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

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A Thesis submitted to

The Department of Microbial, Cellular and Molecular Biology

In Fulfillment of the Requirements for the Degree of Doctor of Philosophy

(Biomedical Sciences)

Addis Ababa University

Addis Ababa, Ethiopia

April 2018

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

Association of major intestinal parasitic infections and nutritional status on academic performance of primary school children from Gurage zone, Southern Ethiopia

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A Thesis Presented to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment of the Requirements for the PhD Degree in Biology (Biomedical Science)

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ACKNOWLEDGEMENTS

I would like to express my deepest thanks and appreciation to my supervisor Professor Beyene Petros, **Professor of Biomedical Sciences, *Addis Ababa University* and Ato Kelbesa Urega, *EPHI*** for their unreserved effort in advising me to conduct my research on this topic and providing me with valuable information and for continuous follow-up of my work to enrich my knowledge and skill in conducting this research. Professor Beyene is not only a supervisor but also a good father, and an excellent model. Particularly his day-to-day follow up and a constructive suggestion has enabled effective finalization of my work.

My sincere appreciations also extend to the Gurage zone health and education department, Enemore and Abeshege woreda council, health and education office, Gunchre mazoria Eyoel clinic,for the provision of laboratory facilities and material support. Laboratory technicians, especially Gunchre hospital and Holle health centre are also greatly acknowledged for helping and facilitating the collection of stool samples during my field work and EPHI for serum ferritin analysis.

My special thanks go to Dr. Lester Chitsulo, *Department of Control of Neglected Tropical Diseases, WHO, Switzerland, Geneva,* for supporting me with the materials necessary for Kato-Katz test.Dr. Girmay Medhin, *Aklilu Lemma Institute of Pathobiology, Addis Ababa University, Addis Ababa, Ethiopia* are highly acknowledged for statistical advices, Ms. Bezawit Daniel for supporting me with writing edition and printing.

Ms. Yirgalem (laboratory technologist), *Aklilu Lemma Institute of Pathobiology, Addis Ababa University, Addis Ababa, Ethiopia* are also acknowledged for her technical support during field and laboratory work.

The Office of Vice President for *Research and Publication and Dean of School of Graduate Studies*, *Addis Ababa University* has provided financial support for which I am grateful. Due thank is also forwarded to the *Department of Microbial, Cellular and Molecular Biology* for facilitating my work.

The study has also received financial support from the *Thematic Research Projects* entitled "Studies on 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". My appreciation also goes to *Hawassa University*, *Ethiopia*, for sponsoring,financial support and giving me a study leave.

Very special and heartfelt thanks go to my wife Meseret Yemane to our children Sofonias and Rakeb for their patience, tolerance and moral endurance during my absence.

My sincere thanks go to my family members: my father Birmeka Adeba, my mother Astede Biraro,my brothers and sisters for their moral and finacial support. My heartfelt thank also extends to heads, staffs and study participants of the Gurage zone schools,hospitals and Health Centers I visited for sample collection.

Many individuals have made important contributions throughout the thesis work.Dr.Mebrate Dufera, Dr. Akmel Nure, Dr.Damtew Bekele, Degife Marega, Zewdu Birmeka, Elfinesh Birmeka, Haile Birmeka, Selamawit Birmeka, Mesfin Mazoria, (Tibebu Moges and Dilnesaw of EPHI). I owe heart felt thanks to all of them.

Finally thanks for those who are involved directly or indirectly in this work who I have not mentioned their name here.

Dedication

To my wife Meseret Yemane, my children Sofonias Melesse and Rakeb Melesse, who weren't sure, what I was doing, but provided their love and support always.

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ABBREVATIONS/ACRONYMS

AOR- Adjusted Odds Ratio

BMI - Body Mass Index

CSA- Central Statistical Authority of Ethiopia

CDC- Centre for Disease Control and prevention

CHW- Community Health Worker

DALYs- disability adjusted life years

DHS- Demographic and Health Survey

EPHI-Ethiopian Public Health Institute

FAO - Food and Agriculture Organization

FGD- Focus Group Discussion

HAZ- Height- for- age Z score

IDA-Iron deficiency anemia

IDD-Iodine deficiency disorder

IHI- Intestinal helminth infection

IP -Intestinal parasites

IPI-Intestinal parasitic infection

LBW-Low birth weight

MN-Malnutrition

MND -Micro nutrient deficiency

MOH- Ministry of Health

MUAC- Mid-upper Arm Circumference

NCHS- National Centre for Health Statistics

NNS - National nutrition strategy

PEM -Protein energy malnutrition

TDS-Trichuis dysentery syndrome

UNICEF- United Nations Children's Fund

VAD-Vitamin A deficiency

WAZ- Weight-for- Age Z score

WHZ- Weight-for- Height Z score

WHO- World Health Organization

YLD -years lived with disablities

ABSTRACT

Intestinal parasitic infection (IPI) and undernutrition have been reported to affect the physical growth, cognitive development, and the general health status of schoolchildren. However, data are scarce regarding their effect on the overall health status and school performance of schoolchildren in Ethiopia. To assess these effects, a school based repeated cross-sectional study was conducted on 680 schoolchildren- 450 from Enemore-Ener and 230 fromAbeshege districts in Gurage Zone, South Central Ethiopia. Data were gathered on the socio-demographic/economic conditions of the selected households of the study participants through structured survey methods, i.e. direct observations, interviews, focus group discussions and document reviews.Heamoglobin concentration was measured and adjusted for altitude to determine anemia. Fresh stool samples were collected and processed by the wet mount, Kato-Katz and formol-ether concentration methods to examine IPI. Anthropometric measurements: weight, height and body mass index were analyzed using WHO (2007) anthro plus software. School performance was determined based on school academic records. SPSS statistical software version 20 was used for data analysis and P-value <0.05 was reported as statistically significant. The prevalence of any IPIs in schoolchildren was 40% in Enemore-Ener and 38.7% in Abeshege districts. The prevalence of anemia was 34.7% in Enemore-Ener, which was significantly (P<0.05) lower than in Abeshege (41.6%). Intestinal parasitic infections in Enemore-Ener district, use of Kocho as staple food, was a significant factor for increased anemia, stunting, thinness and poor school performance (P< 0.05), whereas in Abeshege district, a population that mainly consumes cereals, IPI was a significant factor only for increased stunting, thinness and poor school performance (P< 0.05). Overall, IPI was a significant factor decreased haemoglobin levels population (P=0.00). Thus, children with IPI were significantly (P< 0.05) likely to be anemic than children with no IPI.Increased risk of anemia was significantly associated with hookworm (P=0.02), ascaris (P=0.03) and Giardia (P=0.02). Poor school performance increased with increasing IPI, anemia, thinness and stunting in the study population (P< 0.05). IPI was a significant factor (P=0.00) for increase in undernutrition. Also, stunting and thinness increased with increasing IPI in the two study populations (P< 0.05) ie, severely and moderately stunted children had more IPIs compared with those with normal growth for their age. Similarly, severely and moderately thin children had more IPIs. Anthropometric measurements for WAZ, HAZ, and BAZ of the total study population were below the WHO (2007) growth standard or reference values. Accordingly, 39.6% in Enemore-Ener and 41.6% in Abeshege were stunted (HAZ< -2SD); while 41.8% in Enemore-Ener and 41.3% in Abeshege were thin (BAZ< -2SD) and 48.8% in Enemore-Ener and 46.3% in Abeshege were underweight (WAZ<-2SD). The findings of this study showed the prevalence of IPI to be associated with anemia, undernutrition and poor school performance. The study has provided evidence from undernutrition,IPI and anemia that the livelihood of the schoolchildren in Enemore-Ener and Abeshege ditricts is adversely affected.The findings of this study could serve as a guide in designing and implementing intervention strategies to alleviate the co-morbidity of IPI, malnutrition and iron deficiency anemia on the well-being of schoolchildren under Ethiopian health services condition.

KEYWORDS: Intestinal parasites, anemia, schoolchildren, Malnutrition, Gurage zone, prevalence, incidence, risk factors, school performance.

1. INTRODUCTION

Parasites affect human well-being in various ways since ancient times. For instance, the intestinal parasite, *Ascaris*, has persisted successfully as a human parasite through the stone, copper and iron ages (WHO, 2003; Hotez *et al*., 2006).Even at the present stage of human civilization, parasitic diseases, in association with nutritional deficiencies, remain killers of humans in many parts of the world and conditions are worse in children (Crompton and Nesheim, 2002; Hotez *et al*., 2006).

Intestnal parasitic infections (IPI) in Ethiopia have been shown to be closely associated with low household income, poor personal hygiene and environmental sanitation, overcrowding, limited access to clean water and low altitude (Mengistu *et al*., 2007). Eventhough precise estimates of the populations at risk of infection, morbidity and mortality are difficult to derive, more than 2 billion people might be infected in the world with helminths, which cause high morbidity in pre-school and school-aged children and pregnant women (Hotez *et al*., 2006; King, 2010). Futhermore, helminths have a negative effect on physical fitness and cause growth retardation, delayed intellectual development and cognition (Pullan and Brooker, 2008). In protozoan infections, giardiasis is known to be associated with vitamin A deficiency, malabsorption of vitamin B_{12} and fat and other nutritional deficiencies in children (Matthys *et al*., 2011). In general, IPIs affect about 3.5 billion people globally, of which 450 million are ill, the majority being children (WHO, 1998 cited in Vahid *et al*., 2009).

Intestnal parasitic infection transmission is governed by behavioral, biological, environmental, socio-economic and health systems.The transmission and associated morbidity and mortality are higher in less developed countries (King , 2010).Furthermore,the prevalence and intensity of IPIs the world over have shown significant variation in distribution and in its seasonal occurrence due to geographical and climatic factors and living conditions of the population (Egwunyenga *et al*.,2005).As in many other developing countries, wide-ranging distribution of intestinal parasites occur in Ethiopia mainly due to the low level of environmental and personal hygiene, contamination of food and drinking water that result from inappropriate disposal of human excreta (Legesse and Erko,2004).

Intestinal parasitic helminth and protozoan infections are most common co-infections world wide (Mwangi *et al.,* 2006; Helmby, 2007). The majority of affected population are children in the poor communities.They also are significant causes of anemia in children and pregnant women.In Africa, over a quarter of school aged children are at high risk of coincident infections with helminths and protozoa and consequently at enhanced risk of clinical diseases (Brooker *et al.*, 2006).

School age children are the main IPI risk group leading to nutritional, health, and developmental consequences and more pronounced morbidity and mortality(Ezeamama *et al*.,2005;Jardim-Botelho *et al.*,2008).This might be due to high exposure,their higher nutritional requirements and less mature immune systems (Guyatt,2000). Furthermore, malnourished children are the most affected, and the chronic malnutrition-IPI cycle, which commonly begins during childhood, has been linked to decreased work capacity and productivity in adolescents and adults (Guyatt, 2000; King, 2010).

In Gurage area, Ensete (*Enset ventricosum*) is cultivated as staple food crop similar to the other high lands of central, south and south western Ethiopia. Its products are used for different nutritional, non-nutritional and medical purposes. Kocho (Fermented product of the starchy parts of enset) is the main food product made of enset and also includes *bulla* and *amicho*. Ensete growing areas are characterized by a high density of human population (Tsegaye and Westphal, 2002).It has relatively high yield compared with yields of other crops. *Kocho* is the fermented product of the starchy parts of the plant and can be baked like bread. Dry *kocho* and *bulla* are energy-rich and can provide from 1400 to 2000kJ per 100g (Tsegaye and Westphal, 2002).

Ensete is rich only in carbohydrates, but low in protein and fat (each contributing less than 3% to the total energy content). Ensete products, *kocho* and *bulla*, contain nearly no thiamine, riboflavin, vitamin A and C, but contain some calcium and a quite high content of iron.It is a monotonous staple diet in Gurage region (Agren and Gibson, 1986).

The iron content might be high partly through the fermentation in the soil since some soil types are very rich in iron(Abebe *et al*.,2007).Although fermentation process increases the low essential amino acid content of *kocho*, methionine and isoleucine remain to be the limiting amino acids in *kocho*, whereas lysine is relatively high (Besrat *et al*., 1979).Since, kocho is low in protein,vitamin and fat contents, it is inadequate to meet the minimum protein requirement unless it is supplemented with other sources (Agren and Gibson, 1986).

Because of its low protein content and fermented taste, *kocho* is seldom consumed on its own, except during periods of extreme famine, or by poor households who do not have the means to vary their diet. It is often consumed with cabbage, kale, beans and maize, and on special occasions with meat, cheese and eggs. The most vulnerable group is young children in poor families, because their *Kocho*-based diets are often highly nutritionaly deficient with an exception of iron and carbohydrate (Agren and Gibson, 1986).

Hence, the nutritional deficiency of *Kocho* sheds concern on the perception that " *Kocho* culture" populations are better off in Ethiopia.Children need to be healthy and well nourished in order to perform well in school. They constitute more than 25% of the total population in Ethiopia and are the future productive force. Schoolchildren need more attention and care because they are vulnerable to nutritional deficiencies and the debilitating effects of IPIs. Helminthiasis and parasitic protozoal infections are among the leading causes of medical and nutritional consultations in the country (Asemahagn, 2014; Degarege *et al.*, 2015).

1.1. Global epidemiology of Intestinal Parasitic Infection

Intestinal parasitic infections belong to neglected diseases, one of the major health problems of the present-day world (Hotez *et al*., 2007). It is estimated that over two billion people are infected with intestinal pathogenic parasites, and 5 billion live in areas where intestinal parasites are endemic (Harp,2003).The incidence of gastrointestinal parasitic diseases is exceptionally high in developing countries, where soil and water contamination, a limited number of households with access to safe drinking water sources, a large number of asymptomatic carriers, low standards of hygiene, and lack of health care result in the spread of orally transmitted infections (Fernandez *et al*.,2002; Kucik *et al*.,2004).

Intestinal parasitic infections are prevalent in all stages of human development; so far, children are the worst affected (Bdir and Adwan, 2010).World Health Organization (WHO) estimates that some 50% of the population worldwide are affected by intestinal parasites, and that half a million are ill, the majority being children and women of reproductive age (WHO,1998 cited in Mengistu *et al*., 2007;WHO,2010).They are the top global health problems whereby schistosomiasis, amoebiasis, ascariasis, hookworm infection and trichiuriasis are among the ten most common infections (Mengistu *et al*., 2007).

In developing countries, particularly those with tropical climates and at low altitudes, IPIs remain a serious medical and public health concern among the poor, and the main transmission route is fecal-oral, through contaminated food or water (Mengistu *et al*., 2007; Nyarango *et al*., 2008).

Parasitic protozoa live in the gastro-intestinal tract of humans, cause severe disease and deadly diarrhea (Chen *et al*., 2007). Three of the most common intestinal protozoan parasites are *Entamoeba histolytica*, *Giardia lamblia* and *Cryptosporidium parvum,* infecting human worldwide (Marshall *et al*., 1997). *Entamoeba histolytica/dispar* infections (90%) are asymptomatic and the remaining 10% produce a spectrum of clinical syndromes. More than 500 million are infected and of those 110,000 die every year in the world (Bdir and Adwan, 2010). About 10% of the world's population is infected with *E. histolytica or E. dispar,* and the prevalence may vary 10% to 50% in poor tropical nations (Gamboa *et al*., 2003). Virulent cysts in *E. histolytica* are transmitted chiefly by ingestion of contaminated food or water or through direct contact in humans (Haque *et al*., 2003). *Entameba histolytica* is the third most common cause of death among parasitic diseases (after schistosomiasis and malaria) (Bdir and Adwan, 2010).

Giardia lamblia is widely distributed parasitic protozoa infection in poor nations of the world (20 to 30 %), particularely in temperate and tropical region. It commonly infects infants early in life and children younger than 10 years and undernourished children are more frequently infected than adults (Tigabu *et al*., 2010). It was estimated that about 200 million people are infected each year in Africa, Asia and Latin America (Partovi *et al.*, 2007). Furthermore, the effect of *Giardia lamblia* infections on cognitive function has been reported (Partovi *et al.*, 2007).

Intestinal helminth infections (IHI) are among the most common chronic infections of the developing world (Agbolade *et al.*, 2004),and estimated that very nearly 2 billion people are infected by single or multiple infections,of these almost 300 million result in severe morbidity.This might be caused by the heaviest worm burdens (De Silva *et al*., 2003;Hotez *et al*., 2004).

Children are the most affected group of severe intestinal helminth infections that leads to several nutritional anemias, protein energy malnutrition and reduced physical growth and the development and, morbidity and mortality (Stephenson *et al.*, 2000b).Furthermore, helminth infections have been linked to an increased risk of severe complications, such as bowel obstruction, bile duct infection and pancreatic duct infection, although it evolves slowly and gradually and remains asymptomatic or mildly symptomatic (Bdir and Adwan, 2010). More than 613 million school-age children in the world are at risk of STH infection (WHO, 2010).

In general, helminthiasis has been resulted in poor birth outcome, poor cognitive development, poor school and work performance, poor socioeconomic development, and poverty. Chronic illness, malnutrition, and anemia are further examples of secondary effects (WHO, 2012).

More than 24% of the world’s population are infected with soil-transmitted helminth infections, commonly distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia.Over 270 million preschool-age children and over 600 million school-age children live in areas where these parasites are intensively transmitted, and are in need of treatment and preventive interventions (WHO, 2017).

The most common IHIs are *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms and the parasites grow well in communities without good housing, sanitation, water supplies, health care, education and income (Bethony *et al*., 2006)**.** The largest number of hookworm cases occur in impoverished rural areas of sub-Saharan Africa, Latin America, South-East Asia and China (WHO, 2005).*Ascaris lumbricoides* is the largest and the most common helminth parasitizing the human intestine and infects about 1 billion people worldwide (CDC, 2006). It is estimated that 25% of the world population harbors the parasite. Hand to mouth transmission is most common; it is found in association with poor personal hygiene, poor sanitation, and in places where human feces are used as fertilizer. Consumers of uncooked vegetables and fruits grown in or near the soil fertilized with sewage are most at risk for acquiring infection (Cheesbrough,1998 cited in Chala,2013). *Trichuris trichiura*, the whipworm, is the most common in the warm, moist tropical and sub tropical countries. Heavy infection of *T. trichiura* has long been known to be associated with anemia, protein-energy malnutrition and chronic diarrhea and dysentery (Stephenson *et al*., 2000b).

IPIs are widespread throughout the developing world and frequently result in common morbidities. Fig. 1 presents a conceptual framework which summarizes the complex and self-perpetuating relationships and potential mechanisms between IPIs and morbidity.

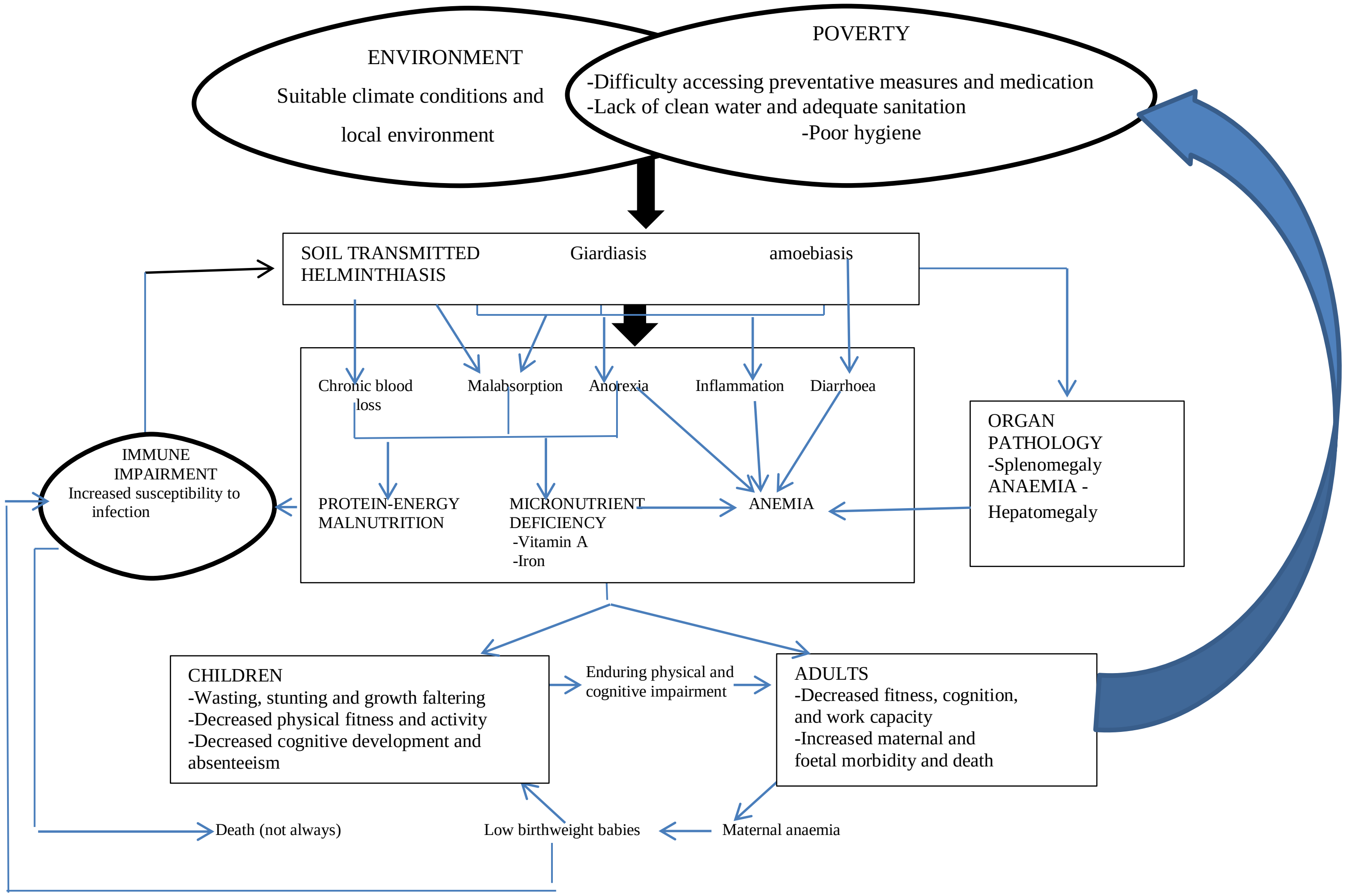

Figure. 1. Conceptual framework: the negative cycle between IPIs, malnutrition and cognitive and physical development.Helminth and intestinal parasitic protozoa infections impact upon host nutrition through a number of mechanisms, which may have additive or multiplicative impacts, especially in children. Parasitic protozoa cause severe disease and deadly diarrhea (Chen *et al.*, 2007), *Giardia lamblia* infections impair cognitive function (Partovi *et al.*, 2007). Helminth infections cause and/or aggravate malnutrition through worm-induced gastrointestinal tract physiopathology and reduced food intake (Crompton and Nesheim, 2002), chronic blood-loss (Hotez *et al*. 2004) and intestinal inflammation (Stephenson *et al*. 2000b).Associations may also be due to the effect of undernourishment on the immune response, leading to an increased susceptibility to infection (Koski and Scott, 2001).PEM and anaemia associated with parasitic infection can result in decreased physical fitness, cognitive development and school achievement in children (Kar *et al.*, 2008; King, 2010), and in decreased cognition and work capacity in adults (Guyatt, 2000; Haas and Brownlie, 2001); factors which are in turn associated with poor socio-economic status, in itself a risk factor for infection.

1.2. Intestinal parasites in Ethiopia

Intestinal parasitic infections, as in many developing countries, are common in Ethiopia and cause serious public health problems such as malnutrition, anemia and growth retardation as well as higher susceptibility to other infections (G/hiwot *et al*., 2014)**.** The low socio-economic development favours the wide distribution of intestinal parasities in Ethiopia (Mengistu *et al.*, 2007).

In Ethiopia, soil transmitted helminthic infections (STH) are frequently reported and highly prevalent particularely in children and pregnant women. Risk factors associated with STH infections could vary with localities (Alelign *et al.*, 2015).Warm climates and adequate moisture, lack of personal or environmental hygiene, and low level of education, walking barefoot, and poor health or nutritional status could increase the risk of STH infections (Alemu *et al*.,2011). As of other developing nations, in Ethiopia, STH infection is a serious public health problem (Degarege and Erko, 2013; Degarege *et al*., 2014).

*A. lumbricoides is t*he most widespread intestinal helminthes, usually occurring together with *Trichuris trichuria* infections (Tedla and Ayele, 1986). Hookworm infection, strongyloidiasis and enterobiasis are widely prevalent, although their magnitude is lesser compared to ascariasis (Amare *et al*., 2007).Amoebiasis and giardiasis are common causes of intestinal protozoan infections throughout the nation.Ingeneral, the prevalence rates vary considerably: rates are lowest in the low land and drier areas of the country than in more humid high lands (Jemaneh, 1998). This wide distribution of intestinal parasites in Ethiopia might be related to differences in altitude that favor the growth of parasite,low socio-economic status and poor sanitation, absence of safe drinking water supplies and inadequate medical care,urbanization,the development of irrigation and new resettlement.

Epidemiological studies of most human intestinal helminthes indicated that due to the greatest risk for acquiring heavy infections with hookworms, *Ascaris* and *Trichuris* infections, the children suffer with anemia, acute ascaris, intestinal obstruction, hepatobiliary ascariasis, *Trichuris* dysentery syndrome (TDS), or rectal prolapse, and physical growth retardation associated with cognitive and educational impairments (Kirwan *et al*., 2009).Periodic deworming has been shown to improve growth, micronutrient status (iron and vitamin A), and motor and language development in preschool children (WHO,2005;Kirwan *et al*., 2009). Furthermore, IPIs produce anorexia, vomiting, diarrhea, abdominal pain, nutrient wastage, blood loss, itching, easy fatigue, insomnia and irritability. Some of these conditions are reasons for under- nutrition and poor school performance. Intensity and severity of IPI are more pronounced in undernourished children, possibly due to immunity depression by PEM. The depressed immunity facilitates invasion by other infection (Stephenson *et al*., 2000b; Crompton and Nesheim, 2002; Hotez *et al*., 2004).

As in many developing countries, cases of intestinal parasitosis are highly abundant in Ethiopia. It is estimated that one third of Ethiopians are infected with *Ascaris lumbricoides,* one quarter is infected with *Trichuris trichiura* and one in eight lives with hookworm. As a result, Ethiopia has the second highest burden of ascariasis, the third highest burden of hookworm, and the fourth highest burden of trichuriasis in Sub-Saharan Africa (Deribe *et al*., 2012).

In Ethiopia, hookworm is estimated to infect 11 million people, thus Ethiopia bears 5.6% of the hookworm burden in Sub Saharan Africa (SSA) and is the country with the third highest burden in SSA (Hotez and Kamath, 2009). Most parts of Ethiopia are suitable for the transmission of STHs, except parts of Somali and Afar regions where the annual mean temperature is too high for transmission (Pullan and Brooker, 2012). The national prevalence of hookworm is estimated at 16% (Tadesse *et al.,* 2008). The prevalence of hookworm among school age children in Ethiopia was reported to be 38% in Jimma (Fekadu *et al*.,2008; Demissie *et al*.,2009), 26.8% in Boloso Sore (Erosie *et al*.,2002), 20.6% in Southwest Ethiopia (Yami *et al*.,2011), and 19% in northwest Ethiopia (Alemu *et al.*,2011). Ethiopia has the second highest burden of ascariasis in SSA: 26 million people are infected, which is 15% of the overall burden in SSA (Hotez and Kamath, 2009).The prevalence among school age children was recorded at 28.9% in northern Ethiopia (Jemaneh, 2000), 83.4% in southern Ethiopia (Erko and Medhin,2003), 22% in northwest Ethiopia (Alemu *et al*.,2011), and the national average is estimated at 37% (Tadesse *et al*.,2008). Similarly, Ethiopia has the 4th highest burden of Trichuriasis, with 21 million people infected,which is 13% of the disease burden in SSA (Hotez and Kamath,2009).The national prevalence is estimated at 30% (Tadesse *et al*.,2008).

1.3. IPI, nutrition and academic performance

Intestinal parasitic infections affect educational achievement of school children directly as ill health or through their negative effect on nutrition (Guyatt, 2000).Both nutrition and education have a relationship of mutual influence. Education helps to improve nutrition, and improved nutrition is necessary for physical (including brain) growth and development (Amara and Ezeamama, 2005; Kar *et al*., 2008).Shortage of nutrients resulting in chronic undernutrition could lead to stunting, and defective cognitive development. Protein energy malnutrition also reduces cognitive functions or academic performance.Better nourished children show greater attention and learning capacity than undernourished children (Walker *et al.*,2015).Undernutrition acts synergistically with poor socio environmental factors to negatively affect cognitive development of a child.The developmental lag of a student could be reversed if a remedical feeding is done or is better combined with psychosocial or environmental stimulation (Branca and Ferrari, 2002;Walker *et al.,*2015).Good health and good nutrition are key factors in achieving high educational performance (Shariff *et al*., 2000). So, poor health hinders educational performance, decreased work capacity and productivity and income (Kar *et al*., 2008; King, 2010).

The causes of nutritional deficiency and poor school performance are multiple and their solution needs a multi sectorial effort. School feeding programs, and deworming serve as short term solution whereas socio economic development and eradication of poverty being the long term solutions that includes improved community hygiene, safe and adequate drinking water supply, health service access, and improved nutrition (Reading,1997; Hilary *et al*.,2010).

1.3.1. Malnutrition and IPI

Malnutrition and infection interact to worsen the clinical consequences of each, and good nutritional status is required to maintain maximum resistance to infections and the ability to recover from disease (Stephenson *et al.*, 2000a).Infections lower the nutritional well-being of individuals and also malnutrition increase the impact of diseases. This malnutrition-infection complex is the most widespread public health problem in the world.This combined effect lower the resistance of the host to infection, decreasing cellular and humoral immunity and leads to an infectious process greater-than expected severity (Stephenson *et al*., 2000b).

The relations between intestinal parasitic infections and nutrition can be considered from: the influence of the intestinal parasitic infection on the host's physiology and nutrition and the effect of host nutrition on the intestinal parasites, i.e. their establishment, persistence and reproductive capacity (Stephenson *et al*.,2000 b;Sackey *et al*.,2003).All infectious diseases have direct adverse metabolic effects and influence on the amount and kind of food consumed (Sackey *et al*.,2003;Petkevicius, 2007). Common features of infection with intestinal helminths are: a reduction in voluntary food intake, reduction of the digestibility of dry and organic matter and a decrease in efficiency of feed utilization (Petkevicius, 2007; Thompson and Lymbery, 2009).

In developing countries, poor people endure the burden of disease caused by four common species of soil-transmitted nematodes (hookworm, Ascaris, Trichuris and Strongyloides) and parasitic protozoa (*E.histolytica*, *Giardia lamblia*) that inhabit gastro-intestinal tract.Disease caused by these infections have nutritional disturbance. Reduced food intake, impaired digestion, malabsorption and poor growth are frequently observed in children suffering from ascariasis and trichuriasis (Sackey *et al*., 2003). Poor iron status and iron deficiency anemia are the hallmarks of hookworm disease. The course and outcome of pregnancy, growth and development during childhood and the extent of worker productivity are diminished during hookworm disease (Crompton and Nesheim, 2002).

The negative effects of intestinal helminthic infections on nutritional status are very common with highest intensity in school age children (Sackey *et al*., 2003). This is possible through directly inhibiting the ability of the host to gaining nutrients from diets (Koski and Scott, 2001). This includes a variety of patho-physiological responses in the gastrointestinal tract such as vomiting, diarrhea, malabsorption, and anorexia. For example, food intake reduction, digestion impairment, malabsorption, and poor growth rate are frequently observed in children suffering from ascariasis and trichuriasis (Muller and Krawinkel, 2005). Ascariasis reduces the body's ability to use protein and to absorb fat, which worsens protein-calorie undernutrition. It also worsens vitamin A deficiency and milk intolerance (Crompton and Nesheim, 2002).

Infections have an adverse effect on metabolism of most nutrients, including protein and amino acids, and since the actual requirement of essential amino acids in schoolchildren may be increased because of an increase intended catch-up growth, aggravates the occournce of undernutrition (WHO, 2007). Intestinal parasites alter net nutrient absorption mainly by diverting nutrients for their own need; therefore, less is available for absorption by the host. Furthermore, parasite-induced mucosal inflammation and villous atrophy over time impair nutrient absorption (Koski and Scott, 2001).

Helminth infections affect child growth by impairing nutritional status of the host by the increased nutrient demands of the parasite itself or by specific actions of the parasite. For example, blocking of the absorbing surfaces of the mucosal wall by adult *Ascaris lumbricoides* and blood loss by hookworm infections affects human health (Jardim-Botelho *et al*., 2008). The high prevalence of ascariasis and trichuriasis in children may lead to micronutrient deficiency (iron deficiency anemia, vitamin A deficiency) and protein-calorie malnutrition (Al-Mekhlafi, *et al.*, 2006). Consequently, anemia in children is associated with stunting, wasting, poor cognitive abilities and impaired immune system (Gashu *et al.*, 2016).

The concentration of different nutrients, such as carbohydrate, protein, fat, non-organic constituents have effect on the helminth populations in a host.For instance, well nourished human populations are better able to withstand the detrimental effects of nematode parasite infections than those less adequately nourished (Kabatereine *et al*., 2007; Koukounari *et al*., 2008). Gastrointestinal helminths have very specific physico-chemical requirements of their host gut environment, and nutritionally mediated changes might have a direct influence on the parasite population (Crompton, 1991; Kabatereine *et al*., 2007).

School-aged children are more at risk for infectious diseases than any other age group, particularly to parasitic infections. In developing countries, 12% of the global disease burden due to intestinal helminths is estimated to occur in children aged 5–14 years (Awasthi *et al*., 2003).Human gastrointestinal parasites are linked with an increased risk for childhood malnutrition and growth deficits (Sackey *et al*., 2003; Oninla *et al*.,2010).

Undernutrition and anemia predominantly occur in children and are common public health problems among people in developing countries. Nearly, a quarter of school age children in the world and 40 % of school age children in the developing world are anemic (Benoist *et al.*,2008).Undernutrition is responsible for the death of one-third of children (7.6 million children) in the world every year (WHO,2010).

According to WHO (2015a), in Ethiopia, 400 000 children faced severe undernutrition in 2015, and another 1 million children and 700 000 pregnant or breastfeeding women faced moderate undernutrition. Those are more likely to get sick during disease outbreaks.

The major forms of malnutrition are Protein Energy Malnutrition (PEM), Vitamin A deficiency, and Iodine deficiency disorders (IDD) and IDA (Iron deficiency anemia).

1.3.2. Measurment of nutritional status

Nutritional status is the best global indicator of well-being related to nutrition and health. Malnutrition has an all-pervasive impact on the physical well-being and socioeconomic condition of a nation. It perpetuates poverty through direct losses in productivity, indirect losses from poor cognitive function, poor child development and deficits in schooling and losses due to increased health costs (Sununtar, 2005; World Bank, 2006).

Child malnutrition is a comprehensive poverty indicator which is reflective of other desirable outcomes of development i.e improvement in gender empowerment, intra-household distribution and equality, and health environment quality (Sununtar, 2005). Good nutrition is the cornerstone for survival, health and development for current and succeeding generations. Well-nourished children perform better in school, grow into healthy adults and in turn give their children a better life. Undernourished children have low resistance to infection; they are more likely to die from common childhood ailments like diarrhoeal diseases and respiratory infections, and for those who survive, frequent illness saps their nutritional status, locking them into a vicious cycle of recurring sickness and growth faltering. Malnutrition due to deficiencies is strongly correlated with social and economic inequalities (Olaf and Michael, 2005).

The weight-for-height index measures body mass in relation to body length and describes current nutritional status. Children whose Z-scores are below minus two standard deviations (-2 SD) from the median of the reference population are considered wasted for their height and are acutely malnourished. Wasting represents the failure to receive adequate nutrition in the period immediately preceding the survey and may be the result of inadequate food intake or a recent episode of illness causing loss of weight and the onset of malnutrition. Children whose weight-for-height is below minus three standard deviations (-3 SD) from the median of the reference population are considered severely wasted (Gibson, 2005).

The weight-for-age curves are used by countries that routinely measure only weight to monitor growth throughout childhood. In older children, i.e. above 10 years, weight-for-age is not a good indicator as it cannot distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as having excess weight (by weight-for-age) when they are just tall. BMI-for-age is the recommended indicator for assessing thinness, overweight and obesity in children 10-19 years (de Onis *et al.,* 2007; WHO, 2007).

For rapid assessment of food crisis, the measurement of wasting alone would provide sufficient information. It is also the best index when difficult to determine the exact age of the children being measured.For designing what type of program is needed in specific area, all three indexes of anthropometric measurements may need to be collected.In programs or projects where intervention impacts are expected within a short period of time (like food supplementation, fortification, stamp, school lunch program etc), by order of sensitivity, the indexes are wasting, underweight and stunting. For interventions not expected to be immediate (more than 3-6 years) the reverse order could help to capture impact (Sununtar, 2005).

1.3.3. Impact of malnutrition on academic performance of children

Intellectual competence throughout adult life may be compromised by childhood malnutrition (Black *et al*., 2013).This is because, nutritional status in early life is important for laying down the foundation of a healthy adulthood through its effect on growth and development, and subsequently on quality of life, productivity, and economic development in later adult life (Walker *et al*., 2015).Undernutrition among pregnant women leads to infants born with low birth weight which is a risk factor for neonatal deaths, and also causes learning disabilities, mental retardation, poor health,blindness and premature birth (Black *et al*., 2013).

Shortage of nutrients chronically could lead to stunting and delay in cognitive development.Because of energy shortage, acute or chronic PEM also reduces cognitive functions or school performance (WHO, 2014).Undernutrition acts synergistically with poor socio-enviromental factors to affect cognitive development (Jardim-Botelho *et al.*, 2008).

In general, learning ability (intelligence) of an individual or a child is determined mainly by the interaction of the child genetic (nature) and environment. The poor mother and impoverished environment provide little for the child to explore and have optimal development. The child is more likely to be abused and to have low self-estem, and poor personality and cognitive development (Maulik and Darmstadt, 2009). Therefore, academic performance in primary schoolchildren depends on their health, past and present nutrition and development status. Past nutritional deficiencies including PEM affect the brain and as a result affect academic performance due to energy shortage (Shonkoff *et al*., 2009). Overall, malnutrition is widely distributed and highly manifested among schoolchildren in developing countries like Ethiopia. It is not only the cause of mortality and morbidity, but also causes significant problem in academic performance that has great influence on socio-economic development in the country.

Malnutrition together with poverty and sickness, affect the physical growth, behavior and learning abilities of children and adolescents.For their optimal growth, and for greater long-term human capital development, children profit not only from improved nutrition but also from improved learning opportunities in the earliest years of life.It is well recognized that the first few years of life are critical both for a child's nutrition and for his or her physical, social, cognitive, and emotional development, and that interventions during this period have maximum impact. Therefore, combining programs to improve nutrition with those for childhood development would reasonable approach (Walker *et al*., 2007; Grantham-McGregor *et al.*, 2008). Poverty, poor health, undernutrition, and lack of early stimulation undermine children's development early in life when brain development is most rapid and the architecture of the brain is most sensitive to the influences of the external environment (Engle and Huffman, 2010). An inadequate dietary supply of any of a number of essential micronutrients can adversely affect brain function (Beard and Connor, 2003; Bryan *et al*., 2004). A causal relation between micronutrient deficiencies and suboptimal brain function would have major public health implications (Lee and Frongillo,2001;Siega-Riz and Popkin,2001).

1.4. Intestinal Parasitic Infection and Anemia

Elimination /control of micronutrient deficiency is given as a global priority now a days.This is because the consequences of micronutrient deficiency such as blindness, anemia, goiter and are unable to achieve their full mental and physical potential due to stunted growth, low physical work capacity, reduced IQ and lower resistance to infection. Eradication of these deficiencies brought sustained economic growth and national development along with health improvement (World Bank, 2006).

Iron deficiency with anemia can occur when a person has low values of both serum ferritin and hemoglobin, while iron deficiency without anemia can occur when a person has normal hemoglobin, but below normal serum ferritin and/or transferrin saturation, whereas nutritional iron deficiency arises when bodily necessities cannot be satisfied by iron absorption from diet (CDC, 2002).

Prevalence estimates of iron deficiency anemia based on hemoglobin alone are over-estimation because other causes of anemia, such as nutritional deficiencies (eg, vitamin A deficiency), infectious disorders, haemo-globinopathies, and ethnic differences are not considered in normal haemoglobin distributions (Nestel,2002;Lynch,2005). In less developed nations, high occurrence of iron deficiency and anemia can be caused by poor living conditions of population, low socio-economic conditions, less access to food and a lack of awareness for good dietary practices and personal hygiene (Hall *et al*., 2001). Furthermore, intestinal parasitic infection, caused as result of poor hygienic conditions, interferes with iron absorption through reduction process, thus increase iron deficiency anemia (Olivares *et al.*, 1999).

In an infected individual, iron is needed both by the individual as well as the infectious agent. Iron deficiency does not protect against infectious agent (Snow *et al.*,1991), but high prevalent iron is reported to increase the risk of respiratory infections and the prevalence and effects of malaria in infants (Smith *et al.*, 1989).Public-health measures for disease control should be integrated with other approaches and intensified in areas where iron-deficiency anemia is strongly associated with high prevalence of hookworm or other parasites. Two main strategies to reduce anemia prevalence through helminth control are deworming, in general, and the reduction in the prevalence of hookworm infestation in particular. Hookworms *(Necator americanus* and *Ancyclostoma duodenale)* infect about 1 billion of the world's population. They cause intestinal blood loss by feeding on the intestinal mucosa, and the amount of blood lost is directly proportional to the number of worms infecting the host that causes anemia (Stoltzfus and Dreyfuss, 1997).

Chronic fecal blood loss because of hookworm infestation is a significant contributor to anemia (Roche and Layrisse 1966; Srinivasan *et al.*, 1987) and can significantly limit the effect of other diet-based interventions.Hookworm infestation increases with age and prevalence rates are higher among adults than children. A hookworm infection of moderate intensity in a woman amounts to a fecal iron loss of 3.4 mg/day (Stephenson, 1987).Schistosomiasis, and to a lesser degree trichuriasis and ascaris infestation, also can adversely affect iron status through provoking gastric or intestinal ulceration and blood loss.A strong association has been found between urinary schistosomiasis and iron status in sub-Saharan Africa, a daily iron loss of 2.1 mg in a woman (Hall,*et al*.,2008).

The prevalence of iron deficiency anemia has been found to increase steadily as hookworm infections intensify and intestinal blood loss increase and in areas of intense hookworm transmission. Deworming at intervals has been found to improve the iron status of school children (Hall, 2007). Therefore, the aim of this study is to assess the impact of major intestinal parasitic infections and poor nutritional conditions on the well-being of primary schoolchildren.

1.5. Statement of the problems

Intestinal parasitic infection, particularly parasitic protozoa and helminth and malnutrition are interrelated key public-health challenges in schoolchildren in developing countries. In Ethiopia, like in other developing countries, intestinal parasitic infections affect childhood development and nutritional status,and lower socioeconomic development of the nation.This is because it perpetuates poverty through direct losses in productivity; indirect losses from poor cognitive function, poor child development and deficits in schooling and losses due to increased health costs.Data are scarce regarding the magnitude of IPI, anemia and their effect on academic performance in Ethiopian schoolchildren particularly those consuming *kocho* as staple food. The same is true regarding the coincidental effect of IPI and undernutrition in academic performance of the children.The effect of socio-demographic factors on undernutrition, anemia, and academic performance are also not adequently studied in primary schoolchildren. Such effects may vary much with location of residence within the same administrative region. As effects of parasitic infections may vary with nutritional status, there is a need to investigate the underlying variations by using nutritional indicators and determinant factors among regions and localities for proper priority setting in interventions. To improve the health condition of children, nutritional status and living conditions in communities, it is necessary to determine the nature, magnitude and cause of parasitic infections and nutritional status. The result of this study, which specifies the prevalence of intestinal parasitic infection with these various causes and their relative contributions by nutritional status, anemia and academic performance can serve as reference in priority setting, designing effective measures to address the problem and its consequences, in monitoring and evaluation of the impacts of measures and for policy responses specifically tailored to the needs of different food consuming population groups.

1.6. Hypothesis

Co-existing of intestinal parasitic infections and poor nutritional conditions in Gurage zone has a compromising effect on the well-being of schoolchildren.

2. OBJECTIVES

2.1. General objective

To assess the association of intestinal parasitic infections and nutritional condition on the well-being of primary schoolchildren in two districts that,in relative terms,differ on the type of staple food in Gurage zone, South Central Ethiopia.

2.2. Specific objectives

1. To identify the socio-demographic and economic factors associated with intestinal parasitic infections in schoolchildren.

2. To asses the nutritional status of schoolchildren South Central Ethiopia.

3. To identify possible consequences of intestinal parasitic infections to growth, haemoglobin level and academic performance in children.

3. MATERIALS AND METHODS

3.1. The study areas

The study was carried out in elementary schools in Enemore-Ener and Abeshege districts, Gurage Zone, South West of Addis Ababa, Southern Nation and Nationlities Peoples Regional State (SNNPR). Gurage zone is found at $7^{0}44'5''$-$8^{0}28'5''$N latitudes and $37^{0}25'5''$-$38^{0}42'5''$ E longitudes and is one of the nine zones in the SNNPR. It adjoins in the north, west and east Oromia region, in the south Silti and Hadiya zones.It has 13 districts (including Enemore-Ener and Abeshege) with an altitude of 1000-3400m asl. The average monthly temperature is generally above 18^{O}C. Average annual rainfall reaches 1,300 mm. The average mean annual temperature between 13-25 °c and mean annual rainfall between 801-1400 mm according to Gurage Zone Agricultural Department Office/Bureau (2014/2015). Gurage zone is a densely populated, rural area with 216 inhabitants per square kilometer. The inhabitants earn their living by cattle raising and growing food crops (ensette, coffee in (Enemore-Ener district), maize, teff, etc). Enemore-Ener district is located 197 km South West of Addis Ababa, 42km from the town of Welkite (Zonal town) on the road to Hosanna. According to the 2014/2015 census, Enemore-Ener district had a total population of 216,706 within 65 rural kebeles and 5 town administrations. Of these, the male population was 102,502(47.3%) and the female population was 114,204 (52.7%). Out of the whole total population, 96.1% live in 65 rural kebeles and the rest (3.9%) live in 5 town administrations. The study area is characterized by diverse altitude, from 1001m asl (Gibe Valley) to over 3400m asl (Aster Mountain).The staple food is *Kocho*. Enemore-Ener district has eight (8) health centers, one hospital and 5(five) private clinics. Each kebele in the district has at least one primary school. In total, the district has 5 secondary schools and 120 primary schools and it adjoins Cheha, Geto and Endegagn districts (three different districts of Gurage zone in the north, northeast and south east respectively), Hadya zone in south and south west and Yem special district in the west within SNNPR, while Abeshege district is located 155 kms south west of Addis Ababa on the road to Jimma. According to the 2014/2015 census Gurage zone Planning and Economic Development Department, Abeshege district had a total population of 109,765 within 26 rural kebeles and 3 town administrations. Of these, 51,809 (47.2%) are male and 57,956 (52.8%) female. Abeshege district is characterized by diverse altitude, from 1000m asl (Gibe valley) to over 3300m asl. The inhabitants earn their living by cattle raising and growing food crops (maize, teff, chick peas, and sorghum etc). The staple food is teff with other cereals. Abeshege district has twenty six health posts and four health centers. Each kebele in the district has at least one primary school. In total the district has three secondary schools and fourty primary schools, and it adjoins Cheha and Kebena (two different districts of Gurage zone in the south and east) and Oromia in the south west, west and north respectively.

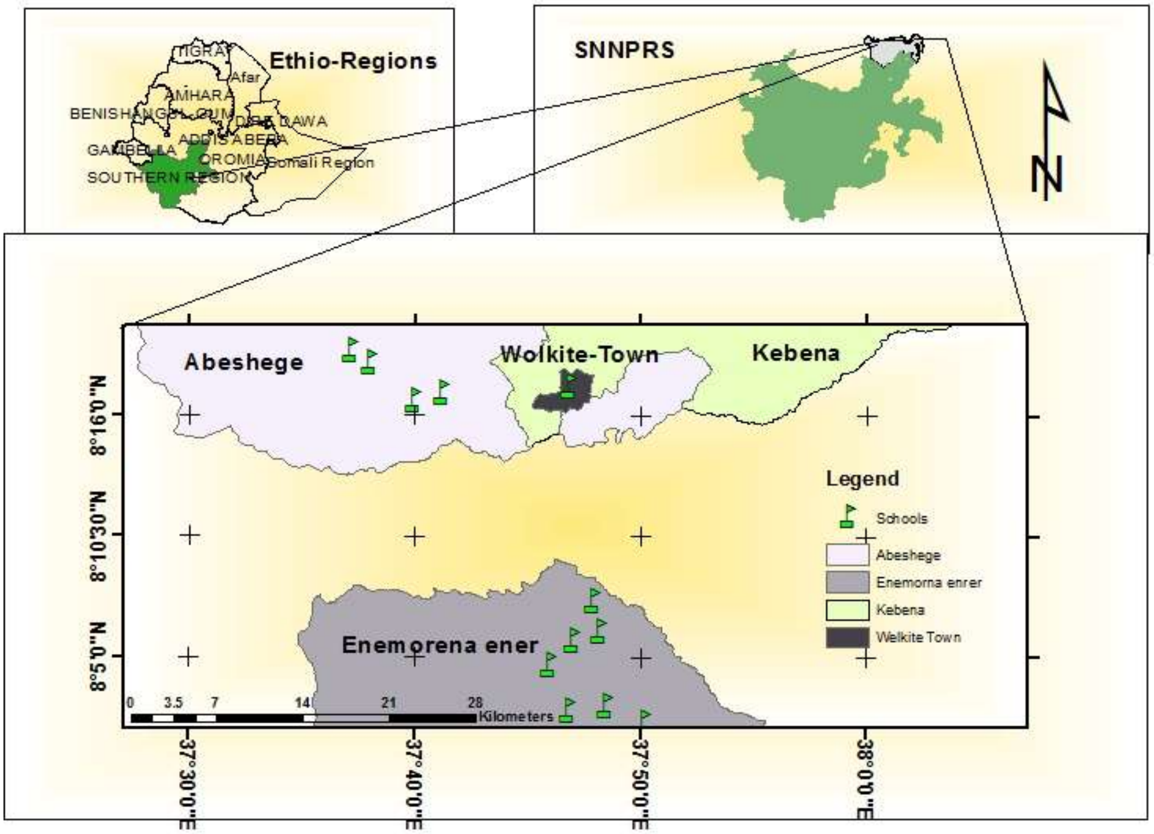

Figure 2. Sketch-map of the study area-Gurage Zone, South central Ethiopia (Source: Garmin 72 GPS)

3.2. The study population

The study participants were children aged 7-19 years in randomly selected kebeles of Enemore - Ener and Abeshege districts. Children of the two districts live under similar environmental sanitation and low socio-economic condition of rural villages.

Eligibility

Prior to conducting the study, meetings were held with parents or guardians and community leaders,school directors,districts health and education office and district council to explain the aims and procedures to be used to collect data. Informed written consents were obtained from the study participants, children's parents or guardians and in addition assent was subsequently obtained from children.

Inclusion criteria: The eligible study participants for the study were (1) children aged 7- 19 years of both sexes; (2) Parents or guardians gave written informed consent; (3) In addition to the written consent from caretakers, children also were supposed to agree and provide informed assent; (4) Children lived in the study area more than one year were included in the study.

The age groups of 7-19 years were chosen because the focus of this study was on elementary school children. Since, no other better source of accurate age records (like vital registration) was available in the study area, the age (in years) and other information of each student was taken from school's master list or roster. Months of the schoolchildren recorded were rounded to the nearest complete years. In such case, the over and underestimation of age could be balanced (compensated or canceled out). Age underestimation leads to underestimation of stunting and underweight. And overestimation of age gives overestimation of stunting and underweight.

Exclusion criteria: Children treated with anti-helminthic, anti-protozoal and anti-malaria drugs within two weeks of the study period.

3.3. Sample size

The study populations were residents of the two purposively selected districts. Sample size was estimated using Daniel's formula $n=Z^2 P (1-P)/d^2$, (Daniel, 1999 cited in Zaied *et al*., 2014). Where P = prevalence of intestinal parasites from previous studies, d = margin of error and Z = standard score corresponds to 1.96. This would give a sample size of 326. The prevalence rate (p) of intestinal parasites from previous similar study was 69.4% in primary schoolchildren

(Erosie *et al.,* 2002) with a 95% confidence interval, a 5% margin of error was added. Due to the use of multistage sampling of which cluster sampling was used, a design effect of 2 was added. To compensate for non-response and incompleteness, additional 5% was added. Using proportional allocations 452 and 233 individuals were included in the study from Enemore-Ener and Abeshege districts, respectively, with a sum of 685 study participants (Figure 2). The study participants were selected from the school lists using stratified random sampling methods from the eleven schools of two districts after informed consent and assent.

3.4. Study design and sampling method

A school based repeated cross-sectional study was conducted from September 2014 to June 2015 to assess the magnitude of undernutition (stunting, underweight and thinness), anemia, school performance and IPI, the impact of IPI on anemia, undernutrition, and the influence of IPI, anemia and undernutition on school performance among primary schoolchildren in two purposively selected Enemore-Ener and Abeshege districts, Gurage zone.

A two-stage sampling using stratified, simple random and systematic sampling was used to select the sample. First, the study area was stratified into Abeshege and Enemore-Ener rural kebeles and then a total of eleven kebeles were randomly selected; based on proportional allocation of total sample size to each district, four from Abeshege and seven from Enemore-Ener rural kebeles considering agro-ecological areas. Systematic sampling method was applied to select study participants. Then, it was followed by proportional allocation of total sample size to each school, and in the second stage, from each school list or roster, the total number of sections for each grade and the total number of students in each section from grades 1-8 was collected. After that stratification with proportion to size allocation by grade and section was done. The unit of sampling in the first stage was sections of a grade, and in the second stage the individual pupil was the unit of sampling. Then to be included in the study or sample, until the required size of a grade level was obtained, one or more section(s) were selected by simple random sampling (lottery) method. Finally, the study subjects were selected by using systematic random sampling using class roster as the sampling frame.

Using proportional allocation to the Abeshege rural and Enemore-Ener rural kebeles based on population, 452(66%) samples from the Enemore-Ener rural kebeles and 233(34%) samples from the Abeshege rural kebeles were selected.

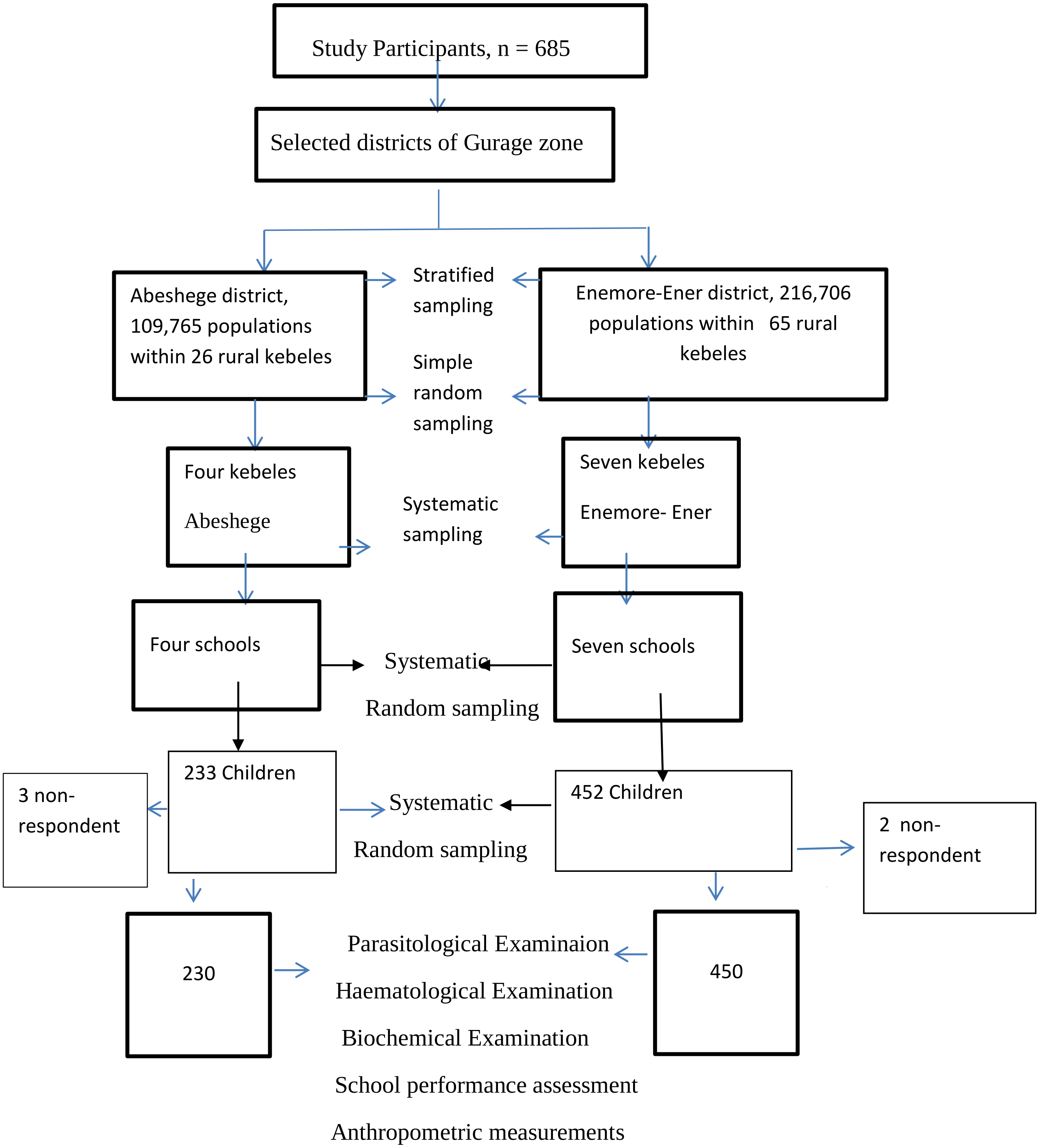

Figure 3. Schematic presentation of sampling frame

3.5. Data collection procedure

3.5.1. Conducting preliminary surveys and the questionnaire standardization

Permission was obtained from the study area relevant authorities. Information regarding the number of students in each school, grade, grade-section, and available spaces for the survey were obtained in a visit to the schools. The time schedule for data collection on each student was arranged with the school principals. The town health center was requested for some support such as microscope and other required materials. Pre-test was done before the actual data collection. Twenty (20) students from grades 1-8 participated in the pre-test. The students were interviewed about their socio-demographic characteristics by the two interviewers, and medical interview was conducted by the nurse using the standardized questionnaires in Amharic language. Weight and height measurements were also taken by the health assistants. The purpose of the pretest was to know the time needed to complete each questionnaires and measurements, and to see whether the interviewers and students were able to understand the questions and to check if weight and height measurements were done correctly. Based on the feedback obtained, some questions were modified or refined or omitted based on the findings. After the preliminary field survey, the final questionnaires, recording formats, and data collectors' instruction materials were prepared in Amharic. The necessary materials were procured.

3.5.2. Personnel recruitment and orientation

After one month of first field work, three interviewers who completed 12^{th} grade were recruited from the study site. They were familiar with the local culture and speak the local language (Gurage language). They were trained for three days on how to conduct the interview. Other data collectors recruited included one nurse for physical examination, two laboratory technicians, one health assistant, school unit leaders and home room teachers. They were also trained by the principal investigator for three days. The health assistants were also trained for three days on medical history interview and measurements of height and weight. During the training, an instruction manual was distributed to each trainee. The nurse, lab technician, health assistant and school personnel were oriented about the research and the work expected from each of them. Each school unit leader and home room teachers were assigned to collect the school record data. Weighing scales were calibrated with stndared weight regularly.

3.5.3. Data collection

Data collection was started after a week of the pre-test and conducted for two seasons from September, 2014-June, 2015. Field assistants were given instruction about the work schedule and the need of good quality work. The teachers and administrators were requested for collaboration, and adequate rooms were given by the schools for use as a work station. The name and age of the eligible students were obtained from the school lists. Using the list, the eligible subjects were called from their section to the data collection room(s). The work place was arranged and the work flow was that the selected students were sent to the examination or interview place from their classes by their attending teachers. Then the students went to the socio-demographic interviewers, from there, they went to the nurse for physical examination, they continued to the lab technician for stool and blood sample collection, and finally, mid upper arm circumference, weight and height measurements were taken.

3.5.4. Physical examination

The examination was based on palpation and inspection guided by standardized,closed-ended and coded format or check list for presence or absence of symptoms or diseases.The included variables were regarding the presence or absence clean clothing,wearing or using shoes,any body abnormalities,eye discharge and others.

The second part of the questionnaire included: medical history or the presence or absence of selected symptoms like vomiting, pain,itching, insominia,poor appetite,cough,easy tiredness,hearing or vision difficulty.Nutritionally important diseases like the presence or absence of recent diarrhea,past history of whooping cough,pulmonary tuberculosis,malaria and IPI were also asked.All the variables of the second part of the questionnaire were collected by trained health assistants.

3.5.5. Anthropometric methods

A digital portable weighing scale was used for weight and height measurements simultaneously. This scale could measure up to 130kg with 0.1kg precision and could be disassembled and re-assembled easily, and measure up to 2 meters with 0.1 cm precision. Weight and height data on each study subject was collected by the lab assistant. Weighing of each student was done with minimal clothing and to the nearest 0.1kg. Boys were weighed wearing their trousers, while girls were weighed wearing their light dresses. Measurement of height was carried out bare footed wearing shoes, to the nearest 0.1cm and the measurements were recorded in the prepared recording format. Raw anthropometric data (height, weight, age and sex) of school children was converted to nutritional indicators (BAZ, HAZ and WAZ) using WHO anthro plus software. These indices were expressed using Z-score (WHO, 1995). Underweight, thinness or low BMI for age and stunting was expressed by weight for age Z-score (WAZ), body mass index for age Z-score (BAZ) and height for age Z-score (HAZ), respectively, using <-2 standard deviations (<-2SD) of Z-score as a cut-off.

3.5.6. Stool and blood sample collection and parasitological examination

From each child, about 2 grams of fresh stool sample was collected using sterilized cups. A portion of the specimen was processed using Kato-katz technique (Birrie and Medium, 1996). The stool from each cup was transferred to a piece of disposable paper and filtered through a disposable sieve using applicators. Each sample was applied on a card plate with a hole, placed on a slide that can deliver 41.7 mg of stool plug (WHO, 1991). After removing the card plate, the fecal sample was covered with cellophane strip which was soaked in glycerin- malachite green solution for at least 24 hours. The preparation was pressed to spread the smear using another slide until evenly distributed and left for 30 minute before reading. Finally, each slide was examined for *Ascaris lumbricoides, Trichuris trichiura*, hookworm and other intestinal helminths.The slides were examined within one hour of Kato slide preparation because thin-shelled hookworm eggs disappear soon after the smear becomes clear enough for examination .The number of eggs per slide were counted and multiplied by 24 to obtain the number of eggs per gram (epg) of feces (WHO,1991).After kato examination of the sample characterstics,a direct wet fecal smear was prepared by emulsification of 2mg of the feces on a glass slide in one drop of Lugol's iodine.The sample was covered with a cover slip and systematically observed at low and high magnification using a light microscope in order to identify any mature parasites, cysts or eggs present. This was done by experienced, laboratory technicians on the day of collection in the field laboratory.

Stool samples of approximately one gram from all subjects were collected into test tube containing 8 ml of 10% formalin and transported to Aklilu Lemma Institute of Pathobiology, Addis Ababa University.A portion of each fresh stool sample was processed as described by Ritchie (1948). One gram of stool sample was mixed with 8ml of 10% formalin and crushed well. It was sieved through double layer cotton gauze into 15 ml conical centrifuge test tube. Three ml of diethyl ether was added and hand shaken for one minute and then centrifuged another two minutes at 2000g,the supernatant was discarded and the sediment was observed for the presence of ova and/or parasites under the light microscope at a magnification of 100x and 400x.

After completing all stool examinations, treatment was given for those who have IPI on the site according to "drug list” guidelines (Lulseged, 1996).

Following identification, the prevalence of the overall or individual IPI was expressed as percentage of the positive students over the total sample, and presented in frequency table.

A finger prick blood sample was collected after cleaning the finger surface using a sterile cotton wool soaked in methylated spirit. Both thick and thin smears were prepared in a single slide labeled with identification number and stained with 10% Giemsa (Sigma, Aldrich, Nairobi) in phosphate buffer (WHO, 1993).

3.5.7. Determination of hemoglobin (Hb) and serum ferritin concentration

After rubbing the finger tip using sterile cotton, finger-prick blood samples were collected and used to fill the microcuvette by touching the cuvette tip on the middle until completely filled with the drop of blood. The loaded microcuvette was then inserted into the holder of a portable, digital counter and/or battery-operated HemoCue Hb 201 analyzer (HemoCue AB, Angel Holm, Sweden) and analysed. The concentration of the hemoglobin was read from the digital counter in g/dL.

Haemoglobin concentrations(Hb adjusted for altitude) were defined based on the reference ranges for hemoglobin concentration in children as 7,<12 years: 11.5 g/dL; ≥12,15 years:12 g/dL male:≥15 years:13 g/dL and non-pregnant females ≥ 15 years 12.0 g/dL (UNICEF, UNU, WHO, 2001).

Then individuals were classified as anemic or non-anemic according to the WHO age/gender cut-off limits (UNICEF, UNU, WHO, 2001).

For serum ferritin analysis**,** blood was drawn from a vein, usually from the back of the hand by health professionals. From each student 5 ml venous blood was collected into an airtight vial or tube attached to the needle, allow the blood to clot by leaving it undisturbed at room temperature for15-30 minutes.The clot was removed by centrifugation at 5,000 rpm for 5-10 minutes. Following centrifugation, the serum was immediately transferred to polypropylene tubes using a Pasteur pipette. The serum sample was maintained at -20°C and transported to EPHI laboratory once a week on dry ice, and stored at -20°C until the analysis was done for ferritin. The serum ferritin concentration was determined with Elegance Amplified Enzyme Linked Immuno Sorbent Assay (ELISA) system using kits (Bioclone Australia Pty.Ltd) at EPHI Diagnostic Laboratory within a month. Iron deficiency was defined as serum ferritin level below 15µg/L as a cut off for five years of age or older (WHO, 2011). Iron depletion, iron deficiency and iron deficiency anemia were defined according to World Health Organization criteria (WHO, 2011b).

3.5.8. Academic performance from academic records

Cognitive development of students was assessed based on academic performance.All the required information from the school about the student's grade report, grade averages and days of absenteeism was collected from school records.

Food frequency questionnaire

A ***food frequency*** questionnaire is designed to obtain qualitative, descriptive information about usual food consumption patterns. The general aim is to assess the frequency with which certain food items or groups are consumed during a specific time period (daily, weekly, monthly, yearly). The questionnaire consists of two components, a list of foods or food groups and a set of frequency-of-use response categories (Gibson, 1993). A food frequency questionnaire of important, nutritious food groups (grains, legumes, vegetable, tuber, fruits, milk products and enset products) was added into the questionnaire to see on how many days these foods were eaten by the index child.

3.5.9. Data quality management

The principal investigator was the overall coordinator and supervisor of the research activities on daily basis. Questionnaire prepared in English was translated into Amaharic language for field work purpose and back to English for checking language consistency. During the data collection, constant monitoring and supervision were carried out. All the activities of the interviewers, the nurses and laboratory (lab) technicians were supervised.

On existences of problems, the questionnaires and formats filled in by interviewers, the principal researcher had carried out counter-checks and any deviations were corrected immediately. From each school, 20 completed records were also checked against the original sources or the school master list (roster) for reliability of the data. The correct use and fill out of questionnaires and recording formats were checked by the supervisor during the night. Any inconsistencies or omissions were corrected as soon as possible. Any missed data were obtained within 24-48 hours.

The socio-demographic and medical history questionnaires were tested for reliability by the pre-test (pilot) study (as it was described above in the personnel recruitment and training part).The necessary readjustment was made based on the pretest results. The physical examination data were also tested for reliability against the supervisor's results on some of the students. No serious problems were encountered. The weight scales were checked at the beginning of each working day and mid-day against a standard of 5 kg object which was kept for such purpose. The scales indicators were checked against zero reading after weighing every child. A random check of 10% of all slides was carried out by an independent microscopists or laboratory technician for each laboratory diagnosis. On daily basis collected information was reviewed and a possible error was corrected.

4. DATA PROCESSING AND ANALYSIS

4.1. Data entry and recording

The majority of the variables were pre-coded before the survey. The coded data were entered into a computer and validation was performed in Microsoft Excel 2010 spreadsheets. Thus, raw nutritional data (height, weight, age and sex) from schoolchildren were converted to nutritional indicators (BAZ, WAZ and HAZ) using WHO anthro plus software. These indices were expressed using Z-score (WHO, 1995) in relation to the reference median of the national center for Health statistics (NCHS). Underweight, stunting and thinness were expressed by weight for age Z-score (WAZ), height for age Z-score (HAZ) and BMI for age Z-score (BAZ), respectively, using <-2 standard deviations (<-2SD) of Z-score as a cut-off.In the weight for age statistical analysis,students who were > 10 years of age (N=529) were excluded.The weight for age measure is regarded as inappropriate indicator of nutritional status for older children experiencing the pubertal growth spurt(de Onis *et al.*,2007). Nutritional status was used as exposure variable for school performance, and as outcome variable for the socio-demographic variables (exposures) and IP infection (exposure).

Each symptom of disease or each disease or physical examination findings was coded individually as yes or no. All the symptoms were also grouped together, and recorded as ‘yes’ when at least one symptom was present and ‘no’ where no symptom was present. The same was done for all diseases or all physical examination.

Determinant variables were also dichotomized individually as yes or no, and grouped as yes or no by the presence of at least one obstacle. They served as exposure for school average score and abseentism.

Average score was categorized into 2 to be used as outcome variable for IPI, nutritional status and socio demographic factors. Also using the median as cut-off, days of school abseentism was classified as "low or no abseentism" when it was equal to or less than the median or zero, and "high" or when it was above the median school abseentism days.

Stool examination results were dichotomized as present or absent of eggs/larvae or cyst of a particular IPI. All IPIs were recorded as one group with yes/no by the presence of at least one IPI.

4.2. Data analysis

The nutritional data imported to WHO anthro plus software. Thus, the software converts raw nutritional data into Z-scores of the indices; WAZ, HAZ and BAZ taking age and sex into consideration using NCHS reference population standard of WHO reference 2007 (5-19 years). The data was then exported to SPSS version 20 programs for analysis; Descriptive statistics was used to provide a clear picture of background variables. The frequency distribution of both dependent and independent variables was determined.Hb and serum ferritin levels, intensity of helminthes infection (Epg),school performance and nutritional status and prevalence of intestinal parasites were used as means among study participants. All graphs were drawn using MS-Excel and all box-plots were drawn using SPSS version 20. Chi-square tests were used to verify possible association between intestinal parasitic infection and exposure to different factors. Univariate analysis was used to identify the possible confounders. Variables that were associated with both exposure and outcome variables in the crude analysis using statistical significance at p-value <0.2 were considered to be possible confounders. Multivariate analysis was used to measure the strength of association of socio-demographic factors and intestinal parasitic infections, haemoglobin status, school performance and nutritional status. 95% confidence interval (CI) was calculated for the odds ratio value. Values were considered significant when $p<0.05$. Descriptive statistics of means, standard deviations and percentages were calculated. Independent sample t-test was used to compare the mean score between two independent groups on some continuous variable. Pearson's correlation coefficient (r) was used to determine the association between anaemia and nutritional and health factors.

a. The anthropometric indices were used to indicate the nutritional status of the study population in relation to the reference median Z-score. Those who were below -2 standard deviation(SD) from the median Z- scores were undernourished, and described by percentage.

b. The prevalence of the overall or individual IPI was expressed as percentage of the positive students over the total sample, and presented in frequency table.

c. The school performances were expressed as percentage of low, average or medium and high average score; high and low or no absentism, and repeat or not repeat at current grade.

d. The association of IPI (using as exposure infected or uninfected) and nutrition status (as outcome variable normal or stunted or underweight or thin) was analyzed by a 2x2 cross-tabulation; Crude OR (95%CI) and Adjusted OR(95%CI).

e .The socio-demographic variables (as exposure) were analyzed in relation to

i) Nutrition status as outcomes using a 2x2 cross-tabulation, chisquare, Crude OR 95% CI, Adjusted OR 95% CI.

ii) School average score (as outcomes using a 2x2 table, chisquare (p-value),absenteeism by using a 2x2 table, Crude OR 95% CI, Adjusted OR 95% CI.

f. The association of IPI and Hb status was analyzed by a 2x2 cross-tabulation, Crude OR 95% CI, Adjusted OR 95% CI.

g. The association of Hb status, IPI (using as exposure anemic or not anemic) and nutritional status (as outcome variable normal or stunted or underweight or thin) was analyzed by a 2x2 cross- tabulation; Crude OR 95% CI, Adjusted OR 95% CI.

5. ETHICAL CONSIDERATION

The ethical aspect of this study was reviewed and clearance obtained from the Ethical Committee of College of Natural Sciences, through the Department of Microbial Cellular and Molecular Biology, Addis Ababa University, and from SNNPR Health Bureau. Informed verbal permission was also obtained from Gurage Zone Education and Health Departments. Each of these zonal departments passed the message of permission to their respective districts including schools and health centers. The freedom of the pupils to participate or not in the study was explained to the study subjects. The objective of the study was explained to the school community, kebele leaders and parents; and written consent was obtained from every participant's parent or guardians of the selected children before conducting the survey and the children also gave their assent before collecting the samples. Participants, who were positive for malaria and intestinal parasitic infections, were referred to health centers for appropriate treatment. Individuals positive for malaria were treated with anti-malarial drugs, chloroquine or coartem (artemether-lumefantrine) as found appropriate. Also individuals found positive for STH infections were treated with mebendazole 500 mg. Individuals positive for parasitic protozoa were treated with tinidazole 200 mg drugs. All treatments were given free of charge under the supervision of health professionals at the health centers according to the national treatment protocol (FMOH, 2004). Any information obtained from the participants remained confidential (access to data was limited only for the research team).Education on nutrition, personal hygiene and environmental sanitation was also given to the pupils and the school staff by the researcher. A few parents of very emaciated children were advised to take the necessary care for their children. They were counseled to keep good hygiene, prevent IPI, anemia, malnutrition and help the children in all possible ways.

6. RESULTS

6.1. Socio-demographic characteristics of the study participants

At recruitment, a total of 685 schoolchildren made up the initial sample, of these 5(0.73 %) had moved out of the study area before the completion of data collection during the first round. Therefore, during the second round of data collection, a total of 680 students were successfully followed-up (99.3% of the original sample) in the study. The mean age of the total study population was 12.56 years (range:7-19) with significantly more in the age group 10-14 years (P=0.02).The male to female proportion was 48.7% and 51.3% in Abeshge, and 54.9% and 45.1% in Enemore-Ener district, respectively with more males overall (Table 1).

The sample size allocated in proportion to the respective District population, consisted of 450(66.2%) students from Enemore-Ener district elementary schools, and 230(33.8%) students from Abeshege district elementary schools (Table 1).

Regarding educational status of parents, out of the total 450 fathers of Enemore-Ener, 183(40.7%) were unable to read /write. Of those able to read/write, about 51% had completed grades 1 through 12 (only 8% of the fathers were above 12 grade levels). Similarly, out of the total 230 fathers of Abeshege, 92(40%) were unable to read /write while, 138 (60%) of them had completed grades from 1 through 12. In contrast, in Enemore-Ener mothers, educational status, those who could not read/write were 241(53.6%), whereas in Abeshege, educational status of mothers who could not read/write was 95(41.3%) (Table 1).There was no difference between male parent education of the two districts whereas more female parents were educated in Abeshege district than Enemore-Ener district.

The majority, 283(62.9%) of the parents of the study participants in Enemore-Ener were farmers by occupation and around 167(37.1%) of them were merchants and farmers (mixed) and some were also involved in many different occupations, including handcrafts, house construction, and daily laborers, etc. In Abeshege, 161 (70%) of the parents were farmers by occupation, while 69(30%) were merchants and farmers (mixed). There is no significant difference regarding this demographic condition by residence (Table 1).

The overall average family size was 5.2 persons (1.74 SD) while 57.2% of the households had more than five family members. The average number of family members was 4.4 in Abeshege, and 5.6 in Enemore-Ener. The number of children in any one family may vary from 1 to 13. It should also be noted that many families had not yet reached the final family size, especially young families.

Table 1. Socio-demographic characteristics of the primary schoolchildren in Enemore-Ener and Abeshege districts, Sep, 2014 -Jun, 2015.

Variable	Residence			Total
	Enemore-Ener (%)	Abeshege (%)	Total	No
Sex				
Male	247(54.9%)	112(48.7 %)	359(52.8)	680
Female	203(45.1%)	118(51.3%)	321(47.2)	
Age				
7-9yr	44 (9.8%)	33(14.3%)	77(11.3)	680
10-14yr	264(58.7%)	142(61.7%)	406(59.7)	
≥15yr	142 (31.6%)	55(23.9%)	197(29)	
Religion				
Orthodox	150(33.3%)	79(34.3%)	229(33.7)	680
Muslim	280(62.2%)	142(61.7%)	422(62.1)	
Others	20(4.4%)	9(3.9%)	29(4.3)	
Father education				
Illiterate	183(40.7%)	92(40%)	275(40.4)	680
Educated	267(59.3%)	138(60%)	405(59.6)	
Mother education				
Illiterate	241(53.6%)	95(41.3%)	336(49.4)	680
Educated	209(46.4%)	135(58.7%)	344(50.6)	
Parent occupation				
Farm	283(62.9%)	161(70%)	444(65.3)	680
Others	167(37.1%)	69(30%)	236(34.7)	
Family size				
2-5	165(36.7%)	126(54.8%)	291(42.8)	680
>5	285(63.3%)	104(45.2%)	389(57.2)	

6.2. Socio-economic conditions of the study participants and their parents

Out of the total of 680 study participnts, 287/450 (63.8%) of Enemore-Ener and 166/230 (72.2%) Abeshege had radio, while 14(3.1%) Enemore-Ener and 8(3.5%) of Abeshege had television. Similarely, 670 (98.5%) had their own house, while the rest had rented their living house from extra house owners. Regarding housing conditions, 146(21.5%), 674 (99.1%), and 460(67.7%) of study participnts were living in houses with corrugated iron sheets, earthen floors, and single room respectively. While the rest, 534 (78.5%), 6(0.9%), and 220(32.3%) were living in thatched, cemented, and two or more room houses, respectively. Around 349(77.6%) of Enemore-Ener and 203(88.3%) districts the study participnts were using safe drinking water, which was from protected springs or hand pump wells. There is significant difference regarding this socio-economic condition by residence (P< 0.001) (Table 2). The rest were getting their drinking water from unsafe sources, including rivers, or unprotected or unclean springs or wells. The categorization of drinking water sources as "safe" and "unsafe" were not based on bacteriological criteria, they were labeled as such simply by common sense, just as one can think of them by their apparent status. Only 41(6%) of the study participnts had electricity supply, and 161(23.7%) of them had kitchen. Availability of latrine was 211(46.9%) in Enemore-Ener while 123(53.5%) in Abeshege districts.There is no significant difference in residence, although more latrine available in Abeshege district.In both districts most families did not use the available latrine properly rather they defecated around home gardens in both districts (Table 2).

Table 2. Socio-economic characteristics of the Enemore-Ener and Abeshege districts primary schoolchildren parents, Gurage zone, South Central Ethiopia, 2014/ 2015.

Variable	Residence		Total No
	Enemore-Ener n(%)	Abeshege n(%)	
Availability of radio			
Yes	287(63.8)	166(72.2)	680
No	163(36.2%)	64(27.8)	
Availability of TV			
Yes	14(3.1)	8(3.5)	680
No	436(96.9)	222(96.1)	
Latrine availability			
Yes	211(46.9)	123(53.5)	680
No	239(53.1)	107(46.5))	
Water supply			
Cleaned spring/well	349(77.6)	203(88.3)	680
Uncleaned spring/well	101(22.4)	27(11.7)	
Availability of kitchen			
Yes	76(16.9%)	85(37%)	680
No	374(83.1%)	145(63%)	

6.3. Diet characteristics

Respondent's diet characteristics in both Enemore-Ener and Abeshege districts

Table 3 shows, 441(98%) of the respondents replied that their commonest staple food was *Kocho* in Enemore-Ener district.In this district 186(41.3%) of respondents had consumption of less than three meals per day and 143(31.7%) of respondents consumed vegetables once in a week, 207(46%) of respondents consumed vegetables twice in a week while 100(22.2%) of respondents responded that they consumed vegetables not on regular basis because of lack of availablity.

Furthermore, 339(75.3%) of respondents replied that they did not consume meat on a regular basis and the source of food they consume shows that they are subsistant farmers (Table 3).

All, 230(100%) of Abeshge respondents responded that their commonest staple food was teff and other cereals. Similarly, more than half 141(61.3) of respondents responded to consume three meals per day. Only 19(8.3%) respondents answered that they consumed vegetables once a day in a week; 52(22.6%) of respondents responded that they consumed meat once a week for a month preceding the survey. All of respondents asserted that they did not consume fruits once a week.Only 3.5% of respondents responded that they consumed *kocho* on special occasions like holiday, different ceremonies either market purchase or obtain from relatives of enset growing districts. Among the families of respondents, most source of food was from own product, but some were supplemented by market purchase.

Table 3. Food Characteristics of Respondents (parents), in Enemore-Ener and Abeshege districts, Gurage zone, South Central Ethiopia, 2014 (N=680).

Characteristics	Enemore-Ener (N%)	Abeshege (N%)
Teff	0(0%)	155(67.4%)
Maize	0(0%)	32(13.9%)
Kocho	441(98%)	8(3.5%)
Sorghum	0(0%)	25(10.9%)
Other *	9(2%)	10(4.3%)
Source of food		
Market purchase only	10(2.2%)	0(0%)
Both own product and market purchase	440(97.8%)	230(100%)
Number of meals per day		
Three or more	264(58.7%)	141(61.3%)
Two	120(26.7%)	64(27.8%)
One	66(14.7%)	25(10.9%)
Intake of fruits and vegetables per week		
Once a week	143(31.7%)	19(8.3%)
Twice a week	207(46%)	0(0%)
Other**	100(22.2%)	211(91.7%)
Intake of meat per week		
Once a week	111(24.6%)	52(22.6%)
Twice a week	0(0%)	20(8.7%)
Three times a week	0(0%)	0(0%)
Other***	339(75.3%)	158(68.7%)

* =Mixed food items

**= Fruits and vegetables cannot be eaten in programmed manner rather they have access to eat at harvesting season those which are produced in the area.

***= Meat is eaten mostly in special occasions like holidays, and different ceremonies.

6.4. The prevalence of intestinal parasites

Miroscopic stool sample examination using wet mount, kato-katz and formol-ether concentration techniques showed that infections with various intestinal helminths and protozoan parasites were found in Enemore-Ener and Abeshege districts elementary schoolchildren. A total of six hundred eighty five (685) students, from grade 1 to 8, were sampled in season one, of these five (5) study subjects did not provide a complete data for analysis. Out of the 680 schoolchildren examined six (6) species of intestinal parasites were identified with an overall prevalence of 180(40%) in Enemore-Ener and 89(38.6%) in Abeshege. Of the total of 180(40%) in Enemore-Ener and 89(38.6%) in Abeshege positive individuals, 91(20.2%) were single infection, 63(14%) were double infection in Enemore-Ener while 52(22.6%) were single infection,18(7.8%) were double infection in Abeshege.There was no significance difference in overall IPI prevalence between Enemore-Ener and Abeshege districts in Table 4 (P>0.05). There was a significant difference in double infection between Enemore-Ener and Abeshege districts (Table 4) (P>0.05).

Table 4. Prevalence of IPIs in Enemore-Ener and Abeshege districts primary schoolchildren, Gurage zone, South Central Ethiopia, 2014.

Type of parasites	Enemore-Ener N=450 No (%)	Abeshege N=230 No (%)	P-value
Hookworm	42(9.3%)	21(9.1%)	0.93
Ascaris lumbrioides	43 (9.6%)	20(8.7%)	0.71
Trichuris trichiura	22(4.9%)	11(4.8%)	0.95
E.histolytica/dispar	26(5.8%)	11(4.8%)	0.58
Taenia spp	7(1.6%)	6(2.6%)	0.49
Giardia lamblia	40 (8.9%)	20(8.7%)	0.93
Any IPI*	180(40)	89(38.7%)	0.74
Single IPI	91(20.2%)	52(22.6%)	0.47
Double IPI	63(14%)	18(7.8%)	0.02
Triple IPI	26(5.8%)	19(8.3%)	0.22

*-Prevalence of any intestinal parasitic infection

6.5. The Incidence of Intestinal parasites

A total of six hundred eighty (680) stool samples examination, from grade 1 to 8, were done in season two in the study. All of the study subjects, 680 (100%) participated in season one were sampled in season II. Out of the 680 schoolchildren examined 6 species of intestinal parasites were identified with an overall prevalence of 175(38.9%) in Enemore-Ener and 83(36.1%) in Abeshege. Of the total of 175(38.9%) in Enemore-Ener and 83(36.1%) in Abeshege positive individuals, 104(23.11%) were single infection, 49(10.9%) were double infection in Enemore-Ener while 54(23.5%)were single infection, 18(7.8%) were double infection in Abeshege (Table 5). There was no significant difference between Enemore-Ener and Abeshege districts (Table 5) ($P>0.05$).

Table 5. Incidence of IPI in Enemore-Ener and Abeshege district elementary schoolchildren, Gurage zone, South Central Ethiopia, 2015.

Type of parasites	Enemore-Ener N=450 No (%)	Abeshege N=230 No (%)	P-value
Hookworm	40(8.9%)	21(9.1%)	0.92
Ascaris lumbricoides	42(9.3%)	19(8.3%)	0.64
Trichuris trichiura	23(5.1%)	8(3.5%)	0.33
E.histolytica/dispar	24(5.3%)	13(5.7%)	0.86
Taenia spp	7(1.6%)	3(1.3%)	0.74
Giardia lamblia	39(8.7%)	*19(8.3%)*	0.86
Any IPI*	175(38.9%)	83(36.1%)	0.47
Single IPI	104(23.11%)	54(23.5%)	0.92
Double IPI	49(10.9%)	18(7.8%)	0.21
Triple IPI	22(4.9 %)	11(4.8%)	0.28

*-Prevalence of any intestinal parasitic infection

6.6. The intensity of helminthic infections

The intensity of infection for hookworm, *Trichuris trichiura* and *Ascaris lambricoides* is shown in Figure 4. The highest egg count for ascaris was 912 eggs per gram (epg) of stool in two male and two female children in Enemore-Ener district and 600 epg for two male children in Abeshege district.Microscopic examination of thick blood film showed that two children in Enemore-Ener and fourteen children in Abeshege were positive for malaria parasite. So, haematological analysis for Hb status of these subjects was not included in the study.All study participants were found in light intensity infection according to WHO, (1998) classification.

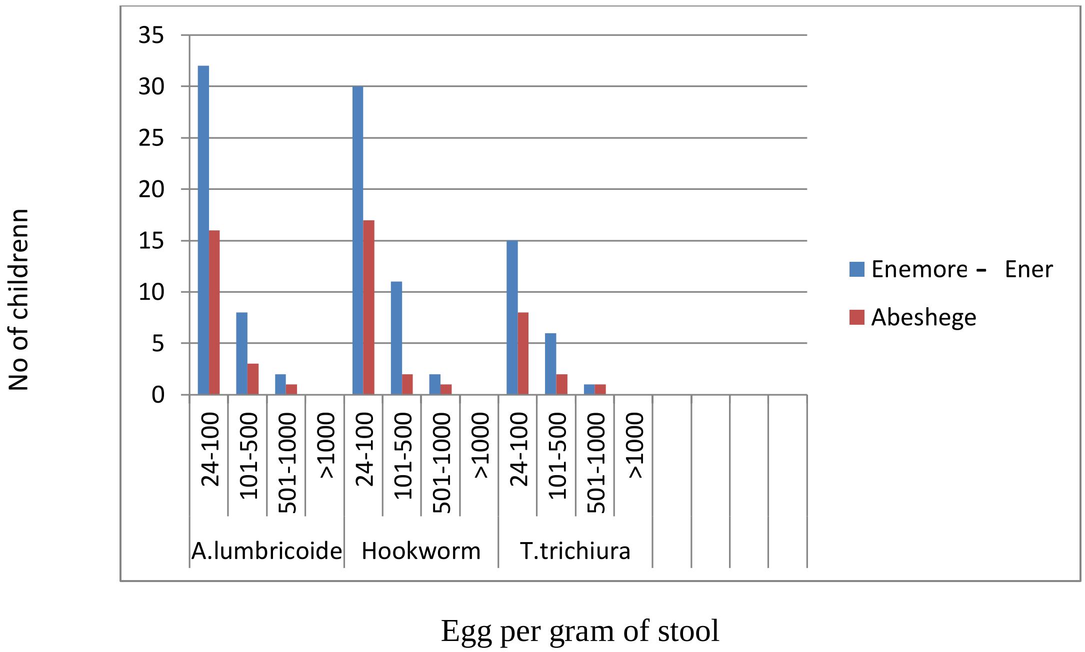

Figure 4. Intensity of helminth infections (epg) among schoolchildren in Enemore-Ener and Abeshege districts, Gurage zone, South Central Ethiopia, 2014.

Stool sample was collected and examined in two consecutive seasons; however, there was no statistical difference between the prevalence of intestinal parasites between the two seasons. Due to this reason the prevalence of each identified parasite in season I was considered for analysis. Analyses of the potential risk factors explored for the IPI showed, 127(35.4%) of males, and 142(44.2%) of females had at least one IPIs. Of these parasitized children, 180(40%) were Enemore-Ener in residence and 89(38.7%) were Abeshege in residence.Residence was not statistically significant for intestinl parasitic infection (P>0.05) (Table 6). The odds of IPI in females were 1.5 times higher than males.Schoolchildren who did not consume protected water were 3.94 times more likely to be infected with IPI.Schoolchildren from families with more than five members were found to be 7.9 times more likely to be infected with IPI as compared to schoolchildren from 2-5 members. This shows family size matters on the transmission of IPI. Schoolchildren who did not wash hands after defecation were 1.9 times more likely to be infected with IPI. Similarely, schoolchildren who did not wash hands before meal were 1.9 times more likely to be infected with IPI.Moreover, schoolchildren from families with latrine were less likely to be infected with IPI. In other words, latrine availability in a family was found to be protective from IPI and it showed reduction by 94% from IPI (Table 6).

Table 6. Univariate and multivariate analysis of some risk factors for IPI prevalence among the schoolchildren, in the two study districts, Gurage zone, South Central Ethiopia, 2014.

Variable		IPI* Positive (%)	COR (95%CI)	P-value	AOR(95%CI)	P-value
Gender	Female	142(44.2)	1.5(1.06-1.97)	0.02	1.5(1.06-1.97)	0.02
	Male	127(35.4)	1		1	
Residence	Abeshege	89(38.7)	1		1	
	Enemore-Ener	180(40)	0.95(0.68-1.3)	0.74	1.02(0.64-1.9)	0.71
Water type used	Safe**	193(35.0)	1		1	
	Unsafe	76(59.4)	0.37(0.25-0.55)	<0.001	3.94(2.84-5.45)	<0.001
Latrine	Available	36(10.8)	0.06(0.04-0.08)	<0.001	0.06(0.04-0.09)	<0.001
	Unavailable	233(67.3)	1		1	
Family size	>5	227(58.4)	8.3(5.7-12.19)	<0.001	7.9(4.9-12.6)	<0.001
	2-5	42(14.4)	1		1	
Washing hands	Yes	175(36.2)	1		1	
after defecation	No	94(48)	0.62(0.45-0.87)	0.006	1.91(1.25-2.92)	0.01
Washing hands	Yes	196(36.9)	1		1	
before eating	No	73(49)	0.60(0.42-0.88)	0.008	1.90(1.24-2.9)	0.01

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

** Safe water categorization was used not based on protozoa/bacteriological criteria; it was labeled as just as one can think of it by its apparent status.

In season two follow up visit, multivariate analysis showed that the odds of IPI in females were 2.0 times higher than males.Schoolchildren who did not consume protected water were 3.94 times more likely to be infected with IPI. Schoolchildren from families with more than five members were found to be 6.70 times more likely to be infected with IPI as compared to schoolchildren from 2-5 members. Schoolchildren who did not wash hands after defecation were 1.61 times more likely to be infected with IPI. Similarely, schoolchildren who did not wash hands before meal were 1.65 times more likely to be infected with IPI.Moreover, schoolchildren from families with latrine were less likely to be infected with IPI. In other words, availability of latrine at home was found to be protective by 94% from IPI infection (Table 7).

Table 7. Univariate and multivariate analysis of some risk factors associated with IPI incidence among the schoolchildren, in the two study districts, Gurage zone, South Central Ethiopia, 2015.

Variable		IPI* Positive N(%)	COR (95%CI)	P-value	AOR(95%CI)	P-value
Gender	Female	136(42.4)	1.42(1.05-1.94)	0.03	2.0(1.3-3.0)	0.001
	Male	122(34.0)	1		1	
Residence	Abeshege	83(36.1)	1		1	
	Enemore-E	175(38.9)	0.88(0.64-1.23)	0.47	0.74(0.83-2.09)	0.24
Water type	Safe	184(33.3)	1		1	
	Unsafe	74(57.8)	0.37(0,25-0.55)	<0.001	3.94(2.84-5.45)	<0.001
Latrine	Available	32(9.6)	0.06(0.04-0.08)	<0.001	0.06(0.04-0.09)	<0.001
	Unavailable	226(65.3)	1		1	
Family size	>5	217(55.8)	7.6(5.2-11.3)	<0.001	6.7(4.26-10.66)	<0.001
	2-5	41(14.1)	1		1	
Washing hands after defecation	Yes	167(34.6)	1		1	
	No	91(46.2)	0.60(0.44-0.86)	0.005	1.61(1.2-2.5)	<0.001
Washing hands before eating	Yes	167(34.6)	1		1	
	No	91(46.2)	0.60(0.44-0.86)	0.005	1.65(1.4-2.81)	<0.001

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

The present study showed a high prevalence of intestinal parasitic infections, especially with hookworm, *G.lamblia* and *Ascaris lumbricoide* infections. The factors that make higher prevalence of *Ascaris lumbricoides*, hookworm and *Giardia lamblia* are not known in the study area. The current study aimed at identifying prevalence and predictors of those intestinal parasitic infections in Gurage zone, which is vital for the effective implementation of control strategies in combating these intestinal parasitic infections (Table 8-10).

Schoolchildren with age category ≥ 15 years were found to be 1.43 times more likely to be infected with hookworm as compared to other respective age category. Schoolchildren from families with no latrines were found to be 2.2 times more likely to be infected with hookworm as compared to schoolchildren with latrine at home.Both small family size and wearing shoes were protective from hookworm infection. In other words, having family members 2-5 were found to be protective by 27% from hookworm infection.Wearing shoes showed reduction by 91% from hookworm infection (Table 8).

Table 8. Univariate and multivariate analysis of some risk factors associated with hookworm infection among the schoolchildren, in the two study districts, Gurage zone, South Central Ethiopia, 2014.

Variable		Hookworm* Positive N(%)	COR(95%CI)	P--value	AOR(95%CI)	P-value
Age category	7-9	5(6.5)	1		1	
	10-14	31(7.6)	2.23(0.85-6.18)	0.10	0.87(0.34-2.22)	0.77
	≥15	27(13.7)	1.9(1.11-3.32)	0.02	1.43(1.2-2.8)	0.03
Latrine	Unavailable	45(13.0)	2.63(1.49-4.64)	<0.001	2.16(1.17-3.97)	0.01
	Available	18(5.4)	1		1	
Family size	>5	47(12.1)	1		1	
	2-5	16(5.5)	2.36(1.31-4.25)	0.004	0.73(1.33-1.62)	0.04
Wearing shoes	No	57(24.8)	1		1	
	Yes	6 (1.3)	24.57(10.4-58.05)	<0.001	0.09(0.48-0.187)	<0.001

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

Analyses of the risk factors for the association of Giardia infections showed 28 (7.8%) of male children, and 32(10%) of female students had giardiasis, however the observed differences were not statistically significant ($p>0.05$) (Table 9).

Schoolchildren who consumed unprotected water were found to be 20 times more likely to be infected as compared to schoolchildren from protected water consumers.Schoolchildren from families with >5 members were found to be 1.02 times more likely to be Giardia infected as compared to schoolchildren from 2-5 members.Latrine availability,washing hands before eating and after defecation were protective from *Giardia lamblia* infection.Availablity of latrine was found to be protective by 60% from giardia infection. Both washing hands before eating and after defecation were found to be protective from giardia infection and it showed reduction by 70% (Table 9).

Table 9. Univariate and multivariate analysis of some risk factors associated with *Giardia lamblia* infection among the schoolchildren, in the two study districts, Gurage zone, South central Ethiopia, 2014.

Variable		*G.lamblia* Positive * N(%)	COR(95%CI)	p-value	AOR(95%CI)	p-value
Gender	Female	32(10)	1.31(0.77-2.23)	0.32	1.18(0.68-2.12)	0.52
	Male	28(7.8)	1		1	
Water type consumed	Unsafe	41(11.8)	0.45(0.26-0.79)	0.006	20(10.14-43.64)	<0.001
	Safe	19(5.7)	1		1	
Latrine	Unavailable	42(12.1)	1		1	
	Available	18(5.4)	0.41(0.27-0.63)	<0.001	0.40(0.25-0.68)	<0.001
Family size	>5	44(11.3)	2.19(1.21-3.96)	0.01	1.02(1.1-2.04)	0.04
	2-5	16(5.5)	1		1	
Washing hands before eating	Yes	33(6.2)	0.29(0.2-0.5)	<0.001	0.33(0.18-0.57)	<0.001
	no	27(18.1)	1		1	
Washing hands after defecation	yes	26(5.4)	0.27(0.16-0.47)	<0.001	0.31(0.18-0.55)	<0.001
	no	34(17.2)	1		1	

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

Socio-demographic risk factors analyses in schoolchildren in relation to ascais infection showed that 36(11.2%) of females had higher prevalence of ascais infection than 27(7.5%) of male children, however the observed difference was not statically significant (P>0.05) (Table 10).

Schoolchildren with 10-14 years age category were found to be 1.75 times more likely to be ascaris infected as compared to schoolchildren from 7-9 and ≥ 15 years. Schoolchildren from families with ≥5 members were found to be 2.23 times more likely to be Ascaris infected as compared to schoolchildren from 2-5 members. Furthermore, schoolchildren who did not wash hands before eating were found to be 6.4 times more likely to be Ascaris infected as compared to schoolchildren from who washed hands before eating.Latrine availability, water type consumed and washing hands after defecation were protective from Ascaris infection.Availablity of latrine was found to be protective by 53 % from ascaris infection. Washing hands after defecation was found to be protective from ascaris infection and it showed reduction by 41% from ascaris infection. Consuming protected water was found to be protective by 51 % from ascaris infection (Table 10).

Table 10. Univariate and Multivariate analysis of some risk factors associated with Ascaris lumbricoide infection among the schoolchildren, in the two study districts, Gurage zone, South Central Ethiopia, 2014.

Variable		Ascaris Positive* N(%)	COR(95%CI)	p-value	AOR(95%CI)	p-value
Gender	Female	36(11.2)	1.55(0.92-2.26)	0.09	1.28(0.73-2.25)	0.38
	Male	27(7.5)	1		1	
Age category	7-9	10(13)	0.93(0.42-2.04)	0.86	1.06(0.45-2.46)	0.89
	10-14	29(7.1)	1.8(1.02-3.18)	0.04	1.75(1.05-3.23)	0.04
	≥15	24(12.2)	1		1	
Water type consumed	Safe	40(7.2)	0.36(0.2-0.6)	<0.001	0.49(0.28-0.89)	0.02
	Unsafe	23(18)	1		1	
Latrine	Available	16(4.8)	0.32(0.18-0.58)	<0.001	0.47(0.25-0.88)	0.02
	Unavailable	47(13.6)	1			
Family size	>5	50(12.9)	3.15(1.7-5.9)	<0.001	2.23(1.15-4.3)	0.02
	2-5	13(4.5)	1		1	
Washing hands before eating	no	51(19)	7.78 (4.06-14.9)	<0.001	6.39(2.88-14.2)	<0.001
	Yes	12(2.9)	1		1	
Washing hands after defecation	Yes	36(7.5)	0.5(0.3-0.87)	0.014	0.59(0.39-0.88)	0.01
	No	27(13.6)	1		1	

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

Univariate analysis of intestinal parasitic infections as risk factors for anemia in Enemore-Ener and Abeshege districts showed IPIs had strong association (P=0.01) with anemia in the schoolchildren in Enemore-Ener district whereas IPIs were not significantly associated with anemia in Abeshege district.Therefore, IPI positive individuals were more anemic than IPI negative individuals in Enemore-Ener district with a significant difference (P<0.05) (Table 11).

Table 11. Univariate and multivariate logistic regression analysis of intestinal parasitic infections (IPIs) as risk factors for anemia, among schoolchildren in Enemore-Ener and Abeshege districts Gurage zone, South Central Ethiopia, 2014.

Risk factors	Anemia N(%)	COR(95% CI)	p-value
IPI Enemore-Ener			
No	105(35.7)	0.6(0.40-0.89)	0.011
Yes	75(48.1)		
IPI Abeshege			
No	50(37.3)	0.87(0.51-1.48)	0.6
Yes	39(40.6)		
Two districts together			
No	155(36.2)	1.45(1.06-1.99)	0.02
Yes	114(45.2)		

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total participants for the respective characteristic

6.7. Serum ferritin and haemoglobin levels among primary schoolchildren in Enemore-Ener and Abeshege districts

Determination of Hb levels in the schoolchildren showed the mean haemoglobin level in Abeshege district (11.52 ±0.94 g/dl) to be significantly lower than the mean haemoglobin level (11.75 ±0.97 g/dl) of Enemore-Ener district schoolchildren (Figure 5) (P =0.03).

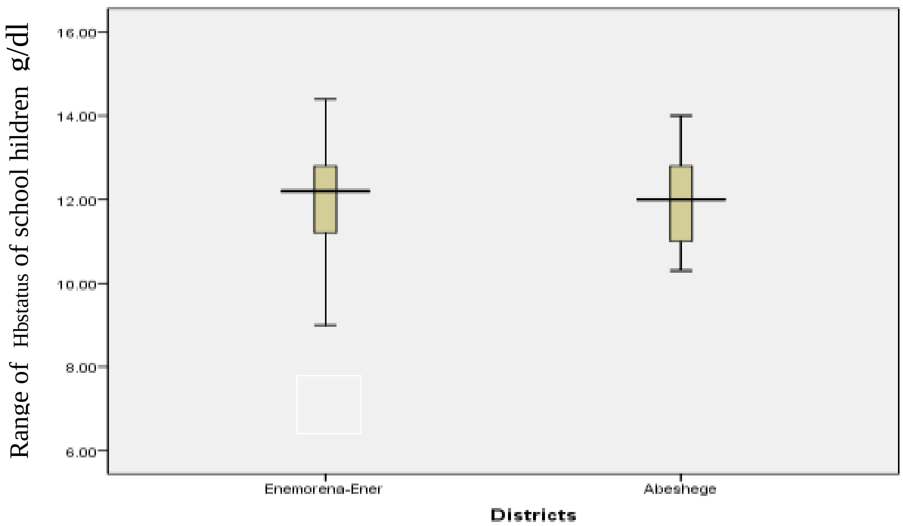

Figure 5.Mean Hb levels in primary schoolchildren in Enemore-Ener and Abeshege Districts, 2014.

Determination of the serum ferritin level among the schoolchildren showed the mean serum ferritin level of the schoolchildren in Abeshege district (41.4 µg/L) to be significantly lower than the mean serum ferritin level of Enemore-Ener district (52.29 µg/L) schoolchildren (Figure 6) (P= 0.00).

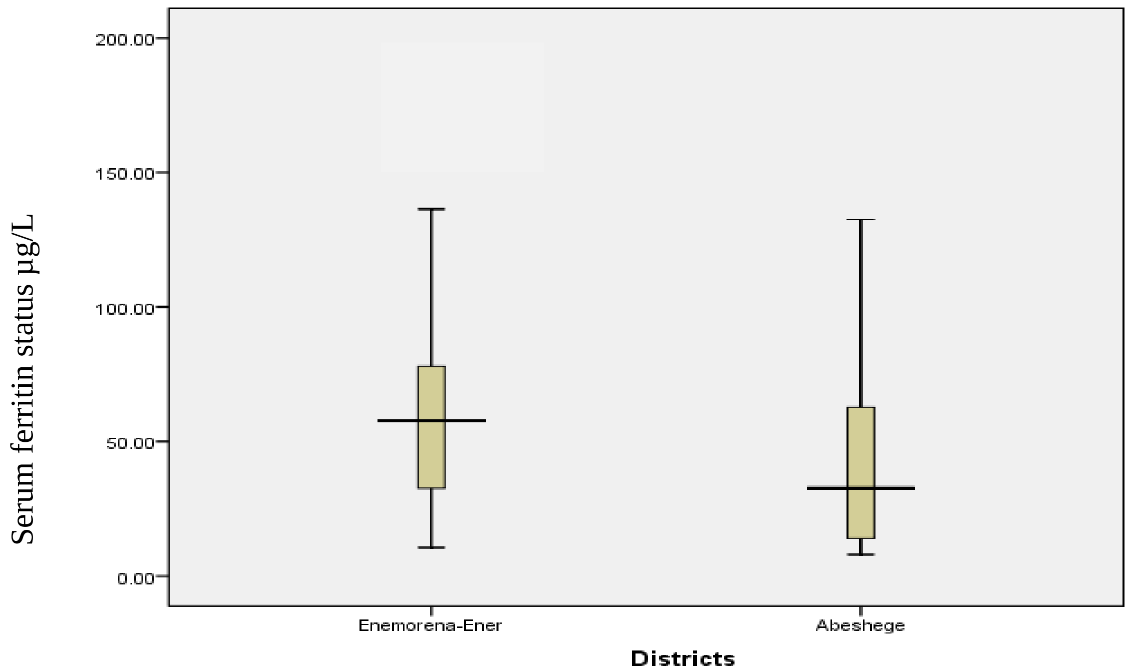

Figure 6.Serum ferritin levels in primary schoolchildren in Enemore- Ener and Abeshege districts, 2014.

6.8. Comparison of correlation between haemoglobin and serum ferritin levels

Pearson's correlation coefficient (r) was used to determine the correlation between haemoglobin measurements and serum ferritin levels. Analysis showed r=0.579, 0.635, in Abeshge and Enemore-Ener districts, respectively. This indicated that there was positive correlation between haemoglobin level and serum ferritin measurement in Abeshege and Enemore-Ener districts ($p<0.05$).

The relationship between mean haemoglobin and mean serum ferritin measurements among schoolchildren in the two districts were examined using independent sample t test. The analysis showed that the mean haemoglobin and the mean serum ferritin values among schoolchildren in Enemore-Ener district were higher than in Abeshege district ($p< 0.05$) (Table 12).

Table 12**.** Comparison of mean haemoglobin and mean serum ferritin among Enemore-Ener and Abeshege districts schoolchildren (n=680) in Gurage zone, South central Ethiopia, 2014.

				95% CI		
Anemic status measurement	N	Mean Hb/SF	t*	Lower	Upper	P
Hb (g/dl)						
Enemore-Ener	450	11.75	2.8	0.06	0.37	0.005
Abeshege	230	11.52				
Serum ferritin(μg/L)						
Enemore-Ener	450	52.29	4.2	9.08	24.6	0.000
Abeshege	230	41.4				

t*=t-test for equality of means

6.9. Gender and infection status based comparison of haemoglobin levels

There was no significant difference between mean haemoglobin levels in males and females in the two districts (Table 13).

The independent sample t-test for mean haemoglobin level comparision showed that except for male and female children, the mean haemoglobin levels were significantly lower in IPI positive, hookworm positive,ascaris positive and,Giardia positive children ($p < 0.05$) (Table 13).

Table 13. Gender and IPI status based comparison of haemoglobin levels among primary schoolchildren (n=680) in the two study districts, Gurage zone, South Central Ethiopia, 2014.

				95% CI		
Variables	N	MeanHb**(g/dl)**	t*	Lower	Upper	P
Gender						
Male	359	11.69	0.58	-0.103	0.188	0.56
Female	321	11.65				
Infection status						
IPI positive	269	11.49	-3.82	-0.43	-0.13	0.00
IPI negative	411	11.79				
Hookworm positive	63	11.4	-2.2	-0.53	-0.03	0.02
Hookworm negative	617	11.69				
Giardia positive	60	11.35	-2.69	-0.5	-0.04	0.01
Giardia negative	620	11.70				
Ascaris positive	63	11.52	-1.28	-0.41	0.08	0.03
Ascaris negative	617	11.69				

t*=t-test for equality of means

The independent sample t-test mean comparision of ferritin values showed that except for gender (P=0.3) and ascaris infection (P=0.18), IPI positive children had significantly higher ferritin values for hookworm and Giardia infection ($p < 0.05$) (Table 14).

Table 14. Gender and IPI status based comparison of serum ferritin levels among primary schoolchildren (n=680) in the two study districts, Gurage zone, South Central Ethiopia, 2014.

				95% CI		
Variables	N	Mean SF**(μg/L)**	t*	Lower	Upper	P
Gender						
Male	359	53.8	1.06	-0.03	0.11	0.3
Female	321	51.75				
Infection status						
IPI positive	269	53.0	-3.5	-0.19	-0.05	0.00
IPI negative	411	52.3				
Hookworm positive	63	52.9	-2.2	-0.27	-.03	0.02
Hookworm negative	617	52.56				
Giardia positive	60	53.0	-2.1	-0.30	-0.01	0.03
Giardia negative	620	52.56				
Ascaris positive	63	52.8				
Ascaris negative	617	52.58	1.3	-0.05	0.25	0.18

t*=t-test for equality of means; SF=Serum ferritin

6.10. Nutritional status and its association with anemia

Assessment of nutritional status and association with anaemia showed underweight to have significant association with anemia ($P<0.05$).Underweight children were more likely to be anemic as compared to children of normal weight for age (Table 15).

Table 15. Overall Nutritional status and its association with anemia in the two study districts, Gurage zone, South Central Ethiopia, 2014.

Nutritional status	Prevalence of nutritional status (%)	r	P-value
Underweight	47.7	0.237	0.003
Stunted	40.3	0.06	0.118
Thin	41.7	0.047	0.084

6.11. Factors associated with academic average score in children

Different variables were tested for their association with academic performance in univariate and multivariate analysis (Table 16). Females were found to be 2.0 times more likely to be lower in academic performance as compared to males.Schoolchildren from families with >5 members were found to be 1.76 times more likely to be lower in academic performance as compared to schoolchildren from ≤ 5 members.Schoolchildren who had absenteeism ≥6 days were found to be 2.5 times more likely to be lower in academic performance as compared to schoolchildren from ≤5 days.Both walk short distance and absence of eye discharge were protective from scoring poor academic performance.Walking short distance (< 30 minutes) was found to be protective by 54% from lower academic performance. Absence of eye infection was found to be protective from lower academic performance and it showed improvement by 96% from lower academic performance (Table 16).

Table 16. Factors associated with performance of Schoolchildren, in the two study districts, Gurage zone, 2014 (N=680).

Variables	Number of students (%) per average grade score		COR(95%CI)	p-value	AOR(95% CI)	p-value
	Below average(n)*	Above average(n)*				
Sex:						
Female	180(56.1)	141(43.9)	1.72(1.39-2.13)	<0.001	2.0(1.24-3.25)	0.004
Male	153(42.6)	206(57.4)	1		1	
Residence:						
Abeshege	115(50)	115(50)	1.06(0.77-1.46)	0.7	1.15(0.68-1.95)	0.59
Enemore-Ener	218(48.4)	232(51.6)	1		1	
Family size:						
>5	231(59.4)	158(40.6)	2.71(2.17-3.38)	<.001	1.76(1.15-1.29)	0.031
≤ 5	102(35.1)	189(64.9)	1		1	
Walk distance						
>30 minutes	180(52.9)	160(47.1)	1		1	
≤30 minutes	153(45)	187(55)	1.38(1.11-1.7)	0.03	0.46(0.28-0.77)	0.003
Absenteeism						
≥6 days	246(66.1)	126(33.9)	4.96(3.93-6.25)	<0.001	2.5(1.41-4.30)	0.002
≤5 days	87(28.2)	221(71.8)	1		1	
Eye discharge						
No	93(25.5)	271(74.5)	0.11(0.09-0.14)	<0.001	0.04(0.02-0.08)	<0.001
Yes	240(75.9)	76(24.1)	1		1	

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total participants for the respective characteristic

6.12. Factors affecting academic performance of schoolchildren

Univariate and multivariate analysis was performed for nutritional factors and IPI with school academic performance (Table 17). Variables, presence of IPI, presence of anemia, being stunted and thin showed significant association with poor academic performance and they were protective from scoring lower academic performance (P<0.05) (Table 17). Thin children were more likely to be poor in academic performance than children with normal weight for height.Schoolchildren who were not thin was found to be protective by 47 % from poor academic performance. Stunted children were more likely to be poor in academic performance than children with normal height for age and children with normal height for age showed reduction by 86% from poor academic performance. Schoolchildren who had no infection were found to be protective from scoring lower academic performance and it showed improvement by 98% from low academic performance. Anemic children were more likely to be poor in academic performance than children with no anemia and it showed reduction by 30% from poor academic performance in non-anemic children (Table 17).

Table 17. Factors affecting academic performance of Schoolchildren, in the two study districts, Gurage zone, 2014 (N=680).

Variables	Number of students (%) per average grade score		COR(95%CI)	p-value	AOR(95% CI)	p-value
	Below average(n)*	Above average(n)*				
BAZ						
Normal	165(41.6)	232(58.4)	0.49(0.39-0.61)	<0.001	0.53(0.33-0.87)	0.01
Thin	168(59.4)	115(40.6)	1		1	
HAZ						
Normal	145(35.7)	261(64.3)	0.25(0.20-0.32)	<0.001	0.14(0.08-0.25)	<0.001
Stunted	188(68.6)	86(31.4)	1		1	
WAZ						
Normal	42(53.2)	37(46.8)	0.76(0.4-1.46)	0.4	1.4(0.5-3.93)	0.5
Underweight	43(59.7)	29(40.3)	1		1	
IPI						
No	106(25.8)	305(74.2)	0.06(0.05-0.09)	<0.001	0.02(0.01-0.05)	<0.001
Yes	227(84.4)	42(15.6)	1		1	
Anemia						
No	205(45.8)	243(54.2)	0.69(0.55-0.86)	0.02	0.7(0.52-0.76)	0.01
Yes	128(55.2)	104(44.8)	1		1	1

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total participants for the respective characteristic

6.13. The anthropometric measurments of the schoolchildren

Distribution of children according to height and weight measurements was assessed between two different districts of Gurage zone. The mean height (P=0.00) and the mean weight (P=0.00) distribution of schoolchildren in Abeshege district was relatively lower than the mean weight and height of Enemore-Ener district schoolchildren (Figure 7).

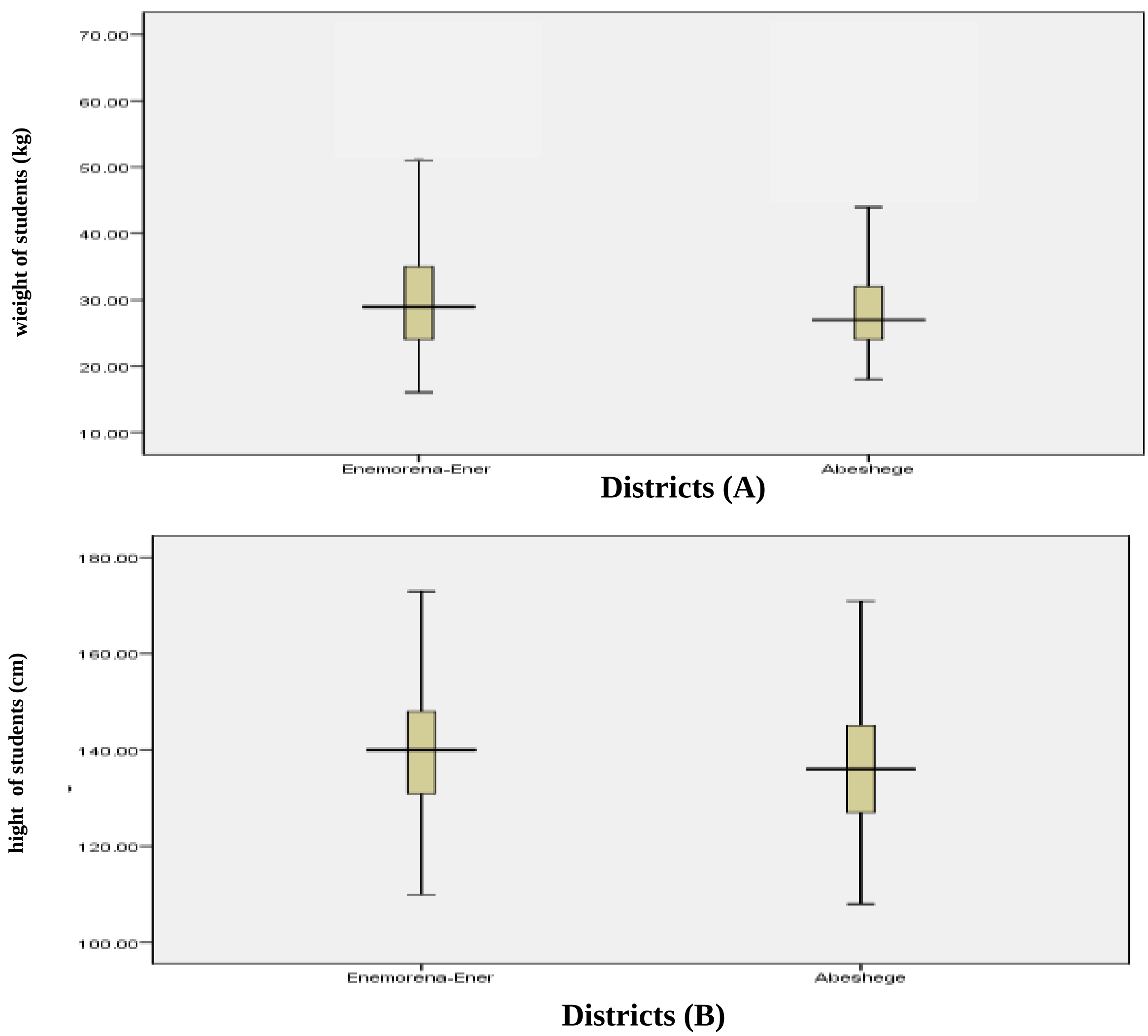

Figure 7.Measures of mean weight (A) and (B) mean height in Enemore-Ener and Abeshege districts, primary schoolchildren, South Central Ethiopia, 2014.

6.14. Nutritional indicator analysis

Nutritional indicator analysis showed that out of the total 680 studied schoolchildren, 132(29.3%) of Enemore-Ener and 76 (33%) Abeshege had mid arm circumfrence measurements of less than 16 cm (malnourished). Similarely, 178 (39.6%) of Enemore-Ener and 96(41.7%) Abeshege children were stunted (HAZ< -2SD). Regarding thinness, 188(41.8%) of Enemore-Ener and 95(41.3%) of Abeshege schoolchildren were thin (BAZ<-2SD), and 41(48.8%) children in Enemore-Ener and 31(46.3%) in Abeshege schoolchildren were underweight (WAZ<-2SD). However, the difference between the two districts were not statistically significant (P>0.05) (Figure 8).

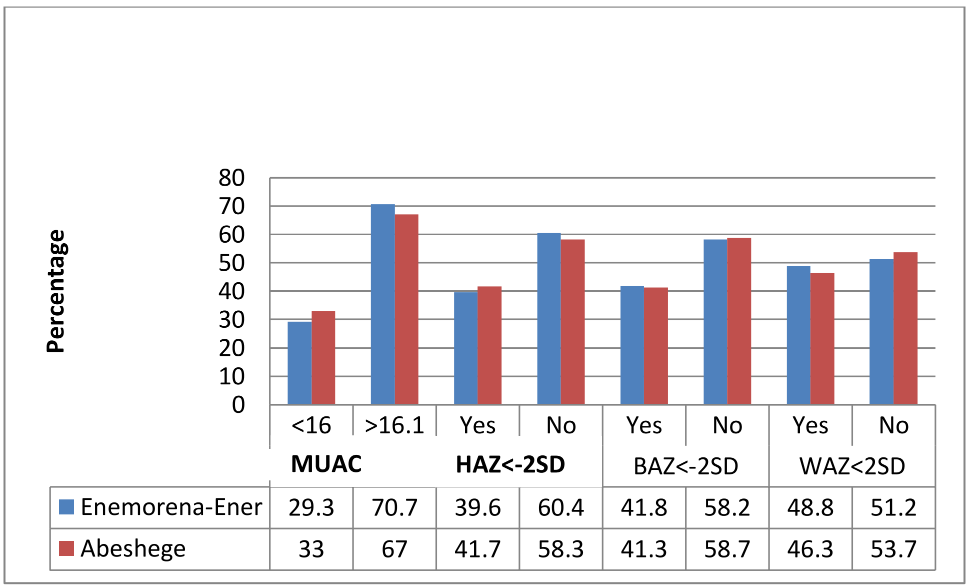

Figure 8. Nutritional status indicators in schoolchildren in Enemore-Ener and Abeshege districts, primary school, South Central Ethiopia, 2014 (N=680).

6.15. Distribution of schoolchildren according to Z-score

Distribution of children according to z-score was assessed in Enemore-Ener and Abeshege districts separately. Normal (Z-score > -2), prevalence of moderate stunting (Z-score -2 to <-3) and severe stunting (Z-score <-3) were found among 60.4%,35.6% and 4% of the Enemore-Ener, and 58.5%, 40.2% and 1.3% of the Abeshege schoolchildren respectively, while normal (Z-score > -2), prevalence of moderate underweight (Z-score -2 to <-3) and severe underweight (Z-score <-3) were found in 51.2%, 45.2% and 3.6% of Enemore-Ener, and 53.8%,35.8% and 10.4% of Abeshege schoolchildren respectively. Similarly, normal (Z-score > -2), prevalence of moderate thinness (Z-score -2 to <-3) and severe thinness (Z-score <-3) were found in 58%,27.3% and 14.7% of the Enemore-Ener children, and 58.7 %, 32.6% and 8.7% of the Abeshege schoolchildren respectively, as shown in Table 18.

The prevalence of moderate underweight was higher in children of Enemore-Ener than Abeshege districts while severe underweight was higher in children of Abeshege than Enemore-Ener districts. Similarly, the prevalence of moderate thinness was higher in children of Abeshege than Enemore-Ener districts while severe thinness was higher in children of Enemore-Ener than Abeshege districts (Table 18).

Table 18. Distribution of schoolchildren according to Z-score, in Enemore-Ener and Abeshege districts primary schools, Gurage zone, Ethiopia, 2014.

	Enemore-Ener district			Abeshege district		
Z-score	WAZ n(%)*	HAZ n (%)	BMI n(%)	WAZ n(%)*	HAZ n(%)	BMI n(%)
> -2	43(51.2)	272(60.4)	261(58)	36(53.8)	135(58.5)	68(58.7)
-2 to -3	38(45.2)	160(35.6)	123(27.3)	24(35.8)	93(40.2)	75(32.6)
< -3	3(3.6)	18(4)	66(14.7)	7(10.4)	3(1.3)	20(8.7)
Total valid	84(100)	450(100)	450(100)	67(100)	230(100)	230(100)

*Weight-for-age reference data are not available beyond age 10 because this indicator does not distinguish between height and body mass in an age period where many children are experiencing pubertal growth spurt and may appear as having excess weight (by weight-for-age) when in fact they are just tall.

6.16. Comparison of the growth patterns of the total study population with the NCHS reference standard values for weight-for-age, height- for- age and BMI-for-age.

The overall growth patterns of the two district study populations with the NCHS growth reference values for weight-for-age, height- for -age and BMI-for-age are shown in Table 19. The overall mean z-scores of weight-for-age, height- for-age, and BMI-for-age of the two district study population were found to be –1.92 ±0.6, -1.87±0.65, and -1.75±1.04, which were below the NCHS growth reference values for each respective anthropometric measure. Compared with the NCHS growth reference values, undernutrition was prevalent in the two districts (Table 19).

The mean Z-score and standard deviation of weight-for-age(–1.92 ±0.6), height- for-age(-1.87±0.65) and BMI-for-age (-1.75±1.04), of the study population in two districts were lower than NCHS growth reference values as it was skewed to the left (Table 19).

The mean Z-score and standard deviation of the mean of weight- for- age, height- for- age, and BMI-for-age of Enemore-Ener district were -1.89±0.54,-1.83±0.7and-1.83±1.03 respectively. These were below the NCHS growth standards or reference values. Undernutrition was prevalent among Enemore-Ener district study participants, as shown in Table 19.

For Abeshege district, the mean Z-score and standard deviation of the mean of weight-for-age, height-for-age,and BMI-for-age were -1.96 ±0.68, -1.94±0.52, and -1.61±1.03, respectively. These values were below the mean of NCHS growth reference standard values, respectively (Table 19).

The mean weight-for-age (-1.89±0.54) of the Enemore-Ener district Primary Schoolchildren were relatively higher than Abeshege district (-1.96±0.68), although the mean values of two districts were descending to the left when compared with NCHS growth reference values.

Table 19. Comparison of the growth patterns of the total two districts study participants, and Enemore-Ener district and Abeshege district separetly with the NCHS reference standard values for weight-for-age, height- for- age and BMI-for-age.

	Enemore-Ener district	Abeshege district	Two districts population
Mean Z-score &SD of weight-for-age	-1.89±0.54	-1.96 ±0.68	–1.92 ±0.6
Mean Z-score &SD of height-for-age	-1.83±0.7	-1.94±0.52	-1.87±0.65
Mean Z-score &SD of BMI-for-age	-1.83±0.7	-1.61±1.03	-1.75±1.04

6.17. Association between Nutritional status and Intestinal parasitic infection

Association between nutritional status and IPI according to z-score was explored in Enemore – Ener and Abeshege districts separately. It was shown that stunting was significantly associated with intestinal parasitic infections in Enemore-Ener district (P< 0.05) (Table 20).Severely stunted children were 3.5 times as likely to have IPIs compared with those with children of normal growth for their age (OR 3.49, 95% CI 1.54-6.61) (Table 20). Similarly, moderately stunted children were 3.24 times as likely to have IPIs compared with those with children of normal growth for their age (OR 3.24,95% CI 1.58-6.63) (Table 20).Like wise, in Abeshege district severely stunted children were 3.63 times as likely to have IPIs compared with those with children of normal growth for their age (OR 3.63, 95% CI 1.04-20.33). And also, moderately stunted children were 2.8 times as likely to have IPIs compared with those with children of normal growth for their age (OR 2.81, 95% CI 1.51-15.6) (Table 20).

In Enemore-Ener district, severely thin children were 2.45 times as likely to have IPIs compared with those with children of normal BMI for their age (OR 2.45, 95% CI 1.05-2.25) (Table 20). Similarly, moderately thin children were 2 times as likely to have IPIs compared with those with children of normal BMI for their age (OR 1.97, 95% CI 1.65-2.46)) (Table 20). Correspondingly in Abeshege district, severely thin children were 3.0 times as likely to have IPIs compared with those with children of normal BMI for their age (OR 2.99, 95% CI 1.49-2.0). And also, moderately thin children were 1.67 times as likely to have IPIs compared with those with children of normal BMI for their age (OR 1.67, 95% CI 1.82-3.42) (Table 20).

Table 20. Univariate analysis for association between under nutrition and IPI, in Enemore-Ener and Abeshege districts Primary Schoolchildren, Gurage zone,South Central Ethiopia,2014.

	Enemore-Ener (IPI)		Abeshege (IPI)	
WAZ	OR(95%CI)	P-value	OR(95%CI)	P-value
>0	1.00(Reference)		ND	
0 to -1	0.59(0.41-1.89)	0.80	1.00(Reference)	
-1 to -2	0.65(0.72-3.15)	0.23	0.75(0.64-19.0)	0.13
-2 to -3	0.71(0.82-2.42)	0.16	0.77(0.9-2.10)	0.07
<-3	0.9(0.49-2.00)	0.98	0.55(0.89-1.89)	0.07
HAZ			HAZ	
>0	1.00(Reference)		1.00(Reference)	
0 to -1	0.67(0.75-9.45)	0.13	ND	
-1 to -2	2.11(0.92-4.79)	0.08	2.0(0.25-11.4)	0.06
-2 to -3	3.24(1.58-6.63)	0.01	2.81(1.51-15.6)	0.02
<-3	3.49(1.54-6.61)	0.02	3.63(1.04-20.33)	0.01
BAZ			BAZ	
>0	1.00(Reference)		1.00(Reference)	
0 to -1	0.89(0.40-1.98)	0.78	1.09(0.41-2.89)	0.86
-1 to -2	1.38(0.86-2.21)	0.18	1.50(0.72-3.15)	0.28
-2 to -3	1.97(1.65-2.46)	0.03	1.67(1.82-3.42)	0.04
<-3	2.45(1.05-2.25)	0.01	2.99(1.49-2.00)	0.02

ND=Not determined because of small sample size

6.17.1. Nutritional status indicator analysis for HAZ <-2SD for age Z- score

Among the socio-demographic determinants, age groups (10-14 years), and the presence of IPI were significantly associated with stunting (HAZ <-2SD) (Table 21).

Schoolchildren with age category with 10-14 years were found to be 2.0 times more likely to be stunted as compared to the respective older or younger age category (COR 1.78, 95% CI 1.19-3.18), and (AOR 2.02, 95% CI 1.1-3.7). Children with no IPI were found to be protective from stunting and it showed reduction by 62% from stunting (probability to be stunted is 0.38) (COR 0.41, 95% CI 0.30-0.56) and (AOR 0.38, 95% CI 0.26-0.59) (Table 21).

Table 21. Univariate and multivariate analysis of selected correlates of HAZ <-2SD for age Z-score in the two study districts of Primary Schoolchildren, Gurage zone,South Central Ethiopia,2014.

Variable N=680	Stunting* No (%)	COR(95% CI)	p-value	AOR(95% CI)	p-value
Residence					
Abeshege	96(41.7)	1.09(0.79-1.51)	0.58	1.2(0.86-1.72)	0.26
Enemore-Ener	178(39.6)	1		1	
Sex					
Female	123(38.3)	1		1	
Male	151(42.1)	0.86(0.63-1.16)	0.32	0.78(0.56-1.07)	0.12
Age group in years					
7-9	21(27.3)	1		1	
10-14	174(42.9)	1.78(1.19-3.18)	0.04	2.0(1.1-3.7)	0.02
≥15	79(40.1)	0.89(0.63-1.26)	0.52	0.95(0.66-1.36)	0.78
IPI					
No	131(31.9)	0.41(0.30-0.56)	<0.001	0.38(0.26-0.59)	<0.001
Yes	143(53.2)	1		1	
Anemia					
No	179(41.8)	1.2(0.86-1.6)	0.29	1.30(0.94-1.86)	0.1
Yes	95(37.7)	1		1	

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

6.17.2. Nutritional stutus indicator analysis for BAZ <-2SD for age Z- score

Univariate and multivariate analysis were performed on selected correlates of BAZ <-2SD for age Z- score**.** Of the socio-demographic factors, being male, 10-14 years old and presence of IPI were significantly associated with thinness (BAZ < -2SD).

Both gender (femaleness) and age category (10-14 years) and absence of infection were protective from thinness. Femaleness was found to be protective by 30% from thinness (COR 0.70, 95% CI 0.51-0.95) and (AOR 0.70, 95% CI 0.50-0.96). Similarly, children with age category 10-14 years were found to be protective by 48 % from thinness (probability to be thin is

52%) (COR 0.50, 95% CI 0.35-0.71),and (AOR 0.52, 95% CI 0.36-0.75). Children with no IPI infection were found to be protective by 51% from thinness (probability to be thin is 49%), (COR 0.53, 95% CI 0.38-0.72), and AOR 0.49, 95% CI 0.34-0.70) (Table 22). In contrast, residence, family size, and presence of anemia did not show any significant association with thinness BAZ for age <-2SD (Table 22).

Table 22. Univariate and multivariate analysis of selected correlates of BAZ <-2SD for age Z-score among the schoolchildren in the two study districts,Gurage zone,South Central Ethiopia,2014.

Variable	*Thinness (BAZ <-2SD) No (%)	COR(95% CI)	P- value	AOR (95% CI)	P-value
Residence					
Abeshege	95(41.3)	1		1	
Enemore-Ener	188(41.8)	0.98(0.71-1.35)	0.90	0.96(0.68-1.34)	0.80
Sex					
Female	119(37.1)	0.70(0.51-0.95)	0.02	0.70(0.50-0.96)	0.03
Male	164(45.7)	1		1	
Age group in years					
7-9	27(35.1)	0.85(0.48-1.48)	0.56	0.99(0.55-1.75)	0.96
10-14	194(47.8)	0.50(0.35-0.71)	<0.001	0.52(0.36-0.75)	0.001
≥15	62(31.5)	1		1	
Family size					
>5	170(43.7)	1.22(0.89-1.66)	0.2	0.93(0.64-1.30)	0.69
2-5	113(38.8)	1		1	
IPI					
No	146(35.5)	0.53(0.38-0.72)	<0.001	0.49(0.34-0.70)	<0.001
Yes	137(50.9)	1		1	
Anemia					
No	176(41.1)	1		1	
Yes	107(42.5)	0.9(0.69-1.3)	0.70	0.9(0.72-1.3)	0.9

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

6.17.3. Nutritional stutus indicator analysis for WAZ <-2SD for age Z- score

Univariate and multivariate analysis of selected correlates of underweight (WAZ) for age Z-score were performed. Among socio-demographic and selected health factors, children with no anemia was found to be protective from underweight and it showed reduction by 70% (probability to be underweight is 30%), (COR 0.42, 95 % CI 0.22-0.82), and (AOR 0.30, 95% CI 0.14-0.63). On the other hand residence, sex, family size and presence of IPI did not show any significant association with underweight (WAZ) for age <-2SD (Table 23).

Table 23. Univariate and multivariate analysis of selected correlates of underweight (WAZ) for overall age Z- score among the schoolchildren in the two study districts,Gurage zone,South Central Ethiopia,2014.

Variable	*Underweight(WAZ<-2SD) No (%)	COR(95%CI)	P- value	AOR (95% CI)	P- value
Residence					
Abeshege	31(46.3)	1		1	
Enemore	41(48.8)	0.90(0.46-1.72)	0.76	0.86(0.40-1.8)	0.7
Sex					
Female	29(41.4)	1		1	
Male	43(53.1)	0.63(0.33-1.19)	0.15	0.48(0.24-1.0)	0.05
Family size					
>5	49(51)	1.45(0.7-2.8)	0.28	1.99(0.85-4.6)	0.11
2-5	23(41.8)	1		1	
IPI					
No	41(50.6)	1.29(0.68-2.45)	0.44	1.7(0.79-3.7)	0.17
Yes	31(44.3)	1		1	
Anemia					
No	26 (36.6)	0.42(0.22-0.82)	0.01	0.30(0.14-0.63)	<0.001
Yes	46 (57.5)	1		1	

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

*The percentage is calculated from the total examined for the respective characteristic

6.18. Determinants of child malnutrition by residence (Enemore-Ener and Abeshege destricts).

Variables that were found significant factors in overall analyses of the determinants of malnutrition (thinness,stunting and underweight) showed variation for Enemore-Ener and

Abeshege district settings; some variables become insignificant factor and other variables showed association with the nutritional outcomes.

Children with no anemia were less likely to be underweight than anemic children.In other words, non-anemic children was found to be protective by 66% from underweight in Enemore-Ener and 78% in Abeshege districts (Table 24).

Table 24. Comparison of selected determinant factors of underweight among the schoolchildren in Enemore-Ener and Abeshege districts, Gurage zone, South Central Ethiopia, 2014.

Variable	Residence					
	Enemore-Ener			Abeshege		
	Underweight* No (%)	AOR (95% CI)	P-value	Underweight* No (%)	AOR(95%CI)	P-value
Sex						
Female	13(37.1)	1		16(45.7)	1	
Male	28(57.1)	0.37(0.14-0.99)	0.05	15(46.9)	0.67(0.23-1.98)	0.48
Family size						
>5	33(50.8)	1.84(0.58-5.9)	0.30	16(51.6)	1.69(0.45-6.3)	0.44
2-5	8(42.1)	1		15(41.7)	1	
IPI						
No	25(55.6)	1		16(44.4)	1	
Yes	16(41)	2.22(0.82-6.02)	0.11	15(48.4)	1.07(0.29-4.02)	0.91
Anemia						
No	15(34.9)	0.34(0.13-0.68)	0.03	6(26.1)	0.22(0.06-0.73)	0.01
Yes	21(51.2)	1		25(56.8)	1	

AOR: Adjusted Odds Ratio; CI: Confidence Interval

*The percentage is calculated from the total examined for the respective characteristic

Multivariate analysis of stunting in Enemore-Ener and Abeshege districts separetly showed that children with no IPI were less likely to be stunted than children with IPI.In other words,IPI was found to be protective by 61% in Enemore-Ener and 56% in Abeshege districts from stunting.Anemic children in Abeshege district were found to be 1.86 times more likely to be stunted than children with no anemia (Table 25).

Table 25. Comparison of selected determinant factors of stunting among the schoolchildren in Enemore-Ener and Abeshege districts, Gurage zone, South Central Ethiopia, 2014.

Variable	Residence					
	Enemore-Ener			Abeshege		
	Stunting * No(%)	AOR(95% CI)	P-value	Stunting * No (%)	AOR(95%CI)	P-value
Sex						
Female	77(37.9)	1		46(39)	1	
Male	101(40.9)	0.79(0.53-1.17)	0.24	50(44.6)	0.73(0.41-1.3)	0.28
Age in years						
7-9	12(27.3)			9(27.3)	1	
10-14	107(40.5)	2.08(0.96-4.48)	0.06	67(47.2)	1.5(0.52-4.3)	0.45
≥15	59(41.5)	1.08(0.70-1.67)	0.70	20(36.4)	0.62(0.31-1.2)	0.18
Family size						
>5	120(42.1)	0.98(0.63-1.52)	0.93	55(52.9)	1.49(0.77-3.2)	0.20
2-5	58(35.2)	1		41(32.5)	1	
IPI						
No	85(31.5)	0.39(0.26-0.6)	<0.001	46(32.6)	0.44(0.21-0.90)	0.02
Yes	93(51.7)	1		50(56.2)	1	
Anemia						
No	54(38.3)	1		30(33)	1	
Yes	124(40.1)	1.22(0.79-1.88)	0.36	66(47.5)	1.86(1.02-3.4)	0.04

AOR: Adjusted Odds Ratio; CI: Confidence Interval

*The percentage is calculated from the total examined for the respective characteristic

In multivariate analysis, the main determinant factors of thinness (BAZ <-2SD) which was found to be significant factor for child thinness in overall analysis was performed separetly in Enemore-Ener and Abeshege districts. In Enemore-Ener district, being female sex and age category 10-14 years and absence of IPI were found to be protective for child thinness in multivariate analysis (Table 26), whereas in Abeshege district only absence of IPI was found to be protective for child thinness (Table 26).In other words, absence of IPI, femaleness and age category 10-14 years were found to be protective by 46%, 41% and 59% respectively in Enemore-Ener and only IPI was found to be protective by 61% in Abeshege districts from stunting (Table 26).

Table 26.Comparison of selected determinant factors of thinness (BAZ) among the choolchildren in Enemore-Ener and Abeshege districts,Gurage zone,South Central Ethiopia,2014

Variable	Residence					
	Enemore			Abeshege		
	Thinness * (BAZ) No(%)	AOR(95% CI)	P-value	Thinness * (BAZ)No(%)	AOR(95%CI)	P-value
Sex						
Female	71(35)	0.59(0.39-0.88)	0.01	48(40.7)	0.9(0.50-1.50)	0.67
Male	117(47.4)	1		47(42)	1	
Age(years)						
7-9						
10-14	16(36.4)	0.79(0.38-1.64)	0.52	11(33.3)	1.67(0.62-4.56)	0.31
≥15	131(49.6)	0.41(0.26-0.64)	<0.001	63(44.4)	0.87(0.44-1.72)	0.69
	41(28.9)	1		21(38.2)	1	
Family size						
>5	117(41.1)	0.73(0.47-1.13)	0.16	53(51)	1.27(0.63-2.56)	0.49
2-5	71(43)	1		42(33.3)	1	
IPI						
No	101(37.4)	0.54(0.35-0.84)	0.01	45(31.9)	0.40(0.19-0.8)	0.01
Yes	87(48.3)	1		50(56.2)	1	
Anemia						
No	122(39.5)	0.68(0.44-1.05)	0.08	57(41)	0.91(0.50-1.6)	0.76
Yes	66(46.8)	1		38(41.8)	1	

AOR: Adjusted Odds Ratio; CI: Confidence Interval

*The percentage is calculated from the total examined for the respective characteristic

7. DISCUSSION

Compared to what has been reported earlier from different parts of Ethiopia, the prevalence and incidence rates of intestinal parasitic infection (IPI) for the present study populations were higher from some and lower from others. This could be explained by the differences in the risk factors in different localities such as environmental sanitation and personal hygiene of the communities. Other investigators have also reported that the prevalence of IPI varies in different regions of Ethiopia (Merid *et al*., 2001; Legesse and Erko, 2004). The study identified key predictors of IPI in children, which included socio-demographic/economic factors, use of unprotected water, large family size, not washing hands before eating and after defecation and lack of latrines. The two district populations in this study were similar on some socio-demographic characteristics, but different on major socio-economic and diet chracteristics. This could be due to the relatively better accessiblity of farm land to farmers in Abeshege district than Enemore-Ener, although located in the same zone and the residents have similar culture.

The number of male schoolchildren in Enemore-Ener was higher than Abeshege district and this appears to be the male children in Abeshege were deplayed relatively more in farm activities than in Enemore-Ener.

The prevalence of IPI was not significantly different between Abeshege and Enemore-Ener schoolchildren, except for the relatively more double infection prevalence in Enemore-Ener district.This may be explained by the higher altitude of Enemore-Ener, a humid area,which has been reported (Jemaneh,1998) to favor high prevalence of soil transmitted parasites such as *Ascaris lumbricoides*. Furthermore, the lower accessibility of clean water in Enemore-Ener district than in Abeshege district may have contributed to the higher transmission of amoebic infections. On the other hand, the higher prevalence of *Taenia spp*. in Abeshege distict could be due to the residents' relatively better economic status that would allow them to buy and consume raw beef, which is very popular in the region and usually carries the infectious hydatid cyst.

Intestinal parasitic infection in the present study was relatively low as compared to earlier reports from different parts of the country, 83-86% Jimma Zone (Ibrahim, 1999; Amare *et al*., 2007) and 80% among North Gondar Delgi schoolchildren (Ayalew *et al*., 2011). The reduction in IPI prevalence might be an indication of improvement in the accessibility of health facilities, and introduction of periodic mass deworming in recent years (FMOH, 2015; WHO,2015b). On the other hand, IPI prevalence comparison with more recent study (Haftu *et al*., 2014) conducted in schoolchildren in Southern Ethiopia (27.7%) showed the overall prevalence (39.6%), in the present study districts to be relatively higher. This difference in IPI prevalence between the two study populations might be due to local variations in eco-geography as well as possible difference in the implementation of mass deworming.

The higher prevalence of IPI observed in the female schoolchildren could be explained by the culture of the community whereby all domestic activities- cleaning houses and around homesteads, are done by female children potentially exposing them to soil-transmitted IPIs.

The prevalence of hookworm in the present study was significantly higher than the prevalence of other intestinal parasites since most of the children did not wear shoes and played or walked over loamy soils potentially exposing them to hookworm larvae from soils contaminated with fecal matter.

Regarding possible association of IPI with risk factors among schoolchildren, several studies had identified a range of socio-demographic risk factors (Haileamlak, 2005; Amare *et al.*, 2007;

Alemu *et al*., 2011; Ayalew *et al*., 2011; G/hiwot *et al*., 2014). These were the same risk factors such as the odds of IPI increasing in children who did not wash hands before eating and after defecation, defecation in open fields, consuming unprotected water and presence of large family sizes that are associated with increase in the prevalence of IPI in the two study districts. This is an indication of little difference in the socio-economic condition of the population in different parts of Ethiopia. However, the relatively higher incidence of IPI in Enemore-Ener district compared to Abeshege may be partly explained by the crowded family size (Mengistu *et al*., 2007).

The most frequent IPIs, *Ascaris lumbricoides*, hookworm and *Giardia lamblia,* were linked with the key socio-demographic risk factors as shown by the univariate and multivariate analyses.Thus, the odds of hookworm infection increased in children with no latrine at home and not wearing shoes. This is a confirmation of a long standing knowledge about such association as reported by Bethony *et al*. (2006).

The significant association with giardiasis and not washing hands before eating and after defecation, lack of latrines and use of unprotected water, found in the study are the characteristic features of most undeveloped countries (Ouattara *et al*., 2010; Steinmann *et al*., 2010).

Ascaris infections were significantly associated with schoolchildren in the 10-14 years age category, large family size and poor hand washing practice. The reason could be that better awareness in washing hands and other personal hygiene measures will be acquired in older age groups.The likelihood of acquiring infections among schoolchildren who do not practice hand washing was 6.39 (95% CI,2.88-14.2) times higher than among those who had good hand washing practice.This finding is consistent with a study conducted in Babile town,Eastern Ethiopia (Tadesse,2005).

The present study has shown that the prevalence of anemia among school age children 34.7% in Enemore-Ener and 41.6% in Abeshege districts to be higher (27 - 37.6%) with that reported for school age children in different regions of Ethiopia (Assefa *et al*., 2014; Herrador *et al.*, 2014).This,also is an indication of significant difference in the socio-economic conditions of Ethiopian populations in different parts of the country.The minor differences in the prevalence of anemia among school- age children in different regions of the country may be partly explained by its multifactorial causes. As a result, the risk factors of anemia may not be exactly similar in all areas as reported by WHO (2001). Accordingly, the findings of this study have indicated that the prevalence of anemia among schoolchildren in the two districts may have been influenced by their staple diets. Thus, the higher prevalence of anemia in Abeshege district may be partly explained by the low iron bioavailability in foods the study participants consumed. This is because the staple food in Abeshege primarily consists of cereals which have high phytate and phenols that can cause poor bioavailability of iron (Phillippy, 2006).Phytate is negatively charged under physiological conditions and thus strongly chelates iron, forming insoluble complexes in the gastrointestinal tract that cannot be digested or absorbed in humans because of the absence of the enzyme phytase (Weaver and Kannan, 2002; Hurrell and Egli, 2010). Phytates are common constituents of cereals and legumes and *Erogristis teff*, the major staple food in Abshege and would contain high amounts of phytate (Schlemmer *et al*., 2009). Therefore, the phytates found in the teff will likely impair the absorption of iron (Hurrell and Egli, 2010), which could lead to iron deficiency anemia (Weaver and Kannan, 2002).

In Ethiopia, like other developing countries, children mainly consume plant-based foods like cereals that contain non-haem iron that are not bioavailable in the presence of iron inhibitors (phytates, phenols, calcium and tannin).This is compounded by the fact that the children also are a high risk group for parasitic infections that also need iron for growth and reproduction (Bermejo and Garcia-Lopez, 2009). This may be partly responsible for the high proportion of anemic children in the study in Enemore-Ener (34.7%) and in Abeshege (41.6%). Thus, the difference in anemia prevalence in children between the two districts appears to be due to the difference in the types of staple food consumed-*kocho* in Enemore-Ener and cereals in Abeshege.

Investigators such as Torre *et al*. (1991) had also shown that cereals, legumes, roots and tubers contain high content of iron inhibitors such as polyphenols and phytates that provide low amounts of bioavailable iron. While this is closer to the staple food situation (cereals) in Abeshege district, which has low bioavailable iron, a relatively better iron status in Enemore-Ener children can be accounted for by the presence of high level of bioavailable iron in *Kocho*.

Enset starchy foods (kocho, bulla, etc) have low phytic acid content (7mg/100g), compared with fermented Teff injera (117-139 mg/100g) (Abebe *et al.,* 2007). Absorption of intrinsic Fe and any exchangeable contaminant iron is unlikely to be compromised by phytate in the fermented foods prepared from enset unless consumed together with high phytate foods such as legumes and oil seeds (Abebe *et al.*, 2007). While food items such as legumes and oil seeds are of limited supply, the Ethiopian kale (*Brassica carinata braun*) is the major staple vegetable in Enemore-Ener.Therefore, the ascorbic acid -rich kale is often consumed with the enset starchy foods. This together with the lactic acid produced during fermentation of *kocho* can act as chelating agents, increasing the solubility of both the contaminant iron(soil contamination of Kocho) and intrinsic iron, thus resulting in increased amounts of the iron being absorbed (Harvey *et al*.,2000; Teucher *et al*., 2004).Because of the low content of inositol phosphate penta(IP-5) and inositol phosphate hexa (IP-6) (Iron storage elements in phytates) in these fermented staple foods, absorption of intrinsic non-heme iron as well as any exchangeable contaminant iron in the foods will not be compromised by phytate (Abebe *et al.*,2007).

Furthermore, although in rural Ethiopia, the diets of the population are predominantly plant-based and low in animal products and the daily consumption of such diets for longer periods may increase the relative risk of deficiencies of iron (Umeta *et al*., 2000), this appears to be compensated for by Kocho nutrition in Enemore-Ener district.

Eventhough the iron content in teff and its bioavailablity is relatively better than in other cereals,the study population did not consume teff alone, as the injera (the flat spongy bread) is prepared by mixing teff with wheat, maize, sorghum or other cereals with low iron bioavailablity and high in iron inhibitors (Umeta *et al*., 2005). In addition, the population in Abeshege does not routinely consume fresh vegetables and fruits that will provide vitamin C that would enhance iron bio-availability. The effect of such poorly balanced diet contributing to higher anemic status has been reported by Hallberg *et al*. (1980).

The present study indicated that anemia was significantly associated with IPI in Enemore-Ener district. This was a similar finding with a study done on Côte d'Ivoire children (Asobayire *et al*., 2001), where 45.3% of anemic children were infested by intestinal parasites. The mechanisms by which IPIs cause anemia can be through blood loss, malabsorption and food appetite reduction.

Evidence for this has been provided by studies from Tanzanian school-age children (Tatala *et al*., 2004) and from Western Kenya (Megha *et al.*, 2005).

The significant association of anemia with hookworm and Giardia infections has been reported to be due to nutritional disturbances by the parasites resulting in low food intake and nutritional competition by the parasites in addition to iron malabsorption in infected individuals (Muller and Krawinkel,2005; Hotez *et al*., 2008; Harhay *et al*.,2010).

With regard to serum ferritin level, the findings of the present study was similar to that reported from Yemeni primary schoolchildren, where mean serum ferritin level was 51.29± 6.58 µg/L (Raja'a *et al.*,2001), and with that reported from Nigeria, where anemia was recorded in 36.2% of the primary schoolchildren with mean serum ferritin level of 77.6 ± 32.6 µg/L(Adebara *et al*., 2011). In contrast, the ferritin level in the present study was higher than in rural schoolchildren in Kenitra, Morocco, where anemia was recorded in 12.2 % of the primary schoolchildren and mean serum ferritin level was 26.7µg/L in boys, and 27.9 µg/L in girls (EL Hioui *et al*., 2008). This might be due to the fact that the cause of anemia, in a population, is multifactorial and can be influenced by blood depleting parasites, chronic infections and haematological conditions,which are more prevalent in the present study sites.

More than 39.6% of the children had worm infections of various kinds, with hookworm (9.3%) and *Ascaris lumbricoide* (9.3%) and *Giardia lamblia* (8.8%) that contribute to anemia, since helminthic infections influence iron status by reducing nutrient intake and by interfering directly or indirectly with iron metabolism and transport (Crompton and Nesheim, 2002;Hotez *et al*. 2004).

In the present study serum ferritin concentration in children with IPIs were relatively higher than children with no infection.This appears to be due to the fact that serum ferritin is an acute-phase reactant protein that can be elevated in the response to infection (WHO/ UNICEF, 1996).

Children who had IPIs achieved poorly academically and this is in line with a study in Jamaica whereby children who were treated for moderate *whipworm* infections raised their test scores, which had lagged by 15%, from the level of uninfected children (WHO, 1997). Several studies point to the fact that IPI can cause nutrient malabsorption and other adverse changes in the intestine that makes the child undernourished (Stephenson, *et al*., 2000b).Similar findings were reported from Ethiopia (Degarege and Erko, 2013) and from Uganda (Francis *et al.,* 2012).The present findings also appear to show that poor academic performance is compounded with the high domestic work load in female children.Large family size and walking long distance from school also appears to have compromised academic performance reflecting serious resource limitations and poverty.

The study showed that thin schoolchildren (BAZ < -2SD) were more likely to achieve poorly academically, which could be explained to have resulted from IPIs and undernutrition. Analysis of thinness in Enemore-Ener and Abeshege districts showed that only the presence of IPI in the schoolchildren was the significant factor for thinness in the overall analysis. Similar study was reported from Nigerian primary schoolchildren where thinness and the overall poor nutritional status significantly affected school performance (Abidoye and Eze, 2000). This is consistent with research finding that show inadequate dietary supply of a number of essential nutrients to adversely affect brain function (Bryan *et al.,* 2004). It has also been reported that undernutrition directly causes central nervous system damage, which negatively impacts on cognitive development (Lozoff *et al.*, 2000; Walker *et al*., 2007) and such children may not work at their full potential because of energy shortage and fatigue. Furthermore, malnutrition has been shown to be improved by providing nutritional supplements and antiparasitic treatments to school-aged children with far reaching positive consquences (Best *et al*., 2010).

The association of stunting (HAZ< -2SD) in Enemore-Ener and Abeshege schoolchildren with poor academic performance is in agreement with the report of Walker *et al*.(2007) and Victora *et al*. (2008) from their study on maternal and child nutrition.This has been shown to be due to an deficit between the supply of energy protein and the body's demand to ensure optimal growth and function. Victora *et al*. (2008) state that "for every 10% increase in stunting, the proportion of children reaching the final grade of primary school drops by 7.9%" in developing countries. Furthermore, Grantham-McGregor *et al*.(2007) also state that "stunted children learn less in school, with lower reading and mathematics scores that are equivalent to fewer years of schooling". In addition,Grantham-McGregor and Walker (2008) have shown that stunting is indicative of long-term undernutrition, and is linked to poor academic performance and enrolment in school-aged children.

Analysis of selected determinant factors of underweight in Enemore-Ener and Abeshege districts showed that the presence of IPI in children, which was found to be a significant factor for child underweight in the overall analysis, was also a significant factor in both destricts separetly.The prevalence of underweight and/or stunting detected among the present study participants from Abeshege and Enemore-Ener was similar to the recent reports among school-age children in northern parts of Ethiopia,stunting 29.3% and 42.7% respectively (Degarege and Erko, 2013; Herrador *et al.*, 2014). Similar findings were also reported on the prevalence of stunting (42.7%)

and underweight (59.7%) in school-age children from different parts of Ethiopia (Reji *et al.*, 2011; Nguyen *et al.*, 2012; Mekonnen *et al.*, 2013). The insignificant differences could be due to fewer variations in the factors affecting undernutrition in the different regions of rural Ethiopia.

Analysis of stunting in the two districts together showed that presence of IPI in children, which was found to be a significant factor for child stunting in the two districts together, was also a significant factor in the respective destricts. However, some studies documented a lower prevalence of undernutrition for the urban centers of Ethiopia, underweight (27.1%) and stunted (11.2%) in Durbete town, North West Ethiopia (Alelign *et al.*, 2015) and stunted (19.6%) and underweight (15.9%) in Addis Ababa (Degarege *et al.*, 2015).This indicated that in urban centers the nutritional status is relatively better than in the rural regions of Ethiopia.

The observed lack of statistically significant difference between the prevalence of undernutition in Enemore-Ener and Abeshege districts, although the two district populations consume different staple food types, could possibly be explained by the likelihood that the poor nutritional content of ***kocho*** may have been compensated for by the nutritionally rich assortment of food items that are usually consumed with it.

The possible explanation for the middle age children (10-14 years) to have been more stunted than the younger age group may be that, younger age (less than 10 years) were more protected by parents so that they have better access to nutritious food and as they are small children,no heavy work is assigned to them. As a result,they are subjected to less energy expenditure that contribute to stunting, whereas the middle age group (10-14 years old) are known to be highly active and participate in the household chores, helping parents.

Analysis of selected determinant factors of thinnes in two districts together showed that the presence of IPI in children, which was found to be a significant factor for child thinness in two districts together, was also a significant factor in both destricts separetly. The higher prevalence of thinness (41.6%) compared to reports North West Ethiopia, with a prevalence rate of 37.2% (Mekonnen *et al*.,2013) may be an indication of regional variability in nutritional quality and availablity.The lower proportion of thin female children found in the study might be a reflection of difference in food accesseblity between the sexes.It is possible that as females stay at home after school,they may have better access to food at home. Possible reasons for the observed positive association of poor nutritional status with IPI include morbidity associated weight loss and altered absorption of micro and macronutrients (Stephenson *et al.,*2000). As a possible indication of regional variation, the prevalence of underweight (47.7%) in the two study sites was lower than that reported in a study done in Northwest Ethiopia (59.7%) (Mekonnen *et al.,*2013).

The mean WAZ, HAZ and BAZ of the study population were lower than WHO 2007 reference values. This may be explained by the moderate and severe stunting and thinness among the children,which was associated with a stastically significant increased odds of IPI among both districts.

The undernutrition detected in the schoolchildren who were infected with IPI could be due to the fact that IPIs cause diarrhea, lower appetite and malabsorption. In addition, the parasites compete for food, and some causing blood loss that would lead to undernutrition (Crompton and Neshein,2002; Muller and Krawinkel, 2005).

The skewing to the left of the mean Z-scores for WAZ, HAZ, and BAZ of the two study district populations, compared with the mean Z-score of WHO 2007 growth reference values, is an indication that the study population on the average was malnourished. This is a reflection of the poor accessibility of food in both quality and quantity coupled with higher prevalence of IPIs (Harhay *et al*., 2010). Furthermore, the mean Z-score of Abeshege children in WAZ, HAZ, and BAZ were relatively more skewed to the left than in children of Enemore-Ener district on the mean Z-score scale of WHO 2007 reference population. This is a reflecton of the relatively higher prevalence of malnutrition among Abeshege schoolchildren compared to children from Enemore-Ener. This is suggestive of the possiblity that deficiencies in kocho as staple food may have been supplemented with other nutritious foods supplements that increase its overall nutritional value as compared to the cereal-based nutrition.

8. CONCLUSIONS

The following conclusions are drawn from the present study:-

1. The prevalence of intestinal parasitic infections correlated strongly with both socio-demographic and economic risk factors.

2. Anemia was a common health problem of the school-age children and it showed strong positive correlation with both prevalence of IPIs and undernutrition.

3. A strong relationship existed between poor school performance and risk factors such as IPI, anemia, stunting and thinness.

4. The nutritional status of schoolchildren in the present study showed that undernutrition was highly prevalent compared to the NCHS international reference standard, which correlated well with both socio-demographic and economic risk factors of undernutrition and the presence of IPIs. This would contribute to reduced school performance.

5. Difference in the magnitude of anemic status was observed between the two study districts with higher anemia in Abeshege district than in Enemore-Ener and this may be explained by the bioavailability of iron in *kocho* and other iron enhancers like vitamin C in food supplements such as cabbage,kale and the like in Enemore-Ener district.

6. The nutritional status of schoolchildren as determined by mean Z-score for weight-for-age, height-for-age and BMI-for-age of Abeshege district was lower than in Enemore-Ener district,where *Kocho* is the staple diet.

9. RECOMMENDATIONS

The following recommendations are made based on the present findings:

1. An intervention strategy should be designed and implemented on the nutritional needs of school-age children in the Gurage zone.This must include school feeding program to address the problem of undernutrition.

2. Deworm and treat protozoan parasites twice a year, with follow-up evaluation of infection prevalence.

3. Strengthen health education program to increase the knowledge, attitude and practice of schoolchildren and parents on how IPIs are transmitted and prevented - improvement of personal hygiene, environmental sanitation as well as wearing shoes, use of safe drinking water and use of latrines must be emphasized.

Limitations of the study that may limit interpretation of the present findings

1. Recall bias was possible for questions related to disease symptoms.
2. Precise age determination not possible since there is no birth registration in the area.
3. The reference standard NCHS used for assessing nutritional status of the schoolchildren is from developed countries.
4. Ablity of parasitological methods to detect light infection was limited on conventional parasitological day to day fecal egg counts.

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APPENDICES

Appendix I(a). Consent form

CONCENT FORM

You are invited to participate in a study of assessment of the impact of major parasitic infections on nutritional status in primary school children in a population that uses kocho as a staple food in Gurage Zone,SNNPR ,Ethiopia. The purpose of the study is to assess the impact of parasitic protozoa and helminth infections on nutritional status in primary school children where Kocho is consumed as a staple food and those that consumed cereal crops of Enemore and Abeshgie districts, Gurage Zone,SNNPR. It is also important to identify the intensity of the parasite that is common in the area. The study is being conducted by Ato Melesse Birmmeka Adeba from the Graduate School of Addis Ababa University. And he is a postgraduate student of Biomedical Sciences in the Department of Microbial Cellular and Molecular Biology. If you decide to participate, you will be asked to give about 5 ml blood by a laboratory technician using sterile and disposable syringe. During the activity of blood taking, there might be some sort of discomforts and pain on your hand. If you are found infected by parasitic protozoa and helminth , you will be treated free of charge. Any information or personal details gathered in the course of the study are confidential. No individual will be identified in any publication of the results. If you decide not to participate, you are free to withdraw from further participation in the research at any time without having to give a reason and without consequence. I, ____________________, the resident of Gurage Zone, Enemore & Abeshgie district, have read (or, have had read to me) and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, knowing that I can withdraw from further participation in the research at any time without consequence, that I might experience some sort of discomforts and pain when I give blood and that I would be treated free of charge if I am found infected IPI & malaria. I have been given a copy of this form to keep.

Participant's Name: -----------------------------Signature:_______________ Date:_________________

Investigator's Name: Melesse Birmeka Signature: ________________Date: ________________

The ethical aspects of this study have been approved by the Ethical Committee of College of Natural Sciences, AAU, and Regional Health Bureau of SNNPR. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the committee through its secretary. Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

Department of Microbial Cellular and Molecular Biology

Addis Ababa University

P. O. Box: 1176

Tel: 011-8959216

Fax: 011-123-9471

Addis Ababa

Appendix I(b). **ASSENT FORM**

Your child is invited to participate in a study of assessment of the impact of major parasitic infections on nutritional status in primary school children in a population that uses kocho as a staple food in Gurage Zone,SNNPR ,Ethiopia. The purpose of the study is to assess the impact of parasitic protozoa and helminth infections on nutritional status in primary school children where Kocho is consumed as a staple food and those that consumed cereal crops of Enemore and Abeshgie districts, Gurage Zone,SNNPR. It is also important to identify the intensity of the parasite that is common in the area.Your child's participation in this study is very important in the control effort of this disease. The study is being conducted by Ato Melesse Birmeka Adeba from the Graduate School of Addis Ababa University.. And he is a PhD student of Biomedical Sciences in the Department of Microbial, Cellular and Molecular Biology. If you let your child to participate, she/he will be asked for blood examination and if parasitic protozoa and helminth diseses is suspected she/he may be asked to give about 5ml blood through venu puncture by a laboratory technician using sterile and disposable syringe. During the activity of blood taking, there might be some sort of discomforts and pain on your child's hand. However, there is no anticipated risk of blood examination. If your child is found infected by maijor parasitic protozoa or helmintiasis, she/he will be treated free of charge. Any information or personal details gathered from your child in the course of the study are confidential. No individual will be identified in any publication of the results. If you decide the child not to participate, you are free to withdraw your child from further participation in the research at any time without having to give a reason and without consequence.

I--------, the resident of Gurage Zone, Enemore and Abeshgie district, have read (or, have had read to me) and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to let my child participate in this research, knowing that I can withdraw her/him from further participation in the research at any time without consequence, that she/he might experience some sort of discomforts and pain when she/he gives blood, that she/he would be treated free of charge if she/he is found infected , and that her/his information is confidential. I have been given a copy of this form to keep.

Participant's Parent orGuardian Name:---------------------------------Signature:----------- Date:---

Investigator's Name: Melesse Birmeka Signature:------------ Date:---------------

The ethical aspects of this study have been approved by the Ethical Committee of College of Natural Sciences, AAU, and Health Bureau of SNNPR. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the committee through its secretary. Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome. Ethical Committee of College of Natural Sciences Addis Ababa University P. O. Box: 1176 Tel: 011-123-94-71 Addis Ababa .

Appendix II(a). Data collection form in Enemore-Ener district

Health center --------------------------------Physician Name ---

Code	**Name**	***Age***	***Sex***	***Add***	***Wt***	***Ht***	***Arm.circ***	***Hb***	***Sf***	***malaria***	***E.his/dis***	***Giardia***	***Al***	***Tt***	***Hw***	***Sm***	***Taenia***	***EPG***		***Remark***
Ene001																				
Ene 002																				
Ene 003																				
Ene 004																				
Ene 005																				
Ene 006																				
Ene 007																				
Ene 008																				
Ene 009																				
Ene 010																				

Appendix II (b). Data collection form in Abeshege district

Health center -------------------------------------

Physician Name ---

Code	**Name**	***Age***	***Sex***	***Add***	***Wt***	***Ht***	***Arm.circ***	***Hb***	***Sf***	***malaria***	***E.his/dis***	***Giardia***	***Al***	***Tt***	***Hw***	***Sm***	***Taenia***	***EPG***		***Remark***
Abe001																				
Abe 002																				
Abe 003																				
Abe 004																				
Abe 005																				
Abe 006																				
Abe 007																				
Abe 008																				
Abe 009																				
Abe 010																				

Appendix III. Questionnaire for structured household survey-parents

Part I. Basic information regarding household

1.Date of interview 2.kebele name
3.Name of household 4.Gott name
5.Sex male female 6. Age
7.Marital status a) single b) married c) divorced d)widowed e)separated
8.Place of birth Kebele Woreda Zone
9.Continues duration of stay at current place of residence/year
10.If your place of birth is different from the present, reason for coming here. a) marriage b) join relative c) displacement by drought d) to get access to land e) divorce f) others
11.Educational status a) Illiterate b) read & write c) church school d) others
12.Is the head economically active? a) yes b) no
13.If inactive, why? a) sick b) aged c) disable d) sick & aged e) other
14.Number of permanent household members at the time of survey male female total
15.The roof of the house for the household is made of a) grass b) Iron c) others
16.Age of permanent household members at the time of survey 0<5 years 5-10 years 11-16 years 17-55 years >55 years
17.How many of them are economically active? -----------------------
18.Relation of the household members with the head a) spouse b) son/daughter c) non-relative d) grand child e) hired as laborer

Part II. Livelihoods and access to resources

1. What is the source of income for the household? a) agriculture b) day labour c) petty trade d) government employment e) other

2. If agriculture, which of the following activity does the HH engage in?

a) crop production b) animal husbandry c) mixed farming d) others specify

3. If crop production, which of the following item & how many quintal of each does the household produce in the year 2004Ec?

a) Teff b) maize c) barely d) root crops e) kocho f) other specify

4. Is your income enough to sustain your family all the year round?

a) enough b) more than enough c) barely enough d) others(specify)

5. If barely enough or not enough, what do you do to supplement it & sustain your family?

a) borrow money or grain b) move to other place(migrate) c) sell live stock d) daily laborer e) sell fuel wood f) others specify

6. What was your income last year (2004)?

a) from sell of crops b) from sell of live stock &products c)from off farm activities d) from working other places e) others specify

7. To which of the following consumption and other items the bulk of your income goes?

a) food b)clothing c)schooling d) medicine e) social obligation f) loan payment g) others

Part III. Food security

1. Which food stuffs are consumed at your home?

Food stuff	How many times was it consumed at your home during the last seven days?	Is there a time of a year when you encounter shortage of specific foods? a)yes b) no	Months of a year with shortage periods
Injera (barely, wheat,teff			
Bread(dabbo)			
Wat(pulses)			
Oil(oil seeds)			
Meat(beef,lamb,goat)			
Chicken or eggs			
Milk or cheese			
Butter			
Kocho			
Potatoes			
Vegetables(cabbage,carrot,tomatoes)			
Fruits(papaya,banana,mango)			

a)whole year b)nine months c) six months d) three months

2. Would you tell us the amount of grains and other foodstuffs that covers the annual consumption food requirements of your household members?

Grain/foodstuff	Amount in quintal or kg	Equivalence in cash(birr)
Cereals		
Pulses		
Oil seeds		
Kocho		
Vegetables		
Fruits		
Meat		

Appendix IV. Health and nutrition

1. Where do you when you or someone in the HH is sick? A) to clinic or health center b)hospital c) Tsebel d) use traditional medicine e)nowhere f) other

2. What is your reason to choose the specific service provider? A)It is easily accessible b) It is affordable c) no other choice d) Other specify

3. How far is the nearest modern health institution? A) less than 15 min walk b) 30 min walk c) one hours walk d) 2-3hours walk e) More than three hours walk

4. What is the source of water? A) River b) Protected spring c) Unprotected spring d) hand dug well e) piped line f)pond g) open wells h) other specify

5. How long does it take to fetch water from the source including possible queuing time? a)less than hour b) 2-3 hours c) 4-5 hours d) more than five hours

6. Do you think your water source is safe? A) yes b) no

7. If yes, why? a) It looks clean b)It never created any problem c) It is chlorinated d) other (specify)

8. Have you ever attended a hygiene education session? A) yes b) no

9. If yes, how many times did you attend in the last three months? A) few times b) many times

10. Who gave the education? A) health workers b)community health educators c) others

11. Have your children received anti-six vaccinations? A)yes b) no

12.If not, why not? A) no service b)I did not want to have them for my children c)only some d) other specify

13. How do you cope up with food shortage seasons? A) reduce quality of food served b) reduce quantity of food served c) reduce number of meals d)eat less preferred food d) eat wild food f) other(specify)

Appendix V

Part I. Questionnaires interview about socio-demographic factors of students and their families.

To be filled in by interviewers by asking primary school students who are up to 18 years of age and in grades 1-8

Instruction

A. Please write clearly and eligibly
B. First tell to the interviewee that you are going to ask him or her question about themselves and their families. And request her / him to give exact answers after listening carefully the questions. Then start asking the questions. Except the 20th question, each question has only one correct answer among the given choices, so you should have to circle the correct response, and if the question is open ended, and a response referring numeral or other thing is provided, then you have to write that number or response in the space provided with (ink) pen.

Greeting (for example, good morning /after noon; how you are and how the children are? Other members of the family? etc."

Name of interviewers _______ signature __________

1. Students name ---------------------- age _______ sex _______.
2. Student a) grade _____ b) section __________
3. Name of house hold owners _________ House No. _________
4. Residence a) town b) rural
5. Village /town name ___________
6. Ethnic group ___________
7. Religion _____________
8. Family members' __________
9. With whom do you live?
    a) with my father and mother
    b) only with my mother (because she has no husband)
    c) with my mother and step father
    d) only with my father (because he has no wife)
    e) other (specify) __________
10. What is your birth order? ______
11. Do you have radio? a) yes b) no
12. Do you have television set? a) yes b) no
13. Whose property is the house in which you live?

a) our own b) Kebele's c) of the organization of government rent house d) I don't known e) other (specify)

14. Of what material is your house roof?

   a) corrugated iron sheets b) I don't know c) Thatched d) other (specify)

15. Of what material is your house floor?

   a) cement b) earthened c) I don't know d) other (specify)

16. How many rooms do have your home? ________

17. Is there electricity in your house? a) yes b) no

18. How many persons do live in your house? ________

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

20. From where do you get your drinking water? One or more than one answers are possible. a) From our own tap. b) From Kebele tap. c) From private tap. d) From protected/cleaned spring /well e) From un protected/un cleaned spring /well f) From river or stream g) From others (specify)

21. Does water storage container have a cover? a) yes b) no

   - If yes, what is the cover?

     a) grass or leaves b) cloth c) iron sheet d) others

   - Is there separate can for powering out water? a) yes b) no

   - How do you pour or take out water from the container?

     a) Inclining the water container b)Immersing the can inside

22. Home yard condition

   - Domestic refuse seen around a) yes b) no

   - Feces seen around a) yes b) no

23. Do you have latrine a) yes b) no

24. Are the children able to use the latrine on their own?

25. If not, where do they defecate?

26. Where is the latrine located?

   a) Inside the courtyard.

   b) Outside the courtyard.

27. How do you dispose of your house waste?

   a) Burning b) Into our own waste pit

   c) on the open field d) other (specify)

28. What is your father /male care taker's husband occupations?

a) farm b) trade c) daily laborer d) government employee

e) private employee f) other

29. What is your mother's /female care taker's occupation?

a) house wife b) house maid c) trade d) daily laborer e) others

30. What activities take place at or near the water source?

a) washing containers b) washing clothes c) bathing/washing self

d) watering animals e) others

31. Is water treated at the source, and if so, how?

a) by filtering with a piece of cloth b) by clorination c) by other means

32. How many children do you have? girls _______ boys ____________

33. Do you always wash your hands before you eat? a) yes b) no c) others (specify)

34. What is your ethnicity? a) Gurage b) Amahara c) Oromo d) other (specify)

35. What is 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 f) Other /specify

36. Would you eat raw meat? a) yes b) no

37. Would you eat raw vegetables? a) yes b) no

Part II – Medical history questionnaire interview.

To be filled in by health assistant by interviewing student.

Instruction

A. Please write clearly and eligibly.

B. First tell to the interviewee that you are going to ask him/her questions about diseases and symptoms which they have experienced. And request her/him to give exact answers after listing carefully the question/s. Then start asking the questions. Each question has only one correct answer among the given choices, so you should have to circle the correct response with (ink) pen. For the open ended questions write the given response in the space provided also with (ink) pen.

38. Have you been sick since last month?

a) yes b) no c) other (specify)

39. If the answer for "38" question is yes, then (ask) have you had?

a) Diarrhea? 1. yes 2. no

b) Lung tuberculosis? 1. yes 2. no

c) IPIs? 1. yes 2. no

d) Malaria? 1. yes 2. No e) Other/s (specify).

40. Since last month which of the following symptoms have you experienced?

a) Vomiting 1. yes 2. no b) abdominal cramp 1. yes 2. no

c) Easy tiredness 1. yes 2. no d) Insomnia 1.yes 2.no

e) Anorexia 1.yes 2.no f) Dizziness 1. yes 2. No g) Others (specify). _____

41. Since last month, have you been treated for the above or other diseases or symptoms? a) yes b) no c) other (specify) ________

42. Do you always wear shoes? 1. yes 2. no

Part IV. Measurement of weight and height.

To be done by health assistants.

Please measure carefully and recorded the results in the space provided.

43. Student's weight in Kg as recorded by the digital weight scale _____ kg.

44. Student's height to the nearest 0.1cm _________ cm,the arm circumference the nearest 0.1cm-----------cm, skin fold to the nearest 0.1 mm-------------mm.

To be done by a nurse

Subject's name _______ subjects age ____sex _____grade ________ and section _______

Instruction

Fill in the space provided or circle the choice which corresponds your findings.

45. Does the child have

a) wearing clean clothes? 1. yes 2. no

b) prevalent eye/s discharges? 1. yes 2. no

c) conjunctival pallor? 1. yes 2. no

d) goiter? 1. yes 2. no

e) dirt in finger nails? 1.yes 2.no

f) abdominal destination? 1. yes 2. no

g) facial /pedal edema? 1. yes 2. no

h) wearing shoes? 1.yes 2. no

i) other gross abnormality/ies (specify) _________

Part V. Laboratory results of stool examination.

To be done by Lab. technician

Instruction

Using the usual way of quantifying, write your finding in the space provided.

46. Number of eggs /larvae per slide of

a) ascaris _______ b) whipworm ______ c) hookworm _____ d) other/s (specify) ______

Appendix VI

In-depth interview & focus group discussion guide for the households kebele representative, school representative& woreda office.

1. Demography and life history narratives

Name -------------------------age--------------------------family size by sex M----------F--------

Experience and perception towards large family size

Place of birth and migration history

Marriage history

Mortality history

Literacy and participation in formal education

Main health problems in the community

Health problems experienced by household members

2. Food security

Main staple food crops of the household

The type of meal eaten frequent at home

Average number of months you able to feed your house hold from own production.

What are the main bottlenecks to produce crops and raise stocks that enable you to be self-sufficient in food?

Does the income you earn from non-farm activities allow you to buy food during shortages?

How do you cope with shortage?

What are your survival strategies?

Declaration

I, the under signed declare that this thesis is my original work and has not been presented for a degree in this or any other university.

Melesse Birmeka, Candidate Signiture--------------------------Date---------------------------

SUPERVISORS

Prof.Beyene Petros ……………………… …………………………..

Signiture Date

Ass.Prof. Kelbesa Urega ………………. ……………..…………….

Signiture Date