FEEDING PRACTICES AND FACTORS CONTRIBUTING TO STUNTING AND LOW HEMOGLOBIN AMONG INFANTS IN SOUTHERN ETHIOPIA

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2003

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 2008

FEEDING PRACTICES AND FACTORS CONTRIBUTING TO STUNTING AND LOW HEMOGLOBIN AMONG INFANTS IN SOUTHERN ETHIOPIA

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ACKNOWLEDGEMENTS

My deepest gratitude goes to the Almighty God who gave me strength in life and helped me finish my studies. My heartfelt gratitude goes to my husband Anteneh for his support, understanding, encouragement and unfailing love; and to my daughter Hanna for her patience. I also thank my major advisor Dr. Kennedy, and my committee members Dr. Stoecker, Dr. Thomas and Dr. Hubbs-Tait for helping me make my dreams come true. I also thank my friends Alemtshay B., Dr. Yewelsew A. Meron G., Gethaun E., Tafere G., Fikadu R., Tesfaye W., Vladmira S., Carmel E., Keneni who helped during blood collection and others who are not mentioned here for their help and encouragement in the process of writing my paper.

Getenesh Berhanu Teshome

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CHAPTER I

INTRODUCTION

1.1. Background

Ethiopia is 1,127,127 square kilometers (435,071 sq. mi) in size, and is the major portion of the Horn of Africa, which is the eastern-most part of the African landmass. Bordering Ethiopia is Sudan to the west, Djibouti and Eritrea to the north, Somalia to the east, and Kenya to the south.

<u>Figure1</u>. Map of Africa, Ethiopia and the world

According to the Ethiopia Demographic and Health survey in 2005, 30.3% of women received antenatal care from health professionals; 12% received iron during pregnancy; 4.2% of births are delivered by a health professional and 3.7% are delivered in a health facility. Out of 571 children under five who had diarrhea, 18.6% sought treatment from a professional health provider; only 31% were given any oral rehydration treatment including oral rehydration salts. Twenty nine percent of children under five were severely stunted and 51.6% were moderately stunted as measured by height-for-age indices and 11.9% were severely underweight and 34.7% were underweight when measured by weight-for-age indices and 0.9 % were severely wasted and 6.5% were moderately wasted when measured by weight-for-height indices in Sothern Ethiopia (Ethiopia Demographic and Health Survey, 2005).

Anemia is a major problem among young children (aged 6-59 months old) due to malaria, dietary deficiencies and parasitic infections. More than half of all children are anemic in Ethiopia as measured hemoglobin by HemoCue; 21% of children are mildly anemic, 28% of children are moderately anemic and 4% of children are severely anemic. Out of 1,004 children who were 6-59 months old, 20.7% had mild anemia; 23.5% had moderate anemia and 2% were severely anemic in Southern Nations, Nationalities and Peoples' region (Ethiopia DHS, 2005).

Southern Nations, Nationalities and Peoples' Region (SNNPR) is one of the nine ethnic divisions or regions of Ethiopia. The SNNPR borders Kenya to the south, the Ethiopian region of Oromia to the north and east and Sudan to the west. It has 13 zones, 8 special woredas (districts) and 96 districts (SNNPR, 2004). This region has an estimated total population of 14,901,990; 91.4% of the population is estimated to be rural. The estimated area is 112,343.19 square kilometers, and has an estimated density of 132.65 people per square kilometer. Fertility rate in the area was 5.9 in 2005 and infant mortality rate was 64 per 1000 live births (Ethiopia DHS, 2005).

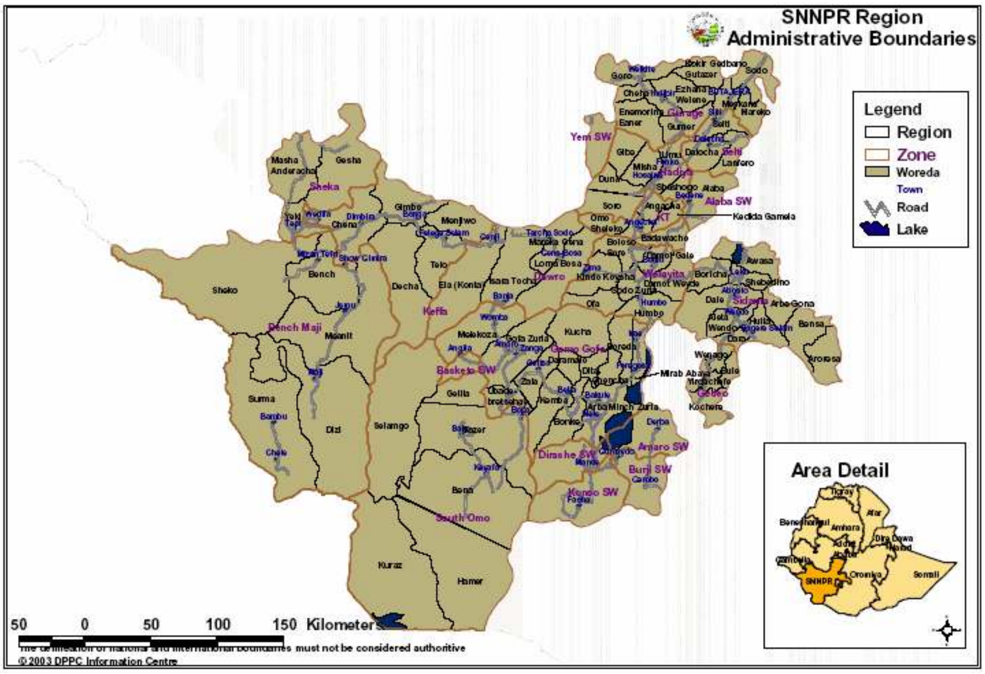

Figure 2.Map of SNNPR

Sidama Zone, which is the study area, is located 273km south of Addis Ababa, and is one of the 13 zones of the SNNPR. The agricultural workers in the area account for 85% of the total population. Major agricultural products in the area are enset (false banana), coffee, corn, wheat, barley, sorghum, sugar cane and chat (Catha edulis). Sidama Zone has 1 hospital, 17 health centers, 54 clinics and 21 health posts. Health coverage in the area was 36% in 2004 (SNNPR, 2004).

Sidama Zone was selected as the research site because this area is affected by poverty and the staple foods are mainly maize and enset which are low in available iron. However, little work has been done so far on iron deficiency anemia and its effect on the development and growth of infants and young children in the area. Therefore, it is the researcher's believe that this study will provide information about the seriousness of this problem and its adverse effect especially on infants and young children.

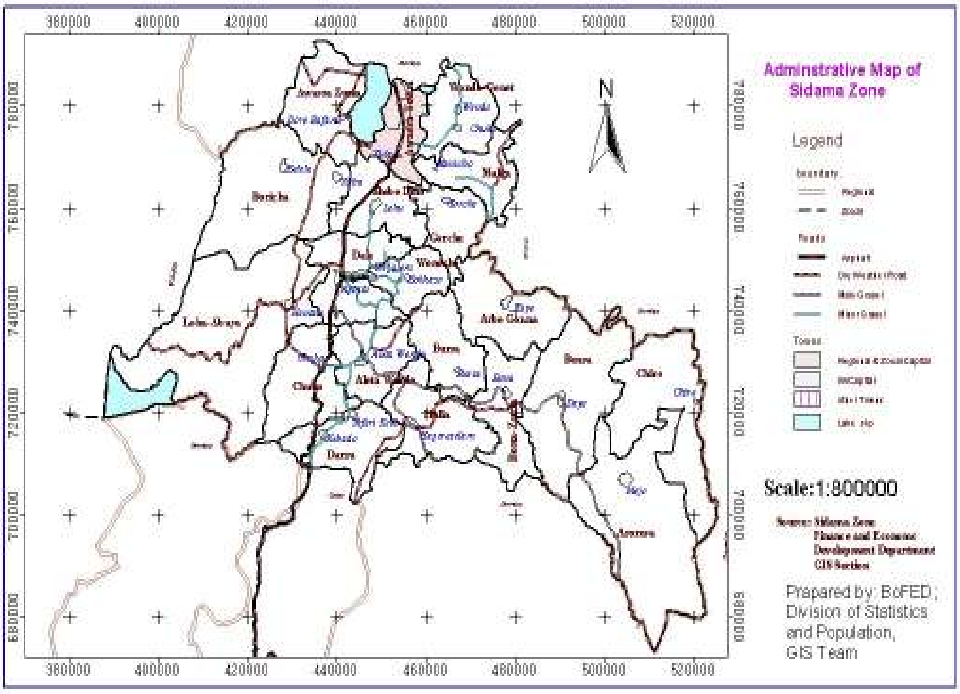

Figure 3.Map of Sidama Zone, Southern Ethiopia

Iron is a very important mineral involved in various bodily functions. Hemoglobin, which contains iron, is the part of red blood cells that is used to transport oxygen from the lungs to the rest of the body (Viteri, 1994). Iron deficiency is one of the most common nutritional problems in the world (Akman et al., 2004; Hernell & Lonnerdal, 2004; Mittal, Pandey, Mittal, & Agarwal, 2002; Ullrich et al., 2005). Iron deficiency has an impact at ages much younger than 9 months and there are a number of researchers who would argue that deficiencies at earlier ages would have even more profound effects (Lozoff et al., 1998; Ryan, 1997). Thus, a slightly different approach should be taken to set the foundation for studying 9-month-old babies (Krebs & Hambidge, 2007). They also require supplemental food which is rich in iron because breast milk no longer provides adequate amounts of iron (CARE, 2004). The prevalence of iron deficiency anemia (IDA) in infants ranges from 3-80% in different societal groups and higher proportions of children are iron deficient without anemia (Dommellof, Dewey, Lonnerdal, & Cohen, 2002; Lozoff et al., 1998). According to World Health Organization (WHO, 2004) half of iron-deficient infants and children are reported to be from developing countries.

Iron deficiency in infants has a long term effect on the infant's cognitive as well as physical development (Akman et al., 2004; Domellof et al., 2002; Kazal, 2002; Ullrich et al., 2005; Wieringa et al., 2007). According to Lozoff et al., (1998) about 30-80% of preschool children in underdeveloped countries were anemic when they reached one year of age and showed a 5 to 10 point deficit in IQ when they reached school age. Animal experimentation showed brain iron is gained early in postnatal life and has a very slow turnover rate (Kazal, 2002; Grein, & Gefen, 2001).

When the diet lacks a sufficient amount of iron, tissue iron starts to deplete. Thus, anemia can be a reflection of tissue iron depletion which somehow affects growth (Walter, 2003). According to Nestel and Davidsson (2002), behavioral changes such as lethargy, irritability and inability to concentrate can be symptoms of iron deficiency in young children.

The diet in southern Ethiopia is based mainly on corn and root crops such as enset (*Ensete Scitamineae*) and cassava which are poor in micronutrients and food fortification is not common (Timotewose & Mulugeta, 2000). Prolonged breast feeding without supplemental food is a major cause of iron deficiency anemia among infants and young children due to the low concentration of iron in breast milk (Kumar, Rai, Basu, Dash & Saran, 2008). Introduction of cow's milk before one year of age is also a risk factor for developing iron deficiency anemia. In addition to these factors, intestinal parasites and malaria are major causes of iron deficiency anemia in infants (Nestel & Davidsson, 2002).

The basic theme of this study was to assess the iron status of infants and associate iron status with growth. This study intended to address this guiding question: does iron deficiency negatively relate to infant growth as measured by anthropometry?

Infants who were nine months old were selected for this study for two reasons. First, nine month old infants are at high risk of IDA due to rapid growth and limited diet (Mittal et al., 2002). Secondly, intervention such as iron supplementation and/or cognitive stimulation can be started early to improve cognitive as well as physical development of iron deficient children.

1.2. Hypothesis

We hypothesized that poor complementary feeding practices are related to iron deficiency anemia and affect infants' growth. Thus iron deficient anemic infants would be stunted by 9 months of age.

1.3. General Objective

The overall objective of the study was to assess and determine the feeding practices and the extent of stunting as well as iron deficiency anemia.

1.4. Specific objectives

- To determine the relation between iron status and stunting as measured by anthropometry.
- To determine the relation of iron status to the presence of malaria

- To identify supplemental drinks and foods commonly given to nine-month-old infants.

CHAPTER II

REVIEW OF LITERATURE

Iron deficiency is the most common nutritional problem in the world (Mittal et al., 2002). Approximately 50% of anemia occurs due to iron deficiency. Often anemia indicates poor nutrition as well as poor health (WHO, 2004). In developing countries half of children (51%) under five years of age are anemic (Ryan, 1997). There are several causes of anemia such as insufficient or abnormal red blood production; excessive red blood cell destruction and red blood cell loss which affect the hemoglobin concentration directly. Other factors which also contribute to iron deficiency include poor nutrition (dietary intake and dietary quality), sanitation, environmental conditions, access to health services and poverty (Galloway, 2003).

Iron deficiency has an adverse effect on cognitive development and physical growth of infants. Iron is important for neurologic metabolic process, including neurotransmitter synthesis, myelin formation and brain growth (Grein & Gefen, 2001). Iron content of the brain is sensitive to iron deficiency during infancy and the cognitive impact of iron deficiency and iron deficiency anemia during infancy may not be reversible even after iron therapy (Schneider et al., 2005; Grein & Gefen, 2001; Ryan, 1997). Thus, iron deficiency during neurologic development could affect long term cognitive and behavioral function (Grein & Gefen, 2001). The first two years of postnatal life are very important to the human brain because most complex neural changes take place during this period (Pollitt, 1993).

2.1 Iron Deficiency and Iron Deficiency Anemia

Iron is stored in the body as ferritin and hemosiderin in liver, bone marrow, spleen and muscle and these are used when the intake of iron is low in the diet (Viteri, 1994). The habitual lack of iron in the diet and depletion of tissue iron leads to iron deficiency. "Anemia is defined as a low level of hemoglobin in the blood, as evidenced by a reduced quality or quantity of red blood cells" (Galloway, 2003, p 7). Often Iron Deficiency (ID) and Iron Deficiency Anemia (IDA) are used interchangeable. But the development of IDA has three stages:

1. Depleted iron store: This occurs when the stored iron is used by the body and the hemoglobin concentration starts to fall but remains above the cutoff level. This situation is detected by measuring serum ferritin and is known as ID.
2. Iron-deficient erythropoiesis: When iron intake is low and stored iron is depleted, red blood cell production is affected. Hemoglobin concentrations might be reduced although the hemoglobin levels remain above the cutoff level. The main indicators of this stage are low serum iron, reduced transferrin saturation levels, increased serum transferrin, and high levels of free erythrocyte protoporphrin. Although the hemoglobin level is above the cut off level in this stage; retarded growth, behavioral changes and slow cognitive development can be found in infants and children (Nestel & Davidsson, 2002; Ryan, 1997).

3. The last stage is iron deficiency anemia (IDA): This stage is the most severe stage of iron deficiency and can easily be detected by measuring hemoglobin. The red blood cells show changes in size and color which are described as microcytic (size) and hypochromic (color) (Nestel & Davidsson, 2002; Ryan, 1997).

Use of multiple indices of iron status helps to get more valid values by avoiding overlapping of normal and abnormal values. Further multiple measures of iron status helps to indicate the severity of iron deficiency by providing information over a wide range of iron status. The three common methods of assessing iron deficiency are (1) ferritin which includes assessment of serum ferritin, transferrin saturation and free erythrocyte protoporphyrin (FEP); (2) mean corpuscular volume (MCV) and (3) transferrin receptor (TfR). Particularly, TfR is the most reliable laboratory assessment of iron deficiency anemia which helps to identify anemia even in the presence of chronic infections. Two or more abnormal values of the above measurements indicate iron deficiency anemia. However, there is no agreement on the best combination of method to assess iron status (Gibson, 2005).

Six to nine months of age is a particularly vulnerable stage for development of ID due to low intake of iron from breast milk and lack of supplemental foods, and it is also a time of rapid psychomotor development. ID can lead to cognitive and psychomotor damage (Nestel & Davidsson, 2002). Infants (7 to 12 months of age) require 11 mg of iron per day for proper physical and cognitive development (Lönnerdal & Kelleher, 2007).

2.2. Standards for assessing hemoglobin status

The sign and symptoms of severe IDA are lack of appetite, shortness of breath, paleness of skin, etc., but these are also symptoms for other nutrient deficiencies. Measuring hematocrit or hemoglobin is a more direct method of assessing iron status. Both tests can be done by assessing capillary blood though the reliability is not high as when venous blood is used. Normal hemoglobin concentration is similar all over the world although adjustments for age, sex, pregnancy and altitude are necessary (DeMaeyer et al., 1990). For children who are 6-59 months of age, a hemoglobin level of <11.0g/dL reflects all anemia, levels of 10-10.9g/dL are considered as mild anemia, and levels of 7.0-9.9g/dL are considered as moderate anemia and levels <7.0g/dL are considered as severe anemia at sea level (Galloway, 2003). In addition to dietary factors, there are other factors which influence iron levels such as altitude (Dirren et al. 1994). Nestel (2002) and Dirren et al., (1994) suggested methods to adjust the hemoglobin level in different situations such as changes in altitude, pregnancy and age. The accepted cutoff values provided by the World Health Organization are based on sea level thus these adjustments are important to estimate the hemoglobin cutoff in high altitudes. According to WHO (2004), the hemoglobin cutoff value for infants who are 6-12 months of age is 11.0g/dL at sea level. The suggested formula (Nestle, 2002) to estimate an altitude specific Hemoglobin (Hb) cutoff value follows:

$$Hb= -0.32 \times (\text{altitude in meters} \times .0033) + 0.22 \times (\text{altitude in meters} \times .003)^2$$

Dirren et al., (1994), suggested another formula for a correction for Hb level for high altitude based on the study done in Ecuador. The study subjects were 8100 children 6-59 month-old who had normal iron status and living at altitudes ranging from sea level to 3400m. The study found that hemoglobin increased with increased altitude. However, the study lacks evidence to show that hemoglobin concentrations change at altitudes below 1000m and make the adjustment unreliable.

A study done on 1127 Tibetan children found increased Hb concentration with increased altitude. The study objective was to examine the nutritional status of children who were below 36 months of age using anthropometry. Height, weight and hemoglobin concentration were measured. Hemoglobin concentration was measured using HemoCue® by collecting about 10µl blood from the finger tip. There was a significant difference between Hb concentrations with increased altitude in rural areas. Hb concentration in high altitude was significantly higher than the lower altitude (Dang, Yan, Yamamoto, Wang & Zeng, 2004). For this study we have chosen to use CDC hemoglobin adjustment (Nestel, 2002).

2.3. Sex differences in iron deficiency

A study done in Southeast Asia on the prevalence of iron deficiency in infancy, found a sex difference in the level of iron status in infants. From a randomized double blind study 2452, 4-6 months old infants who had hemoglobin of greater than 70g/l were included (Wieringa et al., 2007). The researchers supplemented iron (6mg), zinc (10mg), iron with zinc (10mg each) or placebo (2 ml) supplemented as sulphate salt in sugar based syrup for 5-7 days per week for 6 months. They measured hemoglobin and serum/plasma ferritin to identify iron deficiency or iron deficiency anemia, and they found a significant difference between genders on iron status within the placebo group. In the other groups boys had a lower iron concentration than girls before supplementation, but after supplementation they had similar concentrations of iron status. However, the requirement for iron supplementation for the boys was higher than the girls. One possible explanation given by the researchers is that the high iron requirement in boys was required for fast growth during the second half of infancy (Wieringa et al., 2007).

2.4. Factors affecting iron absorption

Heme and non-heme iron are the two types of dietary iron. Good sources of heme iron are the hemoglobin and myoglobin from consumption of animal products and non-heme iron is found in plant foods such as cereals and legumes (FAO & WHO, 2001). Absorption can vary from 40% to 10% based on the need of the body for iron. Generally plant-based iron is considered to be less well absorbed than animal-based iron. Heme iron is highly bioavailable; it is assumed that 25% of the consumed iron can be absorbed in adult (FAO & WHO, 2001; Yang & Tsou, 2006). If heme iron is cooked for a long time, it can be converted to non-heme and bioavailability will be affected (FAO & WHO, 2001).

Phytate, iron-binding phenolic compounds, zinc, copper, calcium, oxalates and tannins can interfere with or inhibit the bioavailability of iron (FAO & WHO, 2001; Kumari et al., 2003). Phytate is found in cereals, grains, vegetables and many fruits and contains inositol hexaphosphate salts which store phosphate and other minerals. Fermentation, germination and soaking helps to degrade the phytate which reduces the inhibitory effects on iron absorption; also, adding ascorbic acid enhances iron absorption in phytate rich diets (Dewey, 2007; FAO & WHO, 2001). Fermentation and germination reduce the phytate content up to 90% (Dewey, 2007). Tea, coffee, and spices contain substances called polyphenols, which strongly inhibits iron absorption. Calcium is an important nutrient yet it inhibits iron absorption. “The mechanism of action for absorption inhibition is unknown, but the balance of evidence strongly suggested that the inhibition is located within the mucosal cell itself at the common final transfer step for heme and non-heme iron” (FAO & WHO, 2001 p201).

Factors influencing dietary iron absorption

HEME IRON ABSORPTION	
Iron status of subject Amount of dietary heme iron, especially as meat Content of calcium in meal (e.g., milk, cheese) Food preparation (time, temperature)	
NON-HEME IRON ABSORPTION	
Iron status of subjects Amount of potentially available non-heme iron (adjustment for fortification iron and contamination iron) * Balance between enhancing and inhibiting factors	
Enhancing factors	**Inhibiting factors**
Ascorbic acid (e.g., certain fruit juices, fruits, potatoes, and certain vegetables) Meat, chicken, fish and other seafood Fermented vegetables (e.g., sauerkraut), fermented soy sauces, etc.	Phytates and other inositol phosphates (e.g., bran products, bread made from high-extraction flour, breakfast cereals, oats, rice [especially unpolished rice], pasta products, cocoa, nuts, soya beans, and peas) Iron-binding phenolic compounds (e.g., tea, coffee, cocoa, certain spices, certain vegetables, and most red wines) Calcium (e.g., milk, cheese) Soy proteins

(Table adopted from FAO & WHO, 2001).

2.5. Enhancers of iron absorption

Some factors contribute to increased dietary iron absorption. Enhancers of iron absorption are vitamin C (ascorbic acid) especially for non-heme iron, animal tissues, vitamin E, folate, and vitamin B_{12} (FAO & WHO, 2001). Some studies found an enhancer effect from cooking fruits and vegetables. According to Yang et al. (2006), boiling vegetables and fruits in water for 10 minutes increased in-vitro iron bioavailability. This study also found that cooked vegetables are better iron sources than cooked fruits. Grain processing increases the bioavailability of iron from cereals and grains (Prom-u-thai et al., 2006). Food diversification is also suggested to increase the bioavailability of some nutrients such as iron by preventing undesirable imbalances of nutrients (FAO & WHO, 2001). Cereal and tuber-based diets are low in iron and the addition of legumes may increase the iron content to some extent. Nevertheless iron from plants is non-heme which is poor in bioavailability. To meet the recommended amount of iron animal sources should be added to cereal or tuber-based diet (FAO & WHO, 2001).

2.6. Malaria and iron deficiency

Malaria is one of the most serious tropical diseases. It is a major cause of death in many parts of the world (Mebrahtu et al., 2004). Around 300 million acute cases of malaria occur every year, and malaria causes more than one million deaths each year (Hay, Guerra, Tatem, Noor, & Snow, 2004). Malaria kills one child every 30 seconds (Crawley, 2001) and 1-3 million children die every year from malaria in Africa (Malaria Site, 2006).

Malaria is particularly severe in children. In malaria endemic areas, one in five or six dies from malaria and its related diseases such as anemia (Malaria site, 2006). Malaria is a “disease of poverty” especially in developing countries, many people die from malaria because of lack of treatment (Weatherall et al., 2002). Although global economic development is increasing, many more people die from malaria than did 40 years ago (Guerin et al., 2002).

Malaria is an infectious disease caused by plasmodium (a parasite) which causes a reduction of red blood cells which leads to anemia (Menendez, Fleming, & Alonso, 2000). Severe malaria in children causes anemia from both the direct destruction of red blood cells and indirect destruction of red blood cells by immune mechanisms and bone marrow suppression (Greenwood, Bojang, Whitty, & Targett, 2005; Menendez et al., 2000). Generally, malaria parasite destroys red blood cells by hemolysis (Weatherall et al., 2002). Around 5 million cases of malaria associated anemia occur in African children every year. Thus, in Africa, malaria is one of the major causes of anemia (Atkinson et al., 2006).

Anemia caused by malaria is a major cause of death (Mebrahtu et al., 2004) with more than 103 million children less than nine years of age affected by anemia resulting from malaria in Africa. "In malaria-endemic regions of Africa, community surveys have shown the prevalence of anemia in children to be between 49% and 89 %"(Greenwood et al., 2005, Pp. 26). A study done in Ghana found that 22% of sampled children had a hemoglobin concentration less than 6g/dL in wet season (Owusu-Agyei et al., 2002). P. falciparum utilize the host's iron probably from intraerythrocytic labile pool of ferrous iron (Prentice, Ghattas, Doherty & Cox, 2007).

Iron supplementation is recommended to prevent anemia, although, there is evidence that iron supplementation affects malaria infection or increases its clinical severity (International Nutrition Anemia Consultative Group (INACG), 1999). An observational study in Kenya found an association between iron deficiency and protection against clinical malaria. According to Nyakeriga et al., (2004) "iron deficiency protects against malaria through an immune mechanism involving a specific defect in the production of particular immunoglobulin subclasses" (Pp. 444) although, they suggested further study to clearly understand the association between production of immunoglobulin, iron deficiency and malarial infection. One explanation for susceptibility to malarial infection when iron is supplemented was a physiological effect rather than the iron itself. In iron-deficient patients' supplementation causes increased reticulocyte production (Nyakeriga et al., 2004). However, some studies found no association between iron supplementation and increased susceptibility to malaria (Mebrahtu et al., 2004). In a randomized control trial "no significant difference in malariometric indices was observed between children in the iron and placebo groups" (Mebrahtu et al., 2004, Pp 3039). They concluded that iron supplementation did not affect susceptibility to malaria or help to improve the hemoglobin level. According to Crawley (2001), after two weeks of effective malaria treatment, children recovered from the severe anemia that was associated with malarial infection without iron supplementation. Thus, iron supplementation for malaria-associated anemia should not be the primary care for the malaria-infected child (Mebrahtu et al., 2004; Crawley, 2001).

A study done in Zanzibar, in the malaria endemic region, gave supplements to 32,155 children. Malaria is found throughout the year with the high peak from June to September (Sazawal et al., 2006). The supplementation included iron and folic acid; iron, folic acid and zinc, or placebo and was given until the children were 48 months of age. The study was terminated because of adverse effects in the iron and folic acid supplemented group. Out of 425 deaths, 102 deaths were caused by malaria as diagnosed by verbal autopsy and by analysis of hospital records. There was more death in the iron and folic acid supplemented group than the iron, or the folic acid and zinc supplemented group. According to the study, there was an adverse effect in the combined treatment group because of clinical malaria (Sazawal et al., 2006). However, children who were iron deficient without anemia were not adversely affected by iron and folic acid supplementation while children without iron deficiency were adversely affected by the iron and folic acid supplementation. This study suggested the identification of anemia prior to supplementation of iron and folic acid in malaria endemic areas. They also suggested that the recommendation of iron supplementation in malaria endemic area combined with malaria treatment be assessed to ensure supplementation is not causing harm in the population.

2.7. Infant diet

Exclusive breastfeeding is recommended for infants until 6 months of age. After 6 months of age, infants need additional food for proper growth and development. The iron requirement increases during the weaning period because of depletion of iron stores during early infancy. Infant diet is a major determinant of infant's nutritional status (Arimond & Ruel, 2002).

Infants are especially susceptible to malnutrition and infectious diseases at 6 to 24 months of age (Dewey, Cohen, & Rollins, 2004). Infants' diets should be nutrient dense with appropriate feeding practices (Chessa & Rivera, 2003). The World Health Organization (WHO) and the Pan American Health Organization (PAHO) guidelines for complementary food suggest the inclusion of nutrient dense food such as meat, chicken and eggs to enrich the local diet which is usually cereal based (PAHO & WHO, 2003).

More than 90% of iron and zinc required by 9-11 month old infants should come from complementary feeding. These trace elements help normal neurological development, somatic growth and immune function (Krebs & Hambidge, 2007). Most of the time complementary food consists of cereals which contain phytate that inhibits the absorption of trace minerals such as iron (Chessa & Rivera, 2003).

According to WHO and PAHO (2003), for breastfed infants who are 6-8 months of age, complementary food should be given at least twice per day with additional snacks, and for infants who are 9-12 months of age, complementary food should be given three times a day with additional snacks. Complementary foods should be diverse enough to provide all nutrients; however diet diversity is a problem in most developing countries. Most of the staple foods are starch based and children in most developing countries are fed gruel which is made from maize, wheat or barley and there is a lack of additional foods such as meat to enrich the diet (Arimond & Ruel, 2004; Onyango et al., 1998).

A study done in western Kenya that assessed relations between prolonged breastfeeding, diversity of weaning food and timing of introduction of complementary feeding found a strong relation between dietary diversity and anthropometric status (Onyango et al., 1998). This study examined 194 children whose age was 12-36 months and assessed breastfeeding status, anthropometry and diet by 24-hour dietary recall. Of 194 children, 64% were fully weaned, 36% were partially breastfed and received additional food from the household diet. There was a positive association between dietary diversity and weight-for-age z score ($p = 0.001$), height-for age z score ($p = 0.008$), weight-for-height z score ($p = 0.01$), triceps skinfold ($p = 0.05$) and mid-upper arm circumference ($p = 0.006$).

Another study which associated child diet diversity with nutritional status of 6-23 month-old children in 11 countries found association between dietary diversity and low height-for-age z scores (Arimond & Ruel, 2004). The study assessed data collected by Demographic and Health Survey (DHS) from countries including Benin, Ethiopia, Malawi, Mali, Rwanda and Zimbabwe from Africa; Cambodia and Nepal from Asia; and Colombia, Haiti and Peru from Latin America/Caribbean. Dietary diversity, maternal and child nutritional status, and proxies for household wealth and welfare were assessed. The study found that 47% of the study's participants were severely stunted (HAZ <-2) in Ethiopia and Malawi, followed by Rwanda (40%), Mali (35%), Zimbabwe (31%) and Benin (28%) from Africa countries. Eighteen percent of children were wasted (WHZ <-2) in Ethiopia and Mali, 16% in Benin, 10% in Rwanda and 9% in Malawi and Zimbabwe. This study also assessed breastfed children fed the minimum recommended number of times per day and found that 15% of children in Rwanda, 25% of children in Mali, 39% of children in Benin, 42% of children in Zimbabwe, 43% of children in Ethiopia and 50% of children in Malawi were fed at least the minimum recommended number of times per day. This study also found that 5% of children in Zimbabwe and Malawi, 19% of children in Rwanda, 28 % of children in Benin, 57% of children in Mali and 59% of children in Ethiopia who were 6-8 months old did not get solid foods in the last 7 days. The mean dietary diversity was lowest in Mali (mean=1.7) followed by Ethiopia (mean=2.2); where the percentage of children receiving a diet low in dietary diversity (contain 0-2 food groups) was 70% and 61% respectively. This study concludes that dietary diversity has a strong association with height-for-age z score and child nutritional status.

In addition to food diversity, maternal perceptions and decisions about complementary feeding play an important role in infant feeding practices. Sellen (2001) studied weaning, complementary feeding and maternal decision making in rural East Africa. This study was a prospective study of breastfeeding and weaning practices. Mothers who participated in the study thought that breast milk is an appropriate food for infants, although they were introducing cow's milk early. A qualitative and quantitative study done to understand early infant feeding practices in Malawi explored the reasons that mothers started feeding infants at 1 month of age. The most common reasons were that the child was hungry, or crying and thirsty. There was a strong belief that breast milk is not enough for the baby especially during the hungry season which was December to March (Kerr et al., 2007). In this study, 99% of caregivers/mothers are the decision makers for choosing the time to start feeding their infants; however mothers-in-law or fathers-in-law are also important decision makers. A study done in Uganda found that 66-93% of mothers were knowledgeable regarding exclusive breastfeeding, the need for improved complementary foods and that sick children needed more liquids. However, a knowledge gap was observed in the study population regarding improving the child's diet by adding oil and that sick children need more food than usual (Wamani, Åstrom, Peterson, Tylleskär, & Tumwine, 2005). In this study both early and late introduction of complementary food was observed, and both created an adverse effect on the health of infants.

We have discussed previous studies about iron deficiency or iron deficiency anemia in relation to infant anthropometric status and diet. Most studies found an association between iron deficiency and infant's diet. The present study has the following specific objectives: (1) to determine the relation between iron status and stunting as measured by anthropometry; (2) to determine the relation of iron status, to the presence of malaria and; (3) to identify supplemental drinks and foods commonly given to nine month-old infants in the study area.

CHAPTER III

METHODOLOGY

This chapter describes the subjects, instruments, procedures and data analysis that were used to investigate the research questions. The Institutional Review Boards of Oklahoma State University (OSU) and Hawassa University in Ethiopia approved the study protocol.

3.1 Subjects

A convenience sample of 108 mothers and their nine months old infants from four different villages in Sidama Zone, Ethiopia were recruited. The subjects were recruited when the babies were 6 months old for a previous study, and we recruited the same subjects when the babies were 9 months old. The researchers communicated with the community health workers from the study area and asked them to inform the mothers about our arrival and asked the women to come to a central place. When the mothers arrived on the first day, we read the consent form and took their consent by recording their voice. After recording the consent of the mothers, we arranged a time for them to return with the babies for the experiment. When the babies were 6 months old, the researchers took the babies' picture with their mother and mothers were asked to bring the picture to make sure they brought the same baby for the second phase of the study.

3.2 Instruments and Procedures

Survey

A semi-structured questionnaire was administered to assess the mothers' demographic and socio-economic status and their child feeding habits. In addition, we asked about breastfeeding, vaccination and use of bed nets for the babies. The questionnaire was read by a trained research associate who recorded exactly what was said (see appendix A). We did not ask the mother's age since most women don't know their exact birthday and questions about age are not culturally appropriate.

Anthropometry

Anthropometric measurements including weight, length, and head and arm circumference were taken from the babies. The babies were dressed in a T-shirt provided by the researchers while taking their weight. Weight was taken using a UNICEF mother-infant solar-powered platform scale manufactured by Seca. The length was taken 3 times and the mean was calculated and used as the length of the babies. The head and arm circumference were also taken in triplicate with the UNICEF tape measure and the mean was calculated.

Blood tests

We took two drops of blood from the tip of the infant's finger to measure their hemoglobin level, assess blood morphology and for a malaria test. Hemoglobin test was done in the field using HemoCue® AB, (Ängelholm, Sweden) immediately after placing the drop of blood on one slide. We used the second drop of blood for the malaria test and morphology assessment which was determined in a private clinical laboratory. A trained and experienced laboratory technician was hired to take blood samples, to do the HemoCue® test in the field and to fix the second slide for the laboratory examination. We considered the infants to have iron deficiency anemia if the hemoglobin level was less than 11.5g/dL. The hemoglobin cutoff was adjusted for the altitude based on the following formula (Nestel, 2002):

$$Hb= -0.32 \times (\text{altitude in meters} \times .0033) + 0.22 \times (\text{altitude in meters} \times .003)^2$$

This adjustment was needed because the altitude of Sidama zone is 1700m above sea level, which gives 5.128662 that will be added on 110g/L and converted to g/dL.

3.3. Data Analysis

The anthropometric measurements were converted to z-scores using World Health Organization child growth standards software. We analyzed the length-for-age, weight-for-age and weight-for-length z scores. The survey was analyzed by SPSS 14.0. We computed frequencies, means, and standard deviation (SD) from survey responses. The iron status of infants was correlated with the length z score and length-for-age z scores of the infants. ANOVA was used assessed relations between categorical variables (including the presence of malaria) and hemoglobin and anthropometric variables. The standard of significance was alpha level of .05 and if p was $< .05$ then the data was considered statistically significant.

CHAPTER IV

RESULTS

There were 108 infants involved in the first phase of the study at 6 month and 98 returned for the second phase of the study at 9 month (90.7% retention). Two participants were excluded due to lack of blood analysis and questionnaire data. Thus we had a total of 96 babies and their mothers in the study (96/108; 88.9% retention). All subjects were recruited for the first phase of the study when the infants were approximately 5-6 months of age. There were 46 male (mean age 9.46 months, ± .50 SD) and 50 female (mean age 9.45, ± .50 SD) infants. Mean weight in male infant was 8.12 kg ± .98 SD and in female infants was 7.75 kg ± 1.0 SD. The mean height in male infants was 68.02cm and in female infant was 67.41cm. There was no significance difference in weight and hemoglobin concentration between genders. The results from t-tests comparing the anthropometric characteristics are presented in Table 1.

Table 1.Anthropometric characteristics of infants

	Sex	n	Mean	SD	P value	t value
Age	Male	46	9.46	.50	.975	.05
	Female	50	9.45	.50		
zlaz*	Male	46	-2.02	1.31	.010	-2.62
	Female	50	-1.36	1.13		
zBMI*	Male	46	.22	1.34	.753	.315
	Female	50	.16	1.04		
zwaz*	Male	46	-1.03	1.12	.164	-1.40
	Female	50	-.70	1.15		
zwlz*	Male	46	.18	1.32	.838	.20
	Female	50	.13	1.02		

zlaz*: Length-for-age z score; zBMI*: Body mass index for age z score; zwaz*: Weight-for-age z score; zwlz*: Weight-for-length z score

The length-for-age measurement is a good indicator of stunting. A length-for-age z score <-3 was an indicator of severe stunting and <-2 is an indicator of mild stunting (Ntab et al., 2005). Severe stunting in all children was 17.7% and 21.9% were mildly stunted. The analysis shows that there was a difference in distribution of growth by gender (X^2 = 9.457, p = .009). Table 2 shows the length z scores of boys and girls.

Table 2. Length z score groupings for male and female infants

Length z score	sex	n	Percentage (%)
<-3	Male	12	26
	Female	4	8.0
-3 to -2	Male	9	20
	Female	10	20
-2 to +2	Male	25	54
	Female	36	72

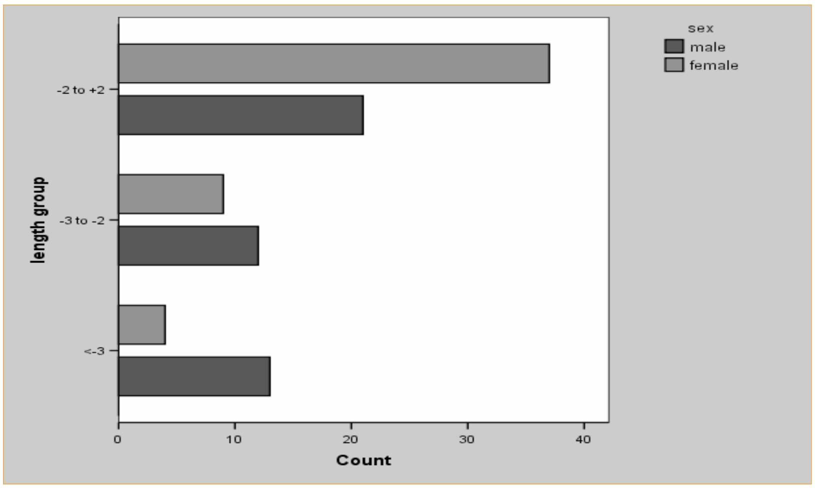

Figure 4.Length z score by malnourished groups and gender

4.1 Association between hemoglobin concentration and stunting

Hemoglobin level was assessed using HemoCue® by taking a blood drop from each infant's middle finger. The maximum Hb concentration was 15.4g/dL, the minimum was 6.0g/dL, the mean was 11.6g/dL and the SD was 1.4. The mean value of Hb for males was 11.7g/dL and SD was 1.3. The mean value of Hb for females was 11.6g/dL and the SD was 1.5. All the mean values of Hb were within the normal limits. Thirty five infants (36.1%) had a hemoglobin concentration less than 11.5 and 60 (61.9%) had hemoglobin concentration greater than 11.5 (see Table 3). There was no significant relation between concentration of hemoglobin and gender ($X^2 = 1.107$, $p = .775$).

There was no significant correlation between hemoglobin concentration and length-for-age z score in all children ($r = .124$, $p = .231$). However when the data was broken into gender groups (male and female); there was a statistically significant correlation between hemoglobin concentration and length-for-age z score in female infants ($r= .285$, $p=.05$) but not in male infants ($r= -.019$, $p= .902$). Results from the analysis of variance of the association of length z score with infants' hemoglobin level is presented separately for boys and girls in table 4 and 5. Although the association does not quite reach statistical significant in girls, the between group difference in hemoglobin levels may be clinically important.

Table 3.Grouping of Hb concentration for both male and female infants who had low Hb concentration (n=95; p=10.5)

Hemoglobin groups (g/dL)	Male	Female	Total (%)
< 7.5	0	1	1.1
7.5 – 10.49	7	7	14.7
10.5 – 11.5	10	9	19
≥11.5	29	32	61

Table 4.Mean Hb concentration in male infants by length z score categories (n=46; p= .815)

Length z score	n	Mean (Hb)	SD
<-3	13	11.82	1.26
-3 to -2	12	11.85	1.79
-2 to +2	21	11.57	1.24

Table 5.Mean Hb concentration in female infants by length z score categories (n=48; p= .102)

Length z score	n	Mean (Hb)	SD
<-3	4	10.17*	3.04
-3 to -2	9	11.30	1.69
-2 to +2	35	11.80*	1.16

* Difference between groups p= .041

There was no significant relation between reports that the mother or infant received iron supplementation and hemoglobin group.

4.2 Association between hemoglobin concentration and presence of malaria

Only 4 (4.1%) infants from a total of 96 babies were positive for malaria in a microscopic test. Table 6 presents the hemoglobin level of infants who were infected with malaria (greater than 11.5g/dL which is within the normal limits).

Table 6.Association between hemoglobin concentration and presence of malaria

Hemoglobin level	Presence of malaria	
	Positive (n)	Negative (n)
<11.5	0	34
>11.5	4	56

Almost half of mothers (43.8%) used a bed net for the infant to prevent malaria. Mothers of two infants with a positive malaria test reported that they used a bed net. Seventy percent of infants had been sick and 64.6% received treatment from medical centers. Slightly more than 1 in 4 women (28.1%) reported that they previously lost a baby.

4.3. Demographic Characteristics

The average of the number of people living in the household was 6.05 and ranged from 3 to 12 family members. Sixty eight mothers (70.8%), owned different livestock (Table 7).

Table 7.Livestock owned by the subjects

Type of livestock	percentage (%)
Cow	49.0
Chickens	26.0
Goat	17.7
Sheep	9.4
Others	6.3

Eighty nine mothers (92.7%) reported having an off-season home garden (Table 8). The most common garden products were enset (91.70%), maize (65.60%), vegetables (4.20%) potatoes (2.10%), and others such as coffee, and chat (54.20%).

Table 8.Off-season garden products

Off-season garden products	Percentage (%)
Enset*	91.7
Maize	65.6
Others	54.2
Vegetables	4.2
Potatoes	2.1

Enset*: The Enset plant looks like a large, thick, single-stemmed banana plant, but it is labeled under the botanical classification *Ensete Scitamineae.* It is the only known wild species in Ethiopia, mainly concentrated in the southern highlands, but it also grows in the central and northern highlands.

More than half of the subjects (59; 61.5%) reported that they bought their food from the market during the last week and the remainder (37; 38.5%) got their food from the garden. More than half, (53; 55.2%) reported that they ran out of food during the previous week.

4.4. Breast feeding practice

All infants were breastfed. Seven mothers (7.30%) breast fed the baby less than seven times during the past 24 hours, 8 mothers (8.30%) breast fed the baby more than seven times during the past 24 hours and the rest didn't know the exact number of times that they breast fed during the previous day.

Table 9.How long after birth did you first put the baby to the breast?

Time to put the baby to breast	Frequency (f)	Percentage (%)
Immediately after birth	65	67.7
After one hour	30	31.3
Don't know	1	1.0

4.5. Complementary feeding practices

Eight five mothers (88.5%) had started complementary foods such as corn bread (67.7%) (see Table 11). According to the mothers, the two most common reasons they started complementary foods were because 'breast milk is not enough' (94.8%) and because 'the baby cries after breast feeding' (5.2%). In the 24 hours before the interview, 42 mothers (43.8%) fed the baby complementary food or liquid once, 19 mothers (19.8%) fed the baby twice and 31 mothers (32.3%) fed the baby thrice. Less than 2% of infants were given green or yellow vegetables, beans, root vegetables or cheese. None of the babies were reported to have received meat, chicken, fish, egg, nut, and oil/butter in the previous day. The food that was given to infants in the previous day was not statistically different between male and female infants (see Table 10).

Table 10.Food that the babies ate yesterday day and night

Food item	Sex	Yes (n)	No (n)
Porridge/gruel	Male	4	42
	Female	2	48
Corn	Male	29	17
	Female	36	14
Enjera	Male	2	44
	Female	0	50
Beans	Male	0	46
	Female	1	49
Pumpkin/yellow	Male	1	45
Orange vegetable	Female	1	49
Root/tubers	Male	1	45
	Female	0	50
Dark green vegetable	Male	1	49
	Female	1	49

There was no difference between genders in whether or not the infants were fed complementary foods, or the frequency of feeding complementary food (once, twice or three times a day). The most common complementary food given to infants was corn and water in the study population (see Table 11 and 12).

Table 11. Common supplemental food (in liquid form) given to infants

Food Items	Frequency (f)	percentage (%)
Plain water	80	83.3
Milk (tinned/powder/fresh)	19	19.8
Anything from bottle	5	5.2
Fenugreek water	4	4.2

Table 12. Common supplemental food (in solid form) given to infants

Food Items	Frequency (f)	percentage (%)
Corn bread	65	67.7
Porridge/gruel	6	6.3
Kocho*/bulla**	2	2.1
Enjera	2	2.1
Pumpkin/yellow squash, carrot, etc	2	2.1

Kocho*: the pulp of the *Enset* pseudostem derived by scraping the individual pieces and excluding the fibrous remains.
Bulla**: the small amount of water-insoluble starchy product that may be separated from *Kocho* during processing by squeezing and decanting the liquid.

All mothers believed that corn porridge, vegetables and fruits are appropriate foods for infants at 9 months of age. Ninety nine percent of mothers agreed that other porridge, enjera, beans, and biscuits are appropriate for 9 month old infants. Maternal beliefs about foods which are appropriate for 9 month old infants are summarized in Table 13.

Table 13.Mothers' perception regarding the foods that infants ***should not eat*** at the age of 9 months

Food Items	Frequency (f)*	percentage (%)
Meat	93	96.9
Kocho	90	93.8
Bulla	17	17.7
Fish	12	12.5
Corn bread	4	4.2
Potatoes	2	2.1
Egg	2	2.1
Cheese	2	2.1

* Frequency of mother's response who said the food item is not appropriate for 9 month old babies

4.6. Immunization

According to the mothers report 97.9% of infants were immunized DPT, 96.9 % polio, 89.6% BCG and 58.3% measles (see Table 14).

Table 14.Summary of immunization type

Immunization type	Frequency (f)	percentage (%)
DPT	94	97.9
Polio	93	96.9
BCG	86	89.6
Measles	56	58.3

There was a difference in hemoglobin levels if mothers reported that their child "has been sick" (X^2= 4.985, p= .026), but other anthropometric measurements were not affected. Only 5/26 (19%) children who were reported to "be not sick" were anemic while 30/68 (44%) children who were reported to "be sick" were anemic.

If mothers reported that the family "ran out of food the previous week," growth was affected (see table 13). There was an association between infant anemia and family food insecurity (X^2= 8.116; p= .041) with 26 food insecure children having a hemoglobin level less than 11.5 compared to only 5 children who were anemic but not food insecure.

Table 15.Household food insecurity in the previous week

	Yes (mean)	No (mean)	P values	t value
zBMI	-.0511	.4712	.025	
zwaz	-1.1287	-.5035	.006	
zwlz	-.0832	.4377	.024	
zlaz	-1.8557	-1.4486	.106	
Hb	11.309	12.058	.008	

CHAPTER V

CONCLUSION

5.1 Discussion

Anemia caused by iron deficiency is a common problem in the world especially in developing countries. Iron deficiency anemia is common in south Asia and sub-Saharan Africa (Tatala, Svanberg, & Mduma, 1998). Infants and children are more vulnerable to iron deficiency due to rapid growth. Infants who are 6-24 months of age are in especially rapid growth thus they need variety and an iron rich diet for proper physical and cognitive development. Several studies examine factors which contribute to iron deficiency such as bioavailability, poverty or socio-economic status, and infectious diseases such as malaria (FAO & WHO, 2001; Menendez et al., 2000; Onyango et al., 1998; Tata la, S. & et al., 1998).

Convenience samples of 98 subjects were recruited for the study from rural area of Southern Ethiopia. They were selected from 4 villages of Sidama Zone. A total of 98 mothers with their 9 months old infants were included in the study.

One of the specific objectives of the study was to determine the association between iron status of infants and stunting. With regard to this objective, stunting was related to iron status of infant girls but not boys. The second objective of the study was to determine association between iron status and presence of malaria. Because of the limited presence of malaria this association could not be tested. And the last objective was to identify supplemental drinks and foods commonly given to infants. We identified the common drinks and foods that are given to infants and examined maternal perceptions regarding complementary feeding.

The participants in this study were living in a rural southern part of the country and they were specifically selected from four districts (kebeles); Kurda, Finchwuha, Loke and Alamura. Infants were considered as having low hemoglobin if the concentration was less than 11.5g/dL. Out of 96 infants in the study, 36.1% of infants had low hemoglobin. The mean hemoglobin level for boys was 11.7g/dL and for girls 11.6g/dL. However, boys were shorter than girls with -2.00 and -1.36 mean length-for-age z score respectively which indicated more severe stunting in boys. Out of 46 male infants 54.4% of them and out of 50 girls 26.0% of them had a length z score of less than -2. There was no relation between length-for-age z score and iron status when all children were analyzed. However there was an association between length-for-age z score and iron status (p=0.05) in girls. However, it is not clear why the hemoglobin level in boys was not correlated with length-for-age z score.

A study done in South East Asia with infants found lower hemoglobin levels in boys than in girls (Wieringa et al. 2007). But in our study boys and girls were essentially the same. We were unable to measure ferritin, thus, further investigation is needed to explain sex differences as early as 9 month old. It may be that the significant difference in growth between boys and girls altered the iron needs associated for growth in boys and thus there was less anemia in boys.

Malaria is as common as iron deficiency in sub-Saharan Africa (Nyakeriga et al., 2004). Malaria causes anemia and it is a major cause of death in many malaria endemic areas (Mebrahtu et al., 2004). In Africa, malaria is the major cause of anemia (Atkinson et al., 2006). In our study, we examined the association between iron deficiency and presence of malaria in infants. Based on the microscopic test for malaria, we found only four infants who had positive malaria tests during the study period. The hemoglobin concentrations of all infected infants were greater than 11.5g/dL. Our findings may support the study which associates iron deficiency with less susceptibility to malarial infections. According to Nyakeriga et al. (2004), iron deficiency results in the production of immunoglobulin subclasses which helps to protect against malaria. The International Nutritional Anemia Consultative Group (1999) suggested that iron supplementation might increase susceptibility to malarial infection. WHO (2007) suggested that screening children for iron deficiency anemia before universal iron supplementation in malaria endemic areas.

We also looked at the association between bed net utilization and malarial presence. Out of the four infected infants, two of them did not use bed nets and the family of the other two used bed nets. Thus, bed net use does not appear to be associated with malarial infection in this study population.

All mothers were breastfeeding their infants during the study. More than half of mothers breastfed the infants' immediately after birth.

However, mothers' knowledge of appropriate complementary foods including the right time to start and the composition of complementary feeding was poor. More that 90% of mothers started complementary food because the infants were crying and/or they thought that breast milk was not enough to satisfy the infant. Sixty seven percent of mothers had started complementary feeding and gave the infants corn bread prepared for the family which is difficult for the infants to chew and swallow. In addition, the major source of iron for infants might be iron from breast milk, even though the iron content in breast milk is not high enough to meet the infant's need.

Only 32.3% mothers fed the infants three times a day and none reported giving the infants additional snacks. All mothers who participated in the study did not meet the WHO & PAHO guidelines for complementary feeding of infants. According to WHO & PAHO (2003), infants who are 9-12 months of age should get complementary food three times a day with additional snacks. Further, infants who were involved in the study were generally given only corn bread which lacks diversity. Although infants were not anemic as expected prior to the data collection, more than half of the infants were found stunted which might be a consequence of lack of diversity and inappropriate complementary feeding practices. Less than 2 % of infants get yellow vegetables and fruits in addition to corn bread. The complementary foods as described by the mothers did not contain animal sources foods such as meat or fruits and vegetables which contain ascorbic acid that can facilitate iron absorption. As the data show there are limited sources of essential nutrients in the infant's diets. This finding is similar with the finding of Arimond and Ruel (2004) who found a mean of 2.2 for infant's diet diversity in Ethiopia.

When mothers were asked about the types of foods that they believe are not appropriate for 9 month old infants, more than 90 % of mothers answered meat and kocho. Meat is a good source of iron and its bioavailability is high due to heme iron (FAO & WHO, 2001). Infants should get meat starting at 6 months of age especially if they do not receive a fortified diet. Most mothers think that bulla, fish, corn bread, potatoes, eggs and cheese are appropriate for infants at 9 moths of age.

More than half of the population gets their food from the market and more than half of them ran out of food during previous week. The main off-season garden products are corn and Kocho followed by other products which usually are coffee and chat. Less than 5% of the study population grew vegetables. The findings also showed that sick infants had lower hemoglobin levels and infants from families who were food insecure also had low hemoglobin. Running out of household staple food also was related with BMI for age, weight-for-age and weight-for-height z scores. Although there was not a significant association between anthropometric characteristics and Hb for all infants, the between groups difference showed that the severely stunted female infants had a lower Hb level than infants with a typical length for age. This finding suggested the need to examine severely stunted infants for iron supplementation instead of supplementing all infants, since the study area is malaria endemic and supplementing iron to all children might be detrimental. The reason for failure to meet the WHO and PHAO complementary feeding guidelines in this study population can be: (1) lack of knowledge about appropriate timing and composition of complementary feeding; (2) poverty which includes food insecurity.

5.2 Summary

The study results suggest the need to design intervention mechanisms for improving complementary feeding practices by building the awareness of the mothers about the importance of starting complementary feeding at the right time and with right dietary composition. Despite early and extensive breastfeeding, the lack of knowledge of appropriate complementary feeding may affect the growth of an infant.

However, more than 60% of infants had hemoglobin concentration within the normal level and hemoglobin concentration was not correlated with stunting in males. Thus infants might be deficient in other micronutrients such as zinc which is also important for growth and development at this early age. Although the statistical analysis was not significance in anthropometric and Hb association, the between groups difference showed that the severely stunted infants in females had a lower Hb concentration.

The survey result indicated that more than half of the families were running out of food during the study period. This revealed that there is food insecurity and poverty in the study population which directly affects the growth of infants. Family size is another factor that might affect the growth of infants in the study population. The mean family size was 6 and the smallest family size was 3 and the largest family had 12 members. When the family size grows without change in the income of the family there will be food competition and infants cannot compete to get enough food. In general, this study showed that there was no statistically significant relation between iron status and anthropometry measurement particularly in males. However stunting was the main problem in the study population which can be an indicator of poverty or zinc deficiency. There were inappropriate food practices in the areas which included lack of nutrient dense food in the right amount, composition and timing for optimum complementary feeding. However, there are foods that mothers thought good to feed for 9 month-old infants such as vegetables and fruits which should be encouraged. If appropriate feeding practices could be encouraged and if food availability and food security could increase, the nutritional status of infants could improve.

5.3. Limitations of the study

We used a convenience sampling method to recruit our subjects which is not a representative sampling method and we recruited subjects from four villages. We chose this method because of time constraints. Thus this has limited the ability generalize the findings to other populations.

Since the mothers refused venous blood sampling for the infant, further investigation of the iron status and the general health of the babies were limited. Hemoglobin can be affected by dehydration and some of the hemoglobin concentration might be high due to dehydration. Even though we included a question which asks the mothers if the baby was recently sick or not, we did not know the severity and/or type of illness that might indirectly affect the iron status of the infants. In addition, it was difficult to find out if premature babies were included in the study since we did not have the birth weight or gestational age of the babies.

This study would have been enhanced if a food record was used instead of a food recall. The mothers might not tell the whole truth especially about food related questions hoping to get some kind of help from the researchers. The other thing that can limit the study was lack of the mother's full attention to analyzing and answering the question due to exhaustion. The subjects walked to the central place and stayed there until we finished the blood collection, anthropometric measurements, the survey and the Laboratory Temperament Assessment Battery (Lab-TAB) which could have created stress.

Because of the above factors the application of the study findings to other populations is limited. Thus further studies are recommended by the researchers to understand the root cause of stunting in the population which can be conclusive and generalized to other population.

5.4. Recommendation and Future study

Nutrition education is important to improve the awareness of mothers about complementary feeding practices which focuses on:

- right time to start complementary feeding;
- dietary diversification;
- nutrient dense and high quality feeding practices and
- frequent feeding practices

To conclude, further research is needed to fully understand the causes of stunting and the root cause of malnutrition in the study population in relation to iron deficiency, iron deficiency anemia and micronutrients and the cause of gender differences. This study will contribute to the existing data on the relationship between iron deficiency, iron deficiency anemia and infant growth. It is the researchers hope that the study will provide baseline data for others who will go to work in the study area in the future.

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APPENDIX A

Survey Questionnaire

Section A. Socio-demographics

YOUR ANSWERS AND DATA WILL BE KEPT STRICTLY CONFIDENTIAL

Interviewer ______________ Date of observation <d/m/y>__________

Village________________

Child's Name ________________________ Child's ID Number ______________________

Child's date of birth <d/m/y> ___/____/____ Child's age (mos)__________Sex of child (M/F) ___

Respondent mother / other (delete one)

1. How many people usually live in this household? ________people

2. List household members

Relation (e.g. mother, father, sibling etc)	Age (y)

3. Who is the head of household?

- ☐ Yourself
- ☐ Husband,
- ☐ Grandparent,
- ☐ Uncle/Aunt
- ☐ Other

4. What is the main occupation of head of household?

- ☐ Farming (owner-operated)
- ☐ Tenant farmer
- ☐ Agricultural laborer
- ☐ Non-agricultural laborer
- ☐ Self-employed non farming
- ☐ Paid employment non farming
- ☐ Unemployed not working
- ☐ Other ________________________________

5. How many years of schooling did you complete?

- ☐ None
- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four
- ☐ Five or more

6. Do you have any livestock?

- ☐ Yes
- ☐ No

7. If yes, how many livestock do you have for the household?

Cows Number ____
Goats Number ____
Chickens Number ____
Sheep Number ____
Other______________ Number ____

8. Are you cultivating an off-season from house garden?

- ☐ Yes
- ☐ No

9. If yes, what crops will be harvested from the house gardening?

- ☐ Enset
- ☐ Maize
- ☐ Potatoes
- ☐ Vegetables
- ☐ Other _____________

10. Where has this week's food come from?

- ☐ Garden
- ☐ Purchased
- ☐ Wages in kind after working
- ☐ Other _______________________

11. Has your household staple food run out?

- Yes
- No

Section B: Breast feeding and infant/child nutrition

Responses to all the questions on Section B are based on mothers' (or other caregivers) recall.
Each question in Section A must be asked as it is written on the questionnaire: this is very important. If the mother or caregiver does not understand the question, you may need to use extra probing questions.

In addition to the questions, there are statements/words that appear in all capital letters. These are interviewer instructions, and should not be read aloud to the mother/caregiver. Most questions have precoded responses. It is important that you do not read these choices aloud. When you ask a question, you should listen to the mother's/caregiver's answer, then check the box next to the category that best matches her answer.

1. Did you ever breastfeed (NAME)

- Yes
- No

2. How long after birth did you first put (NAME) to the breast?

- Immediately/within first hour after birth
- After first hour
- Don't remembers/don't know

3. During the first three days after delivery, did you give (NAME) the liquid that came from your breasts?

- Yes
- No
- Don't know

4. During the first three days after delivery, did you give (NAME) anything else to eat or drink before feeding him/her breastmilk?

- Yes
- No
- Don't know

If Yes, what did you give (NAME)?

(DO NOT READ THE LIST) RECORD ALL MENTIONED BY CIRCLING FOR EACH ITEM MENTIONED

- Milk (other than breast milk)
- Butter

- ☐ Plain water
- ☐ Water with sugar and/or salt
- ☐ Fruit juice
- ☐ Tea/coffee infusions
- ☐ Infant formula
- ☐ Other (Specify) ____________________________

6. Are you currently breastfeeding (NAME)?
   - ☐ Yes
   - ☐ No

7. For how long did you breastfeed (NAME)?

   Months_________________

   IF LESS THAN ONE MONTH, RECORD "00" MONTHS

8. Why did you stop breastfeeding?
   - ☐ Mother pregnant
   - ☐ Mother sick
   - ☐ Mother tired of breast feeding
   - ☐ Introduced solids
   - ☐ Breast milk making child sick
   - ☐ Not enough milk
   - ☐ Other___________________________(Please specify)

9. If you are currently breast feeding, how many times in the last 24 hrs did you breastfeed?
   - ☐ less than 7
   - ☐ more than 7
   - ☐ don't know

10. Now I would like to ask about the type of liquids (NAME) drank yesterday during the day and night.

    Did (NAME) drink any of the following liquids yesterday during the day or night?

READ THE LIST OF LIQUIDS, STARTING WITH "BREASTMILK". PLACE A CHECK MARK IN THE BOX IF CHILD DRANK THE LIQUID IN QUESTION

- ☐ Breastmilk?
- ☐ Plain water ?
- ☐ Abish wuha
- ☐ Commercially produced infant formula?
- ☐ Any other milk such as tinned, powdered, or fresh animal milk?
- ☐ Fruit juice?
- ☐ Coffee or tea?

 Any other liquids such as sugar water, carbonated drinks (e.g. minerals), soup broth?
 Freezies?

11. Did (NAME) drink anything from a bottle with a nipple yesterday or last night?
 Yes
 No
 DON'T KNOW

12. Are you giving your infant any **foods** other than breast milk?
 Yes
 No

13. What made you decide to start giving foods to your infant?
 not enough breast milk
 not enough time to breastfeed
 baby always crying
 baby reaching for food
 baby active
 tradition
 told to
 don't know
 other

14. Now I would like to ask you about the types of foods (NAME) ate yesterday during the day and at night. Did (NAME) eat any of the following foods yesterday during the day or night?
READ THE LIST OF FOODS. PLACE A CHECK MARK IN THE BOX IF CHILD ATE THE FOOD IN QUESTION
 Porridge or gruel prepared from cereal grains (e.g. made with maize, sorghum, millet, wheat, barley, tef)?
 Corn bread?
 Enset foods (for example, kotcho and bulla)?
 Enjera prepared from cereals
 Any foods made from beans (for example kidney beans, haricot beans, field peas, cowpeas, chick peas or others?
 Pumpkin or yellow/orange-fleshed squash, carrots, or yellow/orange-fleshed sweet potatoes?
 Any other food made from roots or tubers other than enset. For example, white potatoes, white yams, cassava)?
 Any dark green leafy vegetables (for example, cassava leaves, pumpkin leaves, kale, amaranth leaves, or other dark green leaves)?
 Any beef, pork, lamb, goat, rabbit (or wild game meat such as antelope)?
 Any chicken, duck, or other birds (for example, guinea hen, others)?
 Any fresh or dried fish, or shell fish?
 Any eggs?
 Any groundnuts/peanuts, or any nuts?
 Any cheese or yogurt?

- Any food with oil, fat, or butter?

15. How many times did (NAME) eat solid, semi-solid, or soft foods other than liquids yesterday during the day and at night?

    Number of times________

    - Don't know

16. Which of these foods do mothers say should NOT be fed to infants at this age (PROBE)

    - corn porridge
    - other porridge
    - corn bread
    - kotcho
    - bulla
    - enjera
    - beans
    - biscuits
    - vegetables
    - fruits
    - potatoes
    - egg
    - fish
    - meat
    - soft cheese

17. Since the birth of your child, have you or your infant received a supplement (oral of injection) of iron?

Myself (mother)	My infant
Yes	Yes
No	No

18. Has your child been immunized?

    - Yes
    - No

19. If Yes, please specify

    - BCG
    - Polio
    - DPT
    - Measles

20. Do you use bed net for your baby?

    Yes

    No

21. Has your child been sick?

Yes

No

22. If yes, what did you do?

Take him/her to hospital

Give him /her traditional medicines

Nothing

23. Have you ever lost a child?

Yes

No

APPENDEX A-1

Survey Questionnaire response

Section A. Socio-demographics

•

1. How many people usually live in this household? Mean = 6.05 people

2. List household members:

3. Who is the head of household?
   - Yourself = 0%
   - Husband = 100%
   - Grandparent = 0%
   - Uncle/Aunt = 0%
   - Other = 0%

4. What is the main occupation of head of household?
   - Farming (owner-operated) = 94.8%
   - Tenant farmer = 0%
   - Agricultural laborer = 1%
   - Non-agricultural laborer = 2.1%
   - Self-employed non farming = 0%
   - Paid employment non farming = 2.1%
   - Unemployed not working = 0%
   - Other = 0%

5. How many years of schooling did you complete?
   - None = 47.4%
   - One = 1.1%
   - Two = 2.1%
   - Three = 8.4%
   - Four = 8.4%
   - Five or more = 32.6%

6. Do you have any livestock?
   - Yes = 70.8%
   - No = 29.2%

7. If yes, how many livestock do you have for the household?

   Cows Number = 49.0%
   Goats Number = 17.7%

Chickens Number = 26.0%
Sheep Number = 9.4%
Other______________ Number = 6.3%

8. Are you cultivating an off-season from house garden?
 - Yes = 92.7%
 - No = 7.3%

9. If yes, what crops will be harvested from the house gardening?
 - Enset = 91.7%
 - Maize = 65.6%
 - Potatoes = 2.1%
 - Vegetables = 4.2%
 - Other = 54.2%

10. Where has this week's food come from?
 - Garden = 38.5%
 - Purchased = 61.5%
 - Wages in kind after working = 0%
 - Other = 0%

11. Has your household staple food run out?
 - Yes = 55.2%
 - No = 44.8%

Section B: Breast feeding and infant/child nutrition

Responses to all the questions on Section B are based on mothers' (or other caregivers) recall.
Each question in Section A must be asked as it is written on the questionnaire: this is very important. If the mother or caregiver does not understand the question, you may need to use extra probing questions.

In addition to the questions, there are statements/words that appear in all capital letters. These are interviewer instructions, and should not be read aloud to the mother/caregiver. Most questions have precoded responses. It is important that you do not read these choices aloud. When you ask a question, you should listen to the mother's/caregiver's answer, then check the box next to the category that best matches her answer.

1. Did you ever breastfeed (NAME)
 - Yes = 100%
 - No = 0%

2. How long after birth did you first put (NAME) to the breast?
 - Immediately/within first hour after birth = 67.7%

- After first hour = 31.3%
- Don’t remembers/don’t know = 1.0%

3. During the first three days after delivery, did you give (NAME) the liquid that came from your breasts?
    - Yes = 100%
    - No = 0%
    - Don’t know = 0%
4. During the first three days after delivery, did you give (NAME) anything else to eat or drink before feeding him/her breastmilk?
    - Yes = 5.2%
    - No = 94.8%
    - Don’t know = 0%

    If Yes, what did you give (NAME)? (Water)

(DO NOT READ THE LIST) RECORD ALL MENTIONED BY CIRCLING FOR EACH ITEM MENTIONED

- Milk (other than breast milk) = 0%
- Butter = 0%
- Plain water = 5.2%
- Water with sugar and/or salt = 0%
- Fruit juice = 0%
- Tea/coffee infusions = 0%
- Infant formula = 0%
- Other (Specify) = 0%

6. Are you currently breastfeeding (NAME)?
    - Yes = 100%
    - No = 0%

7. For how long did you breastfeed (NAME)?

    Months: All mothers were breastfed during the study period

    IF LESS THAN ONE MONTH, RECORD “00” MONTHS

8. Why did you stop breastfeeding?
    - Mother pregnant = 0%
    - Mother sick = 0%
    - Mother tired of breast feeding = 0%
    - Introduced solids = 0%
    - Breast milk making child sick = 0%
    - Not enough milk = 0%
    - Other = 0% (Please specify)

9. If you are currently breast feeding, how many times in the last 24 hrs did you breastfeed?

- less than 7 = 7.3%
- more than 7 = 8.3%
- don't know = 84.4%

10. Now I would like to ask about the type of liquids (NAME) drank yesterday during the day and night.

Did (NAME) drink any of the following liquids yesterday during the day or night?

READ THE LIST OF LIQUIDS, STARTING WITH "BREASTMILK". PLACE A CHECK MARK IN THE BOX IF CHILD DRANK THE LIQUID IN QUESTION

- Breastmilk? = 100%
- Plain water ? = 83.3%
- Abish wuha = 4.2%
- Commercially produced infant formula? = 0%
- Any other milk such as tinned, powdered, or fresh animal milk?=19.8%
- Fruit juice? = 0%
- Coffee or tea? = 1.0%
- Any other liquids such as sugar water, carbonated drinks (e.g. minerals), soup broth? = 1.0%
- Freezies? = 1.0%

11. Did (NAME) drink anything from a bottle with a nipple yesterday or last night?

- Yes = 5.0%
- No = 95.0%
- DON'T KNOW = 0%

12. Are you giving your infant any **foods** other than breast milk?

- Yes = 88.5%
- No = 11.5%

13. What made you decide to start giving foods to your infant?

- not enough breast milk = 94.8%
- baby always crying = 5.2%
- baby active = 0%
- told to = 0%
- other = 0%
- not enough time to breastfeed = 0%
- baby reaching for food = 0%
- tradition = 0%
- don't know = 0%

14. Now I would like to ask you about the types of foods (NAME) ate yesterday during the day and at night. Did (NAME) eat any of the following foods yesterday during the day or night?

READ THE LIST OF FOODS. PLACE A CHECK MARK IN THE BOX IF CHILD ATE THE FOOD IN QUESTION

- Porridge or gruel prepared from cereal grains (e.g. made with maize, sorghum, millet, wheat, barley, tef)? = 6.3%
- Corn bread? = 67.7%
- Enset foods (for example, kotcho and bulla)? = 2.1%
- Enjera prepared from cereals = 2.1%
- Any foods made from beans (for example kidney beans, haricot beans, field peas, cowpeas, chick peas or others? = 1.0%
- Pumpkin or yellow/orange-fleshed squash, carrots, or yellow/orange-fleshed sweet potatoes? = 2.1%
- Any other food made from roots or tubers other than enset. For example, white potatoes, white yams, cassava)? = 1.0%
- Any dark green leafy vegetables (for example, cassava leaves, pumpkin leaves, kale, amaranth leaves, or other dark green leaves)? = 1.0%
- Any beef, pork, lamb, goat, rabbit (or wild game meat such as antelope)? = 05
- Any chicken, duck, or other birds (for example, guinea hen, others)? = 0%
- Any fresh or dried fish, or shell fish? = 0%
- Any eggs? = 0%
- Any groundnuts/peanuts, or any nuts? = 0%
- Any cheese or yogurt? = 1%
- Any food with oil, fat, or butter? = 0%

15. How many times did (NAME) eat solid, semi-solid, or soft foods other than liquids yesterday during the day and at night?

Number of times: once = 43.8%; twice = 19.8%; three times = 32.3%

- Don't know = 0%

16. Which of these foods do mothers say should NOT be fed to infants at this age (PROBE)

- corn porridge- Yes = 100%; No = 0%
- other porridge- Yes = 1%; No = 99%
- corn bread- Yes = 4.2%; No = 95.8%
- kotcho- Yes = 93.8%; No = 6.2%
- bulla – Yes = 17.7%; No = 82.3%
- enjera – Yes = 1%; No = 99%
- beans – Yes = 1%; No = 99%
- biscuits – Yes = 1%; No = 99%
- vegetables – Yes = 0%; No = 100%
- fruits – Yes = 0%; No = 100%
- potatoes – Yes = 2.1%; No= 97.9%
- egg – Yes = 2.1%; No = 97.9%
- fish- Yes = 12.5%; No = 87.5%
- meat – Yes = 96.9%; No = 3.1%
- soft cheese – Yes = 2.1%; No = 97.9%

17. Since the birth of your child, have you or your infant received a supplement (oral of injection) of iron?

Myself (mother)	My infant
Yes = 82.3%	Yes = 83.3%
No = 17.7%	No = 16.7%

18. Has your child been immunized?

 Yes = 97.9% No = 2.1%

19. If Yes, please specify

 BCG = 89.6%
 Polio = 96.9%
 DPT = 97.9%
 Measles = 58.3%

20. Do you use bed net for your baby?

Yes = 43.83%
No = 56.17%

21. Has your child been sick?

Yes = 70.8%
No = 29.2%

22. If yes, what did you do?

Take him/her to hospital =
Give him /her traditional medicines =
Nothing =

23. Have you ever lost a child?

Yes = 28.1%
No = 71.9%

APPENDIX B

Anthropometric measurements form

	1st Obs.	2nd Obs	3rd Obs
Head circumference (cm)			
Length (cm)			
Weight (kg)			
Mid-arm circumference (cm)			

APPENDIX C

IRB approval form

Oklahoma State University Institutional Review Board

Date:	Tuesday, December 19, 2006
IRB Application No	HE06114
Proposal Title:	Iron Deficiency and Temperament in Infants in Southern Ethiopia: Follow-up
Reviewed and Processed as:	Expedited (Spec Pop)

Status Recommended by Reviewer(s): Approved Protocol Expires: 12/18/2007

Principal Investigator(s

Getenesh Berhanu Teshome 40 S. Univ. Pl. #8 Stillwater, OK 74075	Yewelsew Abebe co-pi with D. Thomas Stillwater, OK 74078	Barbara Stoecker 421 HES Stillwater, OK 74078
David Thomas 215 N. Murray Stillwater, OK 74078	Tay Seacord Kennedy 312 HES Stillwater, OK 74078	

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

✓ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu)

Sincerely,

Sue C. Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

Oklahoma State University Institutional Review Board

Date:	Friday, December 07, 2007	Protocol Expires:	12/6/2008
IRB Application No:	HE06114		
Proposal Title:	Iron Deficiency and Temperament in Infants in Southern Ethiopia: Follow-up		

Reviewed and Processed as: Expedited (Spec Pop)
Continuation

Status Recommended by Reviewer(s): **Approved**

Principal Investigator(s)

Getenesh Berhanu Teshome Stillwater, OK 74075	Yewelsew Abebe co-pi with D. Thomas Stillwater, OK 74078	Barbara Stoecker 421 HES Stillwater, OK 74078
David Thomas 215 N. Murray Stillwater, OK 74078	Tay Seacord Kennedy 312 HES Stillwater, OK 74078	

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

☐ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

The reviewer(s) had these comments:

The approval is for continued data analysis only. If additional data collection is found to be necessary, a modification request should be submitted for IRB review and approval prior to initiation.

Signature:

Sue C. Jacobs, Chair, Institutional Review Board

Friday, December 07, 2007
Date

APPENDIX D

Approved IRB document-script

Scientists from Hawassa University and the United States need your help. We want to know what makes children in your area grow and what makes them healthy and smart. We are especially interested in iron, which is an important part of the food we eat, and how it may affect how babies act. We are conducting a study for mothers and their 8-9 month-old infants. We are asking the 100 mothers and their babies from villages in Sidama we tested a few months ago to come back and be tested again to see how the babies are growing.

Procedures: If you agree to take part in this study we will ask your help in the following ways:

- Come to a central place in the village where we will play with your baby. First we will ask you some questions about your home such as who lives there and what kind of work they do. We will also ask what kinds of food you may feed to your baby. We will then play with your baby and show him or her some things that may make them happy, like a toy, or may make them worried, like being spoken to by a stranger. You will be there with your baby and most of the time you will be holding him/her. We are interested to see how your baby reacts to these things and we will videotape the baby during this time *[Lab-TAB]*.
- After we are done playing with your baby, we will weigh and measure him/her and then collect a small amount of blood from him/her. After we collect small amount of blood, we will put a small bandage on the baby. (*Refer to picture showing amount of blood to be collected*). This will take only a few seconds. We are collecting this blood to see how much iron the baby has and if the child has malaria or not. We will also ask you to bring ua a small amount of the baby's stool.
- All of these things will take approximately one hour.

Risks and Benefits:

- During the time that we play with your baby, he/she may show some unhappiness and crying, for example, when a strange person approaches him/her. If your baby becomes too unhappy, then you may pick him/her up and comfort him/her. Please understand that you may ask to stop the study at any time and you will still receive the gifts that we promised you and you will not lose any privileges to which you are entitled.
- Taking blood is a standard medical procedure that may cause momentary discomfort to your baby, but you will hold him/her during this and will be able to comfort him/her. If the place where we took the blood does become sore or infected, please take your baby to your community health worker. He/she will clean to site, put more medicine on the baby and a new bandage. If more medical attention is needed, the community health worker will help you get to the local health clinic where your baby will be treated without cost to your family.

- We will examine the baby's blood to see if there is enough iron in it. If there is not, we will notify you so that you can talk to the village health clinic about what to do.
- Along with knowing if your baby's blood has enough iron in it, we will also give you a scarf, a picture of your baby with you and a t-shirt for him/her.
- There is no cost to you for being in this study.
- From this study, we hope to better understand how the types of food that babies eat affects the way they grow and develop.

Confidentiality: No one except those of us conducting this study will see the videotapes of your baby, the records of your baby's blood test, or your answers to the questions that we ask you. We will store these videotapes and records in a locked office at Hawassa University and at a university in the United States. If any information about your baby is ever presented to other scientists at a meeting or in a written articles, neither your name nor your baby's name will be identified.

Even if you agree for you and your baby to be in this study, you may choose to quit at any time without any penalty. If you have questions after the testing has been done, you may contact your community health worker who will help you contact us so that we can answer them for you. If you do agree to be in this study, when we are finished we will ask you if you would be willing to let us play with your baby again to see if anything has changed. We will NOT ask to take blood or do the other tests again.

APPENDIX E

Approved IRB documents-consent form

(To be read to participants in their own language after the information in the Script has been read)

Invitation for Questions: You may ask any questions you have now. If you have any questions later, you may ask your community health worker who will help you get your questions answered by contacting the people conducting this project. (The following contact information will be given to the community health worker. For general questions about the study: Dr. Yewelsew Abebe at Hawassa University, P.O. Box 5, Awassa or at 62-00-470. For questions regarding ethical standards: Dr. Adugna Tolera at the Hawassa University Ethics Committee at the Research and Extension Office at P.O. Box 5, Awassa, Phone 62-00-221.)

I have been asked to take part in a research study that looks at the amount of iron in my baby's blood and how that might relate to the way he/she behaves. The translator has told me the following things about the study:

- That the study is being done to look at iron, which is an important part of the food we eat, and how it may affect how babies act.
- That I will be asked several questions about my household, the way we live and the food I give the baby.
- That the main part of the study is to see how my baby reacts to things like toys and strangers and that this will be videotaped.
- That my baby will be weighed and measured.
- That a small amount of blood will be taken from my baby and I will be asked to give the project a small amount of my baby's stool.
- That my baby may fuss during the activities. But that I will be there to comfort him/her.
- That all of this will take approximately one hour.
- That there are possible risks and discomforts, but also benefits of the study.
- That the information will be kept private.
- That I can receive free medical care from the community health worker if my baby is hurt in the study.
- That participating will cost me nothing and that I will receive a scarf, and a picture along with a t-shirt for him/her.
- That my baby and I can stop being in the study at any time.
- That I have been given the chance to ask questions about this study and our participation in it.
- That I can contact the community health worker if I have further questions.

Consent: Agreeing to be in this study means that the research project has been described to me orally in language I understand. I have had a chance to ask questions about the study. These questions have been answered to my satisfaction before I have agreed for myself and my baby to be in the study. I may choose for my baby and me not to be in the study or I may quit being in the study at any time without loss of any privileges to which we are entitled. I know what will be done to me and to my baby as part of this study. I also know the possible good and bad things (benefits and risks) that could happen if we are in this study. I choose for my baby and me to be in this study. I know that I can stop being in this study at any time and we will still get the usual medical care.

I agree for my baby and me to be in this study as described above.

Name of Participant (spoken to tape)____

Name of Witness (spoken to tape)____

Name of Translator (spoken to tape)____

Date (spoken to tape)____

VITA

Getenesh Berhanu Teshome

Candidate for the Degree of

Master of Science

Thesis: FEEDING PRACTICES AND FACTORS CONTRIBUTING TO STUNTING AND LOW HEMOGLOBIN AMONG INFANTS IN SOUTHERN ETHIOPIA

Major Field: Nutritional Sciences

Biographical:

Personal Data: Getenesh Berhanu Teshome
Email: geteneshbt@yahoo.com

Education:

Completed the requirements for the Master of Science in Nutritional Sciences at Oklahoma State University, Stillwater, Oklahoma in May 2008.

Completed the requirement for Bachelor of Education in Technology and Home Economics at Adventist University of the Philippines, Putting Kahoy, Silang Cavite, Philippines in March 2003.

Experience:

Graduate Assistant, 2003-2005 Department of Rural Development and Family Sciences, Hawassa University, Ethiopia,

-Teach courses such as Methodology of Education, Philosophy of Education and Introduction to Nutrition

Technical Assistant, 2000-2001 Department of Rural Development and Family Sciences, Hawassa University, Ethiopia
-Assist students in laboratory activity, responsible for purchasing lab teaching materials

-assist courses such as introduction to nutrition, family dietetics and food preservation

Professional Memberships: N/A

Name: Getenesh Berhanu Teshome Date of Degree: July, 2008

Institution: Oklahoma State University Location: OKC or Stillwater, Oklahoma

Title of Study: FEEDING PRACTICES AND FACTORS CONTRIBUTING TO STUNTING AND LOW HEMOGLOBIN AMONG INFANTS IN SOUTHERN ETHIOPIA

Pages in Study: 53 Candidate for the Degree of Master of Science

Major Field: Nutritional Sciences

Scope and Method of Study: The purpose of the study was to assess and determine the feeding practices and the extent of stunting, iron deficiency, and to examine the relation between iron deficiency and stunting. We used cross-sectional survey and blood collection to examine the hemoglobin level and presence of malaria in infants and took anthropometry measurements of infants included length and weight.

Findings and Conclusions: Of the 96 infants (mean age 9.5 months), 18% had length for age z-scores <-3 and 22% had length z-scores between -3 and -2. Males were more likely to be malnourished than females (p=.009). There was statistically significant correlation between hemoglobin level and length-for-age z score in female infants (r= .205, p= .05). There were 4 babies who were infected with malaria, but their hemoglobin level was in the normal limit which is >11.5G/dL. Ninety one percent of male infants and 86% of female infants, received solid foods within the last 24 hours; twice a day on average. The most commonly fed items were plain water (82%); corn bread (65%) and animal milk (28%). Less than 2% of infants were given yellow or green vegetables, beans, root vegetables or cheese. None were given meat, eggs, fruit juice or oil. More than 90% of the mothers did not think kocho and meat were appropriate foods for 9-month-old infants. Stunting is a major problem in this study population and inappropriate food practices in the area included lack of the right amount nutrient dense food, composition and timing to start complementary feeding. However, mothers think that vegetables and fruits are appropriate food types for infants. Thus it is important to utilize local complementary feeding patterns and beliefs when designing interventions to address infant malnutrition.

ADVISER'S APPROVAL: Dr. Tay S. Kennedy