppl1), S80.

Leung AKC, Leung AAM, Wong AHC, Hon KL (2020). Human Ascariasis: An Updated Review. *Recent Patents on Inflammation and Allergy Drug Discovery*; **14**(2), 133-145

Ma'alin A, Birhanu D, Melaku S, Tolossa D, Mohammed Y, Gebremicheal K. (2016). Magnitude and factors associated with malnutrition in children 6–59 months of age in Shinille Woreda, Ethiopian Somali regional state. *BMC Nutrition*; **2**, 44.

Marino M, Masella R, Bulzomi, P, Campesi I, Malorni W, Franconi, F (2011). Nutrition and human health from a sex–gender perspective. Mol. Asp. Med; **32**, 1–70.

Marshall J, Warrington R, Watson W, Kim H. (2018). An introduction to immunology and immunopathology. *Allergy Asthma Clin Immunol*; **14**, 49.

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

Mathewos B, Alemu A, Woldeyohannes D, Alemu A, Addis Z, Tiruneh M (2014). Current status of soil transmitted Helminths and Schistosoma mansoni infection among children in two primary schools in North Gondar, Northwest Ethiopia: a cross sectional study. *BMC Res Notes*; **7**, 88.

Mekonnen Z, Hassen D, Debalke S, Tiruneh A, Asres Y, Chelkeba L (2020) "Soil-transmitted helminthic infections and nutritional status of school children in government elementary schools in Jimma Town, Southwestern Ethiopia." *SAGE open medicine*; **8** 2050312120954696.

Mekonnen Z, Meka S, Zeynudin A, Suleman S (2014). Schistosoma mansoni infection and undernutrition among school age children in Fincha'a sugar estate, rural part of West Ethiopia. *BMC Research Notes*; **7**, 763.

Melesse B (2018). Association of Major Intestinal Parasitic Infections and Nutritional Status on Academic Performance of Primary Schoolchildren in Enemore-Ener and Abeshege Districts, Gurage Zone, South Central Ethiopia. A Thesis submitted to The Department of Microbial, Cellular and Molecular Biology. Addis Ababa University.

Melesse B, Kelebesa U, Beyene P (2017). Prevalence and determinants of intestinal parasitic infections among primary schoolchildren in Gurage zone, South Central Ethiopia. *EC Microbiol*; **8**(2), 59–70.

Mengistu K, Alemu K, Destaw B (2013). Prevalence of malnutrition and associated factors among children aged 6–59 months at Hidabu Abote District, North Shewa, Oromia Regional State. *J nutr disorders ther*; **1**: 1–15

Minetti C, Chalmers RM, Beeching NJ, Probert C, Lamden K. (2016). Giardiasis. *BMJ*; **355**, i5369.

Mulatu G, Beyene G, Zeynudin A (2014). Prevalence of Shigella, salmonella and campylobacter species and their susceptibility patters among under-five children with diarrhea in hawassa town, South Ethiopia. *Ethiop J Health; **26***, 101–8.

Murarkar S , Gothankar J , Doke P , Pore P , Lalwani S , Dhumale G , Quraishi S, *et al*.(2020). Prevalence and determinants of undernutrition among under-five children residing in urban slums and rural area, Maharashtra, India. *BMC Public Health*; **20**, 1559

Myatt M, Khara T, Schoenbuchner S, Pietzsch S, Dolan C, Lelijveld N, Briend A (2018). Children who are both wasted and stunted are also underweight and have a high risk of death: A descriptive epidemiology of multiple anthropometric deficits using data from 51 countries. *Arch. Public Health*; **76**, 1–11.

NNP (2013). Ethiopian National Nutrition Program, (June 2013).

Obeng-Amoako G, Sunday C, Nangendo J, Okiring J, Kiirya Y, Aryeetey R, Mupere E *et al* (2020). Factors associated with concurrent wasting and stunting among children 6-59 months in Karamoja, Uganda. *Matern. Child Nutr;* **17**, e13074.

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

Okyay P, Ertug S, Gultekin B, Onen O, Beser E (2004). Intestinal parasites prevalence and related factors in school children, Awestern city sample--Turkey. *BMC Public Health*; **4**:64.

Opara K, Udoidung N, Opara D, Okon O, Edosomwan E, Udoh A. (2012*)*. The Impact of Intestinal Parasitic Infections on the Nutritional Status of Rural and Urban School-Aged Children in Nigeria. *International Journal of MCH and AIDS*; **1**(1), 73-82

Osman K, Zinsstag J, Tschopp R, Schelling E, Hattendorf J, Umer A, Ali S *et al.* (2020). Nutritional status and intestinal parasites among young children from pastoralist communities of the Ethiopian Somali region *Matern Child Nutr*; **16**, e12955.

Palmeirim M, Ouattara M, Essé C, Koffi V, Assaré R, Hürlimann E, Coulibaly J, *et al.* (2018). Are schoolchildren less infected if they have good knowledge about parasitic worms? *BMC Public Health*; **18**(1), 1-11.

Paniker CKJ (2018). Paniker's Textbook of Medical Parasitology. 8th ed. New Delhi: Jaypee *Brothers Medical Publishers*.

Perez V, Burguillo F, Lopez-Aban J, Muro A (2012). Systematic review and meta-analysis of artemisinin-based therapies for the treatment and prevention of schistosomiasis. *PLoS ONE* **7**(9), e45867

Pijnacker R, Mughini L, Heusinkveld M, Roelfsema J, van Pelt W, Kortbeek, T (2016). Different risk factors for infection with Giardia lamblia assemblages A and B in children attending day-care centers. *European Journal of Clinical Microbiology and Infectious Disease*; **35**, 2005-2013.

Prendergast AJ and Humphrey JH (2014). The stunting syndrome in developing countries. *Paediatr int child health*; **34**(4), 250–245.

Roba A, Assefa N, Dessie Y, Tolera A, Teji K, Elena H, Bliznashka L et al. (2021). Prevalence and determinants of concurrent wasting and stunting and other indicators of malnutrition among children 6–59 months old in Kersa, Ethiopia. Matern. *Child Nutr*. **17**(3), e13172.

Rumsey P and Waseem M (2023). Giardia Lamblia Enteritis. In: Stat Pearls [Internet]. Treasure Island (FL); *PMID*; 30285390.

Sangeeta D, Deepjyoti K, Naba H (2022). Prevalence and Risk Factors of Intestinal Parasitic Infection in Under-Five Children with Malnutrition: A Hospital Based Cross-Sectional Study J*ournal of Family Medicine and Primary Care;* **11**(6), 2794-2801.

Shrestha A, Schindler C, Odermatt P, Gerold J, Erismann S, Sharma S (2018). Intestinal parasite infections and associated risk factors among schoolchildren in Dolakha and Ramechhap districts, Nepal. *Parasitic Vectors*; **11**, 532

Simon A, Hollander G, McMichael A (2015). Evolution of the immune system in humans from infancy to old age. *Proc. R. Soc. B Biol*; **282**, 20143085.

Sousa D, Gonçalves T, Marto N, Horta A (2020). Malabsorption Due to Chronic Giardiasis as a Presenting Symptom of Common Variable Immunodeficiency. *Cureus*; **12**, e12201

Thurstans S, Opondo C, Seal, A, Wells J, Khara T, Dolan C, Briend A et al., (2022). Understanding Sex Differences in Childhood Undernutrition: A Narrative Review. *Nutrients*; **14**, 948.

Thurstans S, Sessions N, Dolan C, Sadler K, Cichon B, Isanaka S, Roberfroid D, *et al*. (2021). The relationship between wasting and stunting in young children: A systematic review. *Matern. Child Nutr*; **18**.

Townsel C, Emmer S, Campbell W, Hussain N (2017). Gender Differences in Respiratory Morbidity and Mortality of Preterm Neonates. Front. *Pediatr*; **5**, 6.

UNICEF/WHO/The World Bank Group joint child malnutrition estimates (2021): levels and trends in child malnutrition: key findings of the 2021 edition. World Health Organization. ISBN 9789240025257

UNICEF. Improving child nutrition: the achievable imperative for global progress. 2013.

Viswanath A, Yarrarapu SNS, Williams M (2023). Trichuris trichiura Infection. In: Stat Pearls [Internet]. Treasure Island (FL): Stat Pearls Publishing; *PMID;* 29939620.

Vivancos V, Gonzalez-Alvarez I, Bermejo M, Gonzalez-Alvarez M (2018). Giardiasis: characteristics, pathogenesis and new insights about treatment. *Curr Top Med Chem*; **18**(15), 1287–1303.

WHO (2021). “Soil-transmitted helminthic infections,” https://www.who.int/en/news-room/factsheets/detail/soil-transmitted-helminth-infections.

WHO (2020). Soil Transmitted Helminthic infections 02 March 2020 Available from: https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections Last accessed on 2021Aug 15

WHO (2016). Nutrition Landscape Information System (NLIS). Accessed February 2016. http://apps.who.int/nutrition/ landscape/report.aspx.

WHO (2014). Nutrition Landscape Information System (NLIS) Country Profile Indicators, 2nd ed. Geneva: Interpretation Guide.

WHO (2000). Complementary feeding. Geneva: World Health Organization, 2000; 1–2.

WHO (1991). *Basic Laboratory Methods in Medical Parasitology*. World Health Organization.

Wolde S, Tefera B, Debebe M (2016) Prevalence of Acute Malnutrition (Wasting) and Associated Factors among Preschool Children aged 36-60 Months at Hawassa zuria, South Ethiopia. *Journal of Nutr Food*; **6**: 466.

Workineh L, Almaw A, Eyayu T (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.

Yirga A, Mwambi H, Ayele D, Melese S (2019). Factors affecting child malnutrition in Ethiopia. *Afr. Health Sci.* **19**(2), 1897.

Yosef A and Beyene H (2020). The high prevalence of intestinal parasitic infections is associated with stunting among children aged 6-59 months in Boricha Woreda, Southern Ethiopia: Across-sectional study. *BMC Public Health*; **20**, 1270.

Zemene T and Shiferaw M (2018). Prevalence of intestinal parasitic infections in children under the age of 5 years attending the Debre Birhan referral hospital, North Shoa, Ethiopia. *BMC Res. Notes*; **11**, 58.

Zemenu B, Tsigereda M, Alemu T, Mesfine, Sintayehu Y (2017) "Malnutrition and associated factors among under-five children (6–59 months) at Shashemene referral hospital, West Arsi zone, Oromia, Ethiopia," *Current Pediatric Research*; **21**(1), 172– 180.

Zonta ML, Cociancic P, Oyhenart EE, Navone GT (2019). Intestinal parasitosis, undernutrition and socio-environmental factors in schoolchildren from Clorinda Formosa, Argentina.Rev Salud Publica (Bogota); **21**:224-31.

Appendix 1. Questionnaire

Questionnaire is prepared for parents/guardians/care takers of the children that is Semi-structured questionnaire prepared after reviewing different literatures for interview.

Name of interviewers _______________ signature ________________

English version questionnaire

Dear Study participants my name is ________________. I am doing the study to figure out the effect of intestinal parasitic infection on nutritional status in under-five children in Assela town, east Arsi zone, Oromia region, Ethiopia. I want to assure you that all of your answers will be kept strictly and only used for research purpose. I humbly ask you to do his part to pass on the right information. 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 ________________

1. **Socio-demographic Information:**

1.1. What is the age gender of the child?

1.2. What is the family's socio-economic status?

1.2.1. Age of the mothers of the children?

a) <21 b) 21 to 30 c) 31 to 40 d) > 41 years

1.2.2. What is the family income/wealth status?

a) <1000 b) 1001-3000 c) 3001-5000 d) 5001-7000 e) >7000

1.2.3. What is the number of house hold size in the house? _________

a) 1-3 b) 4-6 c) >7

1.3. Marital status a) Married b) Single c) Divorced d) Widowed

1.4. What is your occupation?

a) Student b) Unemployed c) Daily labor d) Farmer e) Merchant f) Government employee g) Others (specify)_____

2. **Health History:**

2.1.Has the child received any treatment for intestinal parasitic infections?

a) Yes b) No

3. **Hygiene and Sanitation Practices:**

3.1.Hand washing habit after using the toilet?

3.2.From where do you get your drinking water? One or more than one answers are possible.

a) Tap water. b) From protected/cleaned spring /well

c) From un protected/un cleaned spring /well d) From river or stream

4. Environmental Factors:

4.1.Residence a) town b) rural

4.2.Do you have a kitchen (separate) from your house? a) yes b) no c) other (specify).

5. Socio-Cultural Practices:

5.1.Do you practice the breast feeding habit before six month without any other complementary food?

5.2.Frequency of deworming per year?

5.3.Wearing shoes?

5.4.Finger nails cleanness and status?

5.5.Habit of eating raw meat

6. Access to Healthcare:

6.1.Is there a health facilities around your area?

6.2.Do you have a habit to go health institutions for any disease out breaks?

7. Parental Knowledge and Awareness:

7.1.How much do parents/guardians know about the risks and prevention of intestinal parasitic infections and undernutrition in children?

7.2.Do you have radio or television set? a) yes b) no

7.3.What are your mothers / husband education level?

a) Unable to read /write b) Able to read /write c) Grade 1-6

d) Grade 7-12 e) Beyond grade 12

8. Nutritional Status:

8.1.What is the Frequency meals? a) Less than three times b) Greater than or equal to three times

8.2.What is the child's current weight and height?

Subject’s code number _______ subjects age ________sex _______