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Haemoglobin concentration among camel milk and cow milk consuming pastoralist communities of Somali region, eastern Ethiopia

By

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Declaration

I the undersigned declare that this thesis is my original work and that it has not been submitted or presented for a degree in any other institution and that all sources of materials used for the thesis have been duly acknowledged.

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This thesis work has been submitted for examination with my approval as an advisor of the candidate.

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Acronym and abbreviations

CI	Condition Index
CSA	Central Statistical Agency
DDS	Dietary Diversity Score
DNA	Deoxy Ribonucleic Acid
EDHS	Ethiopian Demographic and Health Survey
EDTA	Ethylene Diamine Tetra-acetic Acid
EPO	Erythropoietin
FANTA	Food and Nutrition Technical Assisstance
FAO	Food and Agricultural Organization
GI	Gastro Intestine
HAZ	Height for Age Z score
Hb	Haemoglobin
ID	Iron Deficiency
IDA	Iron Deficiency Anemia
IDD	Iodine Deficiency Disorder
MOH	Ministry Of Health
MFP	Meat, Fish and Poultry
PEU	Protein Energy Under nutrition

PGA	Pteroyl Glutamic Acid
RBCs	Red Blood Cells
RNA	Ribonucleic Acid
SPSS	Statistical Package for Social Science
UNICEF	United Nations International Childrens Emergency Fund
UNU	United Nations University
VAD	Vitamin A Deficiency
VIF	Variance Inflation Factor
WASH	Water, Sanitation and Hygiene
WAZ	Weight for Age Z score
WHO	World Health Organization
WHZ	Weight for Height Z score
MUAC	Mid-Upper-Arm Circumference

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Abstract

***Background**: Anemia is a public health problem affecting almost 300 million preschool children in the world wide. However, the magnitude is particularly higher in developing countries. Studies demonstrated that children aged 6 to 24 mo present greater vulnerability to anemia. Specifically, children from pastoral areas are at higher risk of anemia mainly due to shortage of health facilities, low dietary diversity, lack of adequate clean water and poor sanitation and hygiene. In addition, consumption of cow's milk which contains higher amount of calcium and caisin but less in vitamin C and iron could be a contributing factor. In contras, camel milk contains higher amount of vitamin C and iron but relatively less amunt of calcium and caisin which could positively influence haemoglobine concentration.*

***Objectives:** This study investigates haemoglobine level among children predominantly consuming cow's milk or camel milk areas in Somali region.*

***Methods:** A cross sectional community based study design was conducted among 332 children aged 6-59 months old in the pastoralist community of Somali region. Purposively, each half of the study participants were recruited from cow or camel rearing areas to find children predominantly consuming cow's or camel's milk. Data on socio-demographic and economic status of the households, dietary characterstics and nutritional status of children were collected. In addition, Haemoglobin level of children was determined.*

***Result:** About 62% of households possess farm land and produce only cereals (maize and sorghum). Literacy level of the caregivers was very low with (98.8%) had no formal education. There was very low water, sanitation and hygiene practices in the study area. The study households are characterized by consumption of less diversified diets. In the study area anemia was a public health problem (77.4%). factors that significantly associated to haemoglobin concentration was possessing house hold farm land (p=0.023), weight of the children (p=0.000) height of the children (p=0.000), age of the children (p=0.000) household waste disposal (p=0.012).*

***Conclusion:** camel milk or cow milk consumption was not significant to haemoglobin in this study. The study recommends; establishing sustained household home gardens as a way of implementing dietary diversification which is likely to improve the micronutrient intakes of the households.*

1. INTRODUCTION

1.1. Background

Anemia is an important public health problem worldwide affecting almost 300 million pre-school children World Health Organization (WHO, 2008). The extent of the problem is especially higher in populations from developing countries. Estimates from WHO, United Nations International Childrens Emergency Fund, and United Nations University (WHO, UNICEF, UNU, 2001). reports shows that 52% of pregnant women's and 39% of children under the age of five in developing countries remained anemic and 23% of a pregnant women and 20% of children under the age of five in industrialized countries are anemic.

Studies have demonstrated that anemia occurs at all stages of the life cycle but its frequency of occurrence is higher in infants, young children, adolescent girls, during pregnancy and elderly people. This is because during these stages the demand for iron increases. In addition, blood loss due to menstruation is high (Edward, 2010; Mbule, 2013). Children aged 6 to 24 mo present greater vulnerability to anemia (Silva, et al., 2001). The situation is even more serious in the 6 to 11 month age group with prevalence rates that reach up to 79% in rural areas (Osorio, *et al.*, 2001).

Anemia is public health problem in Ethiopia generally and especially in pastoralist areas. This can be seen from the 2016, Ethiopian Demography and Health Survey (EDHS) report that more than half of children 6-59 months (56%) suffered from some degree of anemia in Ethiopia: 25% were mildly anemic, 28% were moderately anemic, and 3% were severely anemic. Pastoral communities in Somali and Afar regions are the highest anemia affected societies in the country. That 82.6% and 73.2% of young child Somali and Afar regions are anemic, respectively, compared to the children from other parts of the country. Anemia is associated to several health risks and social and economic complications by reducing working capacity, decreasing the cognitive development in children, and overall productivity of adults (balarajan, *et al.*, 2011 Vivek, *et al.*, 2012).

There are many factors that can cause anemia including genetic factors like immunoglobulino pathies, parasitic infections and consumption of diets poor in micronutrients such as iron and folate or low bioavailability. (WHO/UNICEF/UNU, 2001).

The main food source during early life is milk. However, early introduction of cow's milk, fresh or pasteurized as a substitute for breast milk can cause certain health disorders like anemia due to its very low bioavailability of iron (0.40 and 0.59 mg/l) (Fransson and Lonnerdal, 1983). Iron from cow's milk has lower bioavailability (19%) but mainly attributed to calcium and casein (Hurrell, *et al.*, 1988). Furthermore, consumption of cow's milk has a negative influence on iron status as it reduces bioavailability of iron provided by other foods and has been shown to have a negative effect on non-heme and heme iron absorption (Persson, *et al.,* 2001; Levy-Costa and Monteiro, 2004; Vanderhoof; Silva, *et al.,* 2007; Adu-Afarwuah, *et al.,* 2008; Hurrell and Egli, 2010; 2015).

However, Camel's milk helps in regulating the status of iron in the body (Abdel Salam et al,. 1996). Camel's milk contains several bioactive compounds beneficial for health, three to five times more vitamin C as compared to bovine milk. Therefore, for the inhabitants of desert areas where fruits and vegetables do not grow well, camels milk can be used efficiently as a good source of vitamin C, there is a high mean value of vitamin C concentration (34.16mg/l) present in camels milk l(Sawaya et al,. 1984).

This study was designed to investigate wheather camel's milk consumption is beneficial to heamoglobin (Hb) concentration and to identify factors associated to Hb concentration in children from pastoralist communities of Somali region.

1.2. Statement of the problem

In pastoralist communities of Somali and Afar regions where milk is their staple food, anemia is highly prevalent more than the national average. In younger children, cow's milk consumption is associated to development of milk anemia mainly attributed to low amount of iron but high casein and calcium content. High consumption of cow's milk during first year of life also causes occult blood loss. On the other hand, camel's milk contains high amount of vitamin C and iron compared to cow's milk. However, data on haemoglobin concentration or anemia prevalence as a function of cow's or camel's milk consumption is not available.

1.4. Objectives

1.4.1. General objective

Compare haemoglobine concetration among children from pastoralist communities of Somali region predominantly consuming cow's milk or camel's milk.

1.4.2. Specific objective

- Determine haemoglobine concentration among children from pastoral communities of Somali region
- To determine haemoglobin concentration among children consuming predominantly camel's milk or cow's milk and identifies associated factors.
- Identify factors associated to haemoglobine in children from pastoralist communities of Somali region.

2. LITERATURE REVIEW

2.1.Prevalence of Anemia in children

Anemia refers to a condition in which the Hb content of the blood is lower than normal as a result of a deficiency of one or more essential nutrients (Demaeyer, 1985). Anemia is one of the most nutritional problem observed in the world and affects more than a quarter of worldwide population (WHO/CDC, 2008; Haidar, 2010). Anemia is a major public health problem affecting all ages of the population with its highest prevalence among children under five years of age and pregnant women (Balarajan, 2011; Salhan, 2012) Iron Deficiency Anemia (IDA) was considered to be among the most significant causal factor for the burden of the disease globally (WHO,2002) Clinical signs of anemia include breathlessness, dizziness, and perceived paleness or change of skin color (Gies, 2003).

Anemia causing from severe ID is the most prevalent and widespread nutrition problem in infants and young children in the developing world (INACG, 2000). Anemia was estimated to affect 46-51% of children under five years in developing countries and 7-12% in developed countries (Demaeyer, 1985). Prevalence of anemia remains high among the poorest and most vulnerable populations (De La Cruz-Góngora, *et al.*, 20013; Gutiérrez, *et al.*, 2012). In children under the age of 5 years, anemia can have irreversible negative consequences for the higher intellectual functions of the brain if timely action is not taken (Hermoso, 2011). Anemia has been associated with increased morbidity and mortality among the most vulnerable populations (Tolentino, 2007).

2.2 Etiology of Anemia

Anemia is the result of a wide variety of factors that can be lonely, but more often co-occur. Globally ID is the most common cause of the occurrence of anemia, so that IDA and anemia are always used synonymously and the prevalence of anemia has often used as a proxy for IDA. Generaly it’s assumed that 50% of anemia is instigated by ID. This is because iron is the sole component of Hb and about four atoms of iron are found per Hb (WHO, 2001). Studies suggesting that behavioral abnormalities occur in children with ID these abnormalities are related to changes in the concentration of chemical mediators in the brain (Lozoff, *et al.*, 1987). However, the percentage of anemia may be differing among population groups and in different areas according to the local conditions. The main risk factors for IDA includes lower intake of iron rich foods, poor absorption of iron from foods high in phytate or phenolic combinations, and period of life when iron requirements are specially high (worldwide prevalence of anemia, 1993-2005). ID in the absence of anemia is associated with poor performance on Bayley Mental development Index (Idjradinata, 1993).

The other causes of anemia includes, heavy blood loss as an outcome of parasitic infections that cause inflammation (hook worm, ascaris, schistosomiasis and other parasitic infections), gastrointestinal bleeding from ulcerations, hemorrhoids, diarrhea, and other occult blood losses may lead to anemia, or menstruation; the pregnancy-delivery-lactation cycle, as all this can lower the blood Hb concentration (Bothwell and Charlton, 1981). Acute and chronic infections including malaria, cancer, tuberculosis and HIV, can correspondingly lower blood Hb concentration. The existence of other micronutrient deficiencies such as vitamins; Folate, vitamins B2, B12, A, C, and the mineral copper can also raise the risk of anemia. Genetically inherited traits such as thalassaemia and drepanocytosis may be independent or superimposed causal factors (WHO, 2001). Other factors, that can also contribute to anemia includes low socio-economic status and poor sanitary conditions, because low sanitary conditions disturbs utilization of iron from foods and cause diarrhea (Crompton, 1993) Iron nutritional status depends on long-term iron balance. It is favored by the ingestion of sufficient iron in food in a bioavailable form or through iron supplementation. Regulation of iron absorption is crucial in favoring absorption in iron deficiency and in avoiding iron excess, mucosal turnover and skin desquamation; intestinal excretion (Bothwell and Charlton, 1981).

2.3. Other micro nutrients that can cause anemia

2.3.1. Folate and anemia

Folate is a B vitamin also known as folic acid, folacin or PteroylGlutamic Acid (PGA) Folate is a central component of human erythropoiesis besides iron and vitamin B12. One of the main clinical manifestations of folate deficiency is the production of megaloblastic marrow cell, macrocytic erythrocytes and ultimately macrocytic anemia (Scholl and Johnson, 2000). Folate is essential for a number of enzymes that are critical for DeoxyriboNucleic Acid (DNA) synthesis and amino acid metabolism. In addition, folate’s role in assisting with cell division makes it a critical nutrient for growth, the synthesis of new cells, such as Red Blood Cells (RBCs) and for the repair of damaged cells and tissues. The balance between the loss of mature RBCs and new production is maintained by an oxygen sensing system, which responds via erythropoietin (EPO) production; cytokines, hormones, interactions with cells in the bone marrow and elements, such as iron, folate and vitamin B12 are involved in control mechanisms of the process (Kyriazi, 2011).

Folate deficiency impairs cell division and protein synthesis processes which are critical to growing tissues. In a folate deficiency causes faltering the replacement of RBCs and Gastro Intestinal (GI) tract cells. Then the two of the first symptoms of folate deficiency are anemia and GI weakening. Anemia of folate deficiency is characterized by large cell anemia (macrocytic anemia, megaloblastic anemia), immature RBCs. without folate DNA damage destroys many of the RBCs as they attempt to divide and mature (Koury and Ponka, 2004).

2.3.2. Vitamin B12 and anemia

There are two anemias. Non nutritional anemia including high blood loss due to hemorrhage, hookworm infestation, malarial infestation, chronic diseases and genetically related traits, the other one is nutritional anemia due to deficiencies of vitamins; B12, B2, A, C and folate, and deficiencies of certain trace minerals involved with RBC production like iron and copper (Haidar, 2010). Vitamin B12 and folate are closely related. Vitamin B12 deficiency is the second one caused by Megaloblastic anemia. There are few data on global prevalence of vitamin B12 deficiency and also less is known about its global contribution to anemia. A study which was conducted Mexico in anemic preschool children showed that children with higher initial vitamin B12 concentrations were more likely to respond to iron supplements with improved Hb concentrations than children with low vitamin B12 status (Allen, 2004).

The regeneration of the amino acid methionine and the synthesis of DNA and RNA depend on both folate and vitamin B12. Vitamin B12 functions as a methyl donor and works with folic acid in the synthesis of DNA and RBCs (Ly, *et al*., 2012). Moreover, without folate vitamin B12 alone maintains the sheath that surrounds and protects nerve fibers and promotes their normal growth, bone cell activity and metabolism. Clinically the main symptom of the vitamin B12 deficiency is pernicious anemia, a condition characterized by large, immature RBCs. In addition to this the deficiency may also manifest itself in neurological dysfunction that is almost distinguishable from senile dementia and Alzheimer's disease (Dreskell and Wolinsky, 2006).

Vitamin B12 is classified as a water soluble vitamin and is a distinctive among all vitamins due to its large size, complexity and that it contains the metal ion cobalt. It is necessary for appropriate nervous system function and for the metabolism of energy nutrients. Vitamin B12 deficiency can lead to inefficient erythropoiesis and megaloblastic anemia, neurological disorders such as neuropathy, myelopathy, memory impairment, dementia, depression and brain atrophy (Rusher and Pawlak, 2013).

2.3.3. Vitamin A and Haemoglobin

Vitamin A is a versatile vitamin, known to influence over 500 genes and the major roles of vitamin A includes: promoting vision, participating in protein synthesis, cell differentiation and supporting reproduction and growth (Bestien and Rochette-Egly, 2004).

Vitamin A is needed for erythropoiesis and also Hb is not incorporated into RBCs in a normal way in persons who suffer from vitamin A deficiency, supplementation with vitamin A alone significantly increases Hb, hematocrit or plasma ferritin in children and pregnant women. In some populations, simultaneous supplementation with iron and vitamin A increases Hb concentrations to a greater extent in anemic pregnant women than does iron supplementation alone (Walczyk, *et al*., 2003). Vitamin A deficiency may cause anemia by impairing iron metabolism, but the mechanism of this effect is not quite clear. In vitamin A deficient populations, improving vitamin A status reduces the prevalence of anemia in most but not all studies. Erythropoietin (EPO) produced mainly by renal per tubular cells acts on the late stages of EPO, primarily on colony forming unit erythroid cells and stimulates maturation through the norm oblast into reticulocytes and mature erythrocytes (Zimmermann, *et al.*, 2006).

One of the several suggestion mechanisms of causes of anemia by vitamin A is vitamin A deficiency decreases transferrin synthesis and thus reduces iron transport to the bone marrow, reduces bone marrow iron uptake; impairs the differentiation of blood cells due to lack of retinoic acid and impairs mobilization of iron from ferritin stores. In addition, alternative high prevalence of infections, which frequently reported during vitamin A deficiency, is indirectly responsible for decreasing Hb concentrations because the body sequesters iron during infections

(Walczyk, *et al*., 2003). Besides, the presence of vitamin A significantly increases the absorption of iron from non heme iron containing diets, as iron solubility significantly decreased while go from gastric pH to intestine pH which leads to very low iron absorption ; but the solubility was increased tremendously as a result of presence of vitamin A or beta carotene (Garcia-Casal, *et a*l., 1998).

2.4. Health consequences of anemia in children

Anemia is an indicator of both poor nutrition and poor health. The consequences of iron-deficiency anemia are serious and can include diminished intellectual and productive capacity and possibly increased susceptibility to infections (Oppenheimer, 2001). Anemia are associated with increased risk of maternal and child mortality due to severe anemia and infectious diseases (INACG, 2002). Moreover, the negative consequence of IDA includes retardation of cognitive, physical development and school performance of children and on physical performance especially work productivity in adults are of major concern (WHO, 2001).

2.5. Prevention and control of anemia

Correcting anemia often needs integrated approach. In order to effectively combat it, the causative features must be recognized and addressed. In settings where iron deficiency is the most common cause, supplemental iron intake is usually provided through iron supplements to vulnerable groups; in specificaly pregnant women and young children. Food based techniques to upsurge iron intake through food fortification and dietary diversification are important, sustainable strategies for preventing iron deficiency anemia in the general population. In situations where iron deficiency is not the only cause of anemia, methods that combine iron interventions with other measures are needed. Strategies should include addressing other causes of worldwide prevalence of anemia (WHO, 2006), and should be built into the primary health care system and existing programs. These policies should be tailored to local conditions, taking into account the specific etiology and prevalence of anemia in a given setting and population group (Crompton, *2003*). Micronutrient-fortified fat-based meals are also operational in decreasing ID and well approved by young children (Adu-Afarwuah, 2008).

Active interventions to progress iron status will likely have important health benefits. Action to reduce young child ID would benefit from overarching policy and programmatic guidance that updates discussion makers about appropriate interventions. Most policies do not consider the role of maternal iron status or birth practices in the etiology of ID; supplementation for pregnant women is suggested for maternal health and not as a broader strategy to also improve newborn iron status. Interventions that could protect iron status at birth and during the first 6 months of life, such as delayed umbilical cord clamping (Chaparro, *et al.,* 2006) and promotion of exclusive breast-feeding should be considered. In some settings, deworming is also a valuable intervention to consider (Stoltzfus, *et al.,* 2004).

Specialists agree that food fortification is the best long-term strategy to prevent iron deficiency in the population in general. Though, there is a variation of relevant procedural considerations regarding the use of iron as a fortifier. In the first place, the food vehicle must be consumed on a regular basis by the target population. In the second place, the absorption of fortifying iron must be regulated by the iron nutritional status of the subject; otherwise, there may be a potential risk of overload; this regulation has been described for both heme and non-heme iron. In the third place, the fortificant must be bioavailable. From the nutrition standpoint, iron bioavailability has been shown to be more important than the iron content of a certain food. Over 95% of dietary iron is found as non-heme iron, the absorption of which is influenced by enhancers such as ascorbic acid (WHO/FAO, 2006) or inhibitors such as tannins, phytate and calcium.

2.6. Milk

Milk is the lacteal secretion of the mammary glands and plays an important role in human nutrition promoting growth and maintenance of body tissue (Chye, *et al*., 2004; Javaid, *et al*., 2009; Grimaud, *et al.,* 2009). It is the most complete food of animal origin providing essential nutrients (protein, energy, vitamins and minerals) in significant amounts than any other single food (Pandey and Voskuil, 2011).

There are three different family of animals that produces milk in this world; ruminant animals (bovine, camel, goat, sheep, buffalo, etc), equid animals (donkeys and horses) and human milk. In Ethiopia the major animal milk products are ruminant animals (cows, camels, goats and sheep) but the most widely used farm animal milk is cow’s milk (Bereda, *et al.,* 2014). Ethiopia holds the largest livestock animal in Africa especially camels and cows. It is estimated at about 35 million of cattle and 2 million of camels (MOARD, 2004).

Generally, Milk is an important source of mineral substances, especially calcium, phosphorus, sodium, potassium, chloride, iodine, magnesium, and small amounts of iron. The main mineral compounds of milk are calcium and phosphorus, which are substantial for bone growth and the proper development of newborns (Al-Wabel, 2008).

2.6.1. Camel's milk

According to Food and Agriculture Organization (FAO, 2009) there are around 22 million camels in this World. Among of this, 19.58 million are supposed to be one-humped dromedary camels (*Camelus dromedarius*), whereas the remaining 2.42 million are two-humped bacterian camels (*Camelus bactrianus*). Camels live in the vast pastoral areas in Africa and Asia and divided into two different species belonging to the genus Camelus. Dromedary camels (*Camelus dromedaries*, one humped) that mainly live in the desert areas (arid), and Bactrian camel (*Camelus bactrianus*, two-humped) which prefer living in the cooler areas. More than 60% of the dromedary camel population is concentrated in the four North East African countries. Somalia, Sudan, Ethiopia and Kenya, Ethiopia has over 925, 000 dromedary camels in 2013 that stand the country may be the sixth rank in Africa in camel population. But previously the country was rated in third next to Somalia and Sudan by holding around 2.4 million heads of camel. The majority of camels in the country are found in the drier areas of the Eastern part of the country and kept, among other animals mainly for milk production in these areas.

Dromedaries' camels have many importance ecosystems like transport in semi-arid areas inhabiting societies, and serve as a source of milk, meat and skin in many pastoralist communities in the world (Simeneh, 2015). It is widely admitted that dromedary camels produce more milk of high nutritional quality and for a longer period of time than other species in an environment that may be rightly termed as hostile in terms of extreme temperature, drought and lack of pasture (FAO, 2010). Dromedary camels produce milk for quite longer period even during dry periods compared to cattle (McDowell, 1986). In terms of milk production, Ethiopia ranks the second most camel milk producers in the world next to Somalia. The annual camel milk production in Ethiopia is estimated at about 75,000 tones (Asresie A, 2014).

Camel milk is a foremost source of food security and income and also assists as a substantial cultural function to the pastoral communities (Guliye, *et al.,* 2007; Mehari *et al.,* 2007a, 2007b; Mahmoud, 2010). It forms basic diet for the pastoral communities, where it contributes up to 50% of the total nutrient intake and 30% of their annual caloric intake (Farah and Fischer, 2004). Bonus, camel milk is usually sold in urban centers and the raised money contributes to the household cash income.

Camel milk is an essential constituent of social food in many parts of the world. In most camel rearing communities of the world consume milk in the raw state without processing and treatment. In Ethiopia, most of the pastoralist communities' drunken camel milk as a fresh or when it's slightly sour, Traditionally camel milk is primarily used for direct consumption in arrow form or fluid milk by the majority of pastoralists and some consumed as a fermented milk (*Dhanaan*) and an ingredient for eating porage, soups, kinchie, rice, shuro and pasta in Somali regional state (Knoess KH 1979). However, recent report from Morocco indicated that consumption of raw camel milk has higher levels of total aerobic count, enterococci, fecal coliforms and *Staphylococcus aureus* were detected in raw camel milk and this suggests the potential hazard associated with consumption of raw camel milk (Bestuzheva, KT, 1964 and Benkerroum, *et al.*2004).

2.6.2. Camel milk and health claims compared to cow's milk

According to the pastoralist's view of points, milk from each species has its own exceptional attributes and properties. Pastoralists claim that camel milk is better than the milk of other species. They gave many reasons for their preference of camel milk to milk of other domestic animals. Cows' milk tend to make people fat, that is, it causes obesity but camel milk gives strength, endurance and energies, an attribute that pastoralists need in order to pursue a nomadic life style. Unlike cows' milk, camel milk has medicinal values and can be used to treat a number of aliments in human beings. Besides, the pastoralists believe that camel milk keeps for a long time, it has high nutritional value, it contains higher levels of vitamins, it is easier to digest, and it quenches thirst. The informants also indicated that cow and sheep milk are sweeter than camel milk and have high fat content and thus suitable for butter-making (Knoess, 1979; Sisay, and

Awoke, 2015). Camel milk may be another good substitute for human milk (Konuspayeva, *et al.*, 2009a) as it does not contain β-lactoglobulin, a typical milk protein characteristic of ruminant milk (Laleye, *et al.*, 2008).

Camel milk has white color, normal odor and more similar to human milk than any other milk and differ from other ruminant animal milk because of its low cholesterol, low sugar, high minerals like sodium, potassium, iron, copper, zinc and magnesium, large concentration of insulin, Protective proteins mainly enzymes that have natural healing properties of the milk which may have possible role for enhancing immune defense mechanism, like (lysozymes, lactoferrin, immunoglobulin, lacto peroxidase, Peptidoglycan recognition protein) and the values of trace minerals were significantly higher in camel milk as compare to bovine milk (Kappeler, 1998; Agarwal, *et al*., 2004; Arrowal, 2005). Another crucial anti-allergenic factor is that the functional components of camel milk include immunoglobulins similar to those in human milk, which are known to reduce children's allergic reactions and strengthen their future response to foods (Shabo, *et al.*, 2005).

In Trace minerals like, iron, copper, zinc and manganese concentration in cow milk is naturally low and influenced by the presence of lactoferrin and xanthine oxidase transferase; however, Camel milk is the richest in these minerals (Al-Wabel, 2008). Iron, zinc, and copper in ruminant milk are related mainly to the casein fraction, whereas in human milk they are connected to soluble proteins (Raynal-Ljutovac, *et al.*, 2008).

Camel milk has power full antioxidant property because of high vitamin C. Camel milk contains high concentration of vitamin C (Haddadin, *et al.*, 2008). Camel milk contains 30 times more vitamin C than cow milk does, and 6 times more than human milk. This is highly important in desert areas, where fruits and vegetables are scarce. Therefore, camel milk is often the only source of vitamin C in the diet of inhabitants of Afar and Somali regions (park, *et al.*, 2007; Haddadin, *et al.*, 2008). In addition to this, camel milk has relatively low pH probably caused by high concentration of ascorbic acid (vitamin C). The low pH due to high vitamin C content stabilizes the milk and can be kept for relatively longer period of time. (Beg, *et al.*, 1986; Yagil, 1985; Farah, 1996). According to Yagil, (2000) Camel milk also contains high concentration of calcium (camel milk calcium content is 80mg%, cow's milk calcium 130mg% and human milk calcium 34mg%). However, high vitamin C concentration of camel milk (vitamin C content of camel milk 35mg/ml, cow milk 10mg/ml) helps the absorption of iron from the duodenum (Singh, *et al*, 2006). Camel milk also contains high concentration of vitamin B3 and vitamin B6 as compared to bovine milk (Stahl, *et al*., 2006; Haddadin, *et al.*, 2008). Cow's milk contains eight times less vitamin B12 and folic acid than camel milk does, this is another reason that cow milk diet consuming communities is thought to result in anemia rather than camel milk consumers (Jandal, 1996; Park, 2007; Raynal-Ljutovac, *et al.*, 2008).

Camel milk is used for treating dropsy, jaundice, spleen ailments, asthma, anemia and piles (Rao, *et al*., 1970). El-Agamy, *et al*., (1992) and El-Hatmi, *et al.*, (2007) reported that camel milk contains higher amounts of antibacterial substances (for example, lysozyme, lactoferrin, and immunoglobulins), anti-cancerous and antiviral activities as compared to cow and buffalo milk.

Ethiopia is one of the countries in sub-Saharan Africa pretentious by anemia, and contributes to high rates of infants, young child and maternal mortality. Some studies show that anemia is a wide spread problem in a pastoralist communities of Ethiopia. Like Somali and Afar regions, because pastoralists communities are heavily depend on animal milk consumption and milk are low in iron bioavailability (Belachew, 2005; kibangou, et al., 2005).

2.6.3. Cow's milk consumption and anemia

Cow's milk has long been considered as a highly nutritious and valuable human food and is consumed by millions of people daily in a variety of different products in the world (Ali, 2010). Cow's milk is an important component of the diet which is consumed without any taboo across the different parts of the country. It is also an economically important farm commodity and investment option for smallholder farmers in Ethiopia (Welearegay, *et al.*, 2012). It is reported that daily consumption of one liter of cow's milk furnishes an average human approximately all the fat, calcium, phosphorous and riboflavin, one third of vitamin A, ascorbic acid, and thiamine, one fourth of the calories, however, cow's milk contains low amount of iron, copper, ascorbic acid, manganese and magnesium, all the minerals needed daily (Pandey and Voskuil, 2011).

According to Stahl, *et al*., (2006) where reported to that the levels of vitamin A, E, and B1 to be low in camel milk compared to the cow milk, cow milk contains â carotene but lack in camel milk. On the other hand, The Vitamin C content in camel milk is two to three folds higher as compared to cow milk.

After 6 months of age young children are vulnerable to anemia because their diet tends to be low in iron and there is high iron requirement at this age for their rapid growth. Many studies have shown that the most important dietary risk factors for anemia was early introduction of Cow's milk to infants and to young children and the duration with this milk are strongly associated with reduced iron stores and an increased probability of IDA (Thane, *et al.,* 2000; Male, *et al.,* 2001; Thorsdottir, *et al.,* 2003). For every month of feeding with cow's milk, there was a reduction of 2 g/l in the Hb levels of children aged 12 months (male, *et al.,* 2001).

There are certain studies that have been exposed that, high cow's milk consumption in nature can cause high risk of anemia for children less than the age of 1 year (male, *et al.,* 2001; Assis., *et al.,* 2004). In a study done in Iceland involving 180 healthy infants, iron status at 12 months of age was found to be strongly negatively associated with Cow's milk consumption between 9 and 12 months of age (Thane, *et al.,* 2000). This is because cow's milk contains low amount of iron (2.6mg of iron per 1,000 kcl), especially poor amount of heme iron, the form which is best for iron absorption in the body. According to the experimental (Hallberg, *et al.,* 1991; Rossander-Hulthén and Hallberg, 1996) cow's milk consumption has the possibility of hindering the absorption of both the heme and non-heme iron in the other foods consumed by the child. It also contains low amount of vitamin C and high amount of calcium that can also inhibit iron absorption in the body (fairweather, 1992; olivars, *et al.,* 1999). In addition, casein is the protein which is mostly present in cow's milk that adversely influences iron uptake in the body (hurrel RF, *et al.,* 1988). Moreover, Wilson, *et al.,* (1974) were the first to recognize that the feeding of cow's Milk to infants and toddlers can lead to an increase in intestinal blood loss. Infants consuming with consistent Cow's Milk-induced blood loss lost, on average, 1.7 mL of blood each day the iron status of infant's highly consuming cow's milk was worse than that of infants consuming lesser amounts of cow's milk. Thus, the negative effect of cow's milk on iron status is dose dependent rather than all or none. This may advocate that consumption of lesser amount of cow's milk may not negatively affect the iron status of infants (Thorsdottir, 2003)

The Institute of Medicine, (2001) has estimated that the growing infant needs to have a net iron gain of 0.7 mg per day, and therefore needs to take in 7 mg of iron every day; the toddler needs to take in 11 mg/day. If the availability of iron from Cow milk were assumed to be 10%, the infant would have to consume 14 L of Cows milk every day to meet iron requirements. Clearly, neither infants nor toddlers can depend on Cow's milk to meet their iron needs. Rather, infants and toddlers depend on other foods or iron supplements to meet the body's demands for iron. In contrast, formulas that have iron concentrations between 6 and 12 mg/L easily meet infants' iron needs. Most complementary foods are low in iron unless they are fortified with iron. Fruits and vegetables are also low in iron content. Only meats and meat-containing infant foods contain appreciable amounts of iron, but they are only sparingly consumed by infants.

According to the studies which says that pastoralist communities in Ethiopia like Somali and afar regions anemia is higher prevalence since they consumed more milk and milk is lower in iron absorption (Belachew, 2005 and kibangou, *et al.,* 2005) this may be an indication for cow's milk consuming communities.

2.7. Increasing Dietary iron bioavailability

One of the main sources of ID is low bioavailability of dietary iron, especially in developing countries where diets are mostly cereal- and legume-based (Zimmermann, *et al.*, 2005). Iron absorption depends on its part of dietary source (Theil, 2004).

There are two forms of iron foods, heme iron which is originated only foods derived from animal flesh such as meat, poultry and fish (Saunders, *et al.*, 2012). Although heme iron accounts for about 10% but its absorption is substantial for about 25%. Non heme iron which is found in both plant and animal foods, Non heme iron accounts a large proportion for about 90% but it's less well absorbed only almost 17%, depending on dietary factors and body's iron stores (Committee on Dietary Reference Intakes, 2001) in ID, the absorption of iron upsurges, while iron overload absorption falls (Miret, *et al.*, 2003).

A good source of iron like fish, meat and poultry contains not only the well absorbed heme iron but also a peptide called Meat, Fish and Poultry (MFP) factor that promotes the non heme iron from other foods eaten at the same meal (Hurrell, 2006). Vitamin C is also the only other food rather than meat that enhances iron absorption of non heme iron foods in humans, by capturing the iron and keeping it in the reduced of ferrous form, ready for absorption. The simplifying effect of vitamin C is directly associated with dose (Cook and Reddy, 2001). Other traditional effective ways of increasing iron bio-availability includes germination, soaking, fermentation and malting of grains, a process which activates phytates that breakdown phytic acid as this is the most important anti-nutrient that inhibits iron absorption (Jain, 2013; Hunt, 2003).

Scholarships examining methods to increase iron content and bio-availability have focused mainly on bio-fortification strategies using marker-assisted breeding, improved agronomic practices, and removal of the seed coat from lentil seed (Della valle, *et al.*, 2013; Khazaei, *et al.*, 2017). Yet, iron bio-fortification of food crops has numerous disadvantages, such as low bioavailability, limitations to increasing the total content in food crops, and insufficient consumption to show significant health benefits. The bioavailability of iron from lentil is often compromised due to the presence of anti-nutritional factors (e.g., phytate, polyphenols, cotyledon cell wall) in the seed (Grusak, 2009; Glahn, *et al.*, 2016). Fortification, on the other hand, often can overcome the inhibitors and provide significant bioavailable iron (Hurrell, 2002) as long as the addition of iron does not alter the appearance and taste of the target food product.

2.11. Dietary iron bioavailability inhibitors

Several dietary factors can influence the absorption of iron. Thus, inhibiting factors are mostly found in plant based diets like vegetables, cereals, legumes, tea and coffee and compounds which are present in this foods and highly inhibit iron absorption includes phytates, polyphenols and calcium (Itske, *et al.*, 2000).

2.11.1. Phytates

In a plant based diets, absorption and bioavailability of dietary iron can be considerably decreased by the phytic acid (Hunt, 2003). The chemical components found in phytates are called myo-inositol hexakisphosphate salts and found in all kinds of grains, seeds, nuts, vegetables, fruits and roots like potatoes. Other foods contain chemical entities called ligands that strongly and irreversibly bind ferrous ions and thus inhibit absorption. Phytates and phosphates in bran products, bread made from high extraction flour, breakfast cereals, oats, rice, especially unpolished rice, pasta products, cocoa, nuts, soya beans and peas contain high amounts. The negative effect of phytate on iron absorption has been shown to be dose dependent and starts at very low amount of meal. Cereals and legumes often have high contents of inhibitors of mineral absorption, including phytates and polyphenols which inhibit zinc and iron absorption by forming insoluble complexes in the intestine. Subsequently, the availability of these micronutrients from diets based on cereals and legumes is often poor (Minihane and Rimbach, 2002).

Therefore, such dietary components are thought to be in part responsible for the low absorption efficiency of iron and high incidence of IDA evident in most developing countries, where largely vegetable and cereal diets consumed (Luo and Xie, 2012). Several studies indicate that there is a reduction of non-heme iron absorption at marginal dietary iron supply due to phytic acid in humans and mono gastric animals. In addition phytic is also known to inhibit the availability of other divalent minerals such as Zinc and Magnesium (Minihane and Rimbach, 2002). It has been also displayed that completely removing phytates from cereal based diets increases the percentage of iron absorption as much as 12 folds. Still it is not practical to remove completely from those foods instead WHO recommends that to use sodium iron with ethylene Diamine Tetra acetic Acid (EDTA) in fortification like flour (Zemmerman, 2013)

2.12.2. Polyphenols

Polyphenols occur in various amounts in plant foods and beverages such as vegetables, fruits, cereals, tea, coffee, wine, and legumes (Mascitelli and Goldstein, 2011). In low income populations ID is wide spread due to low consumption of meat and high consumption of cereal grains and legumes which contain inhibitors of iron absorption. Therefore, a major cause of ID is low bioavailability from plant based diets containing iron bioavailability inhibitors such as polyphenols (Tako, *et al*., 2014).

Inhibitors, Phytic and polyphenolic compounds can be strong inhibitors of iron absorption, forming unabsorbable complexes in the gut lumen. The effect of polyphenols on inhibiting iron absorption has largely been demonstrated, but the ability of complex formation with iron in the intestine and there by the reduction of iron uptake into the body depends on their structure

(Petry, *et al.,* 2010). The phenolic compounds are released from food or beverages during digestion and can combine with iron in the intestinal lumen making it unavailable for absorption. Polyphenols are such powerful inhibitors of non heme iron that substantially changes in the amount of iron absorbed. It was noticed that a single serving of coffee contains 120mg of polyphenols. At comparable amounts the polyphenols from black tea were shown to be more inhibiting than the polyphenols from herb teas and wine (Mascitelli and Goldstein, 2011).

2.12.3. Calcium

Absorption of iron can be inhibited by the presence of calcium in the same food; the larger the dose of calcium especially in supplements, the greater the reduction of the absorption of both heme and non heme iron (Hunt, 2003). Calcium is the only dietary factor found to inhibit the absorption of both heme and non-heme iron. Maximal inhibition of non-heme iron absorption (50%) has been shown to occur at a 300mg dose of calcium. This inhibitory effect may present a public health problem because of the recommendations by the Institute of Medicine and National Institute of Health for the stoppage of osteoporosis has led to widespread use of calcium supplements and fortificants. These practices may exacerbate the effect of marginal iron intakes (Roughea, *et al.,* 2005). Recently, it was suggested that the inhibition effect occurs during initial uptake in to the enterocytes. In contrast to iron, calcium absorption can occur throughout the intestine, when the intakes is low, Trans cellular transport in the duodenum is up regulated, entry into duodenal cells occurs across the brush borders down an electrochemical gradient via calcium channels (Lynch, 2000).

2.12. Nutrition problems in pastoralist communities

Malnutrition is increasingly recognized as a prevalent and important health problem in many countries. This problem has serious long-term consequences for the child and adversely influences development of a nation. Most common nutritional problems are Protein Energy Under-nutrition (PEU), iron deficiency anaemia (IDA), iodine deficiency disorders (IDD) and vitamin A deficiency (VAD) (ACC/SCN, 2000).

According the Central Statistical Agency (CSA, 2005), immediate consequences of poor nutrition during the early formative years include significant morbidity and mortality and delayed mental and motor developments. Malnutrition at the early stages of life can lower child resistance to infections (Leonor, *et al*., 2011). Furthermore, the potential negative impact of child malnutrition goes beyond the individual, affecting society and future generations (Victora, *et al.*, 2008; Grantham-McGrgor, *et al.*, 2007).

There are numerous features which contribute to malnutrition that have been identified, including poor breastfeeding and child feeding practices (Stalin, *et al.*, 2013; Ahmed, *et al.*, 2012; Muhimbula and Issa-Zacharia, 2010; Anderson, *et al*., 2010), lack of access to enough nutritious food (Lang'o, 2011), low levels of parental education (Rayhan, 2006; Janevic, *et al.*, 2010; Wijaya, 2011) and belonging to the low-income group (Reji, *et al.,* 2011; Idris, 2007; Eticha, 2007). Moreover, lack of access to health services (Lang'o, 2011 and Wijaya, 2011), and poor follow up of antenatal services (Stalin, *et al.,* 2013) were also recognized as a key determinant of child malnutrition. Besides, nutritional status is clearly compromised by diseases (Blössner and de Onis 2005), such as HIV-infection (Arinaitwe, *et al.,* 2012), parasitic infection (giardia) (Sackey, 2001), diarrhea and other illness including fever, cough, common cold, pneumonia, ear infection, and/or skin diseases (Ahmed, *et al.,* 2012; Wijaya, 2011; Hasanain, *et al.,* 2012; Njuguna and Muruka, 2011).

Ethiopia, is one of the developing countries, its rate of child malnutrition is one of the highest, even within Sub-Saharan Africa (Mekonnen, 2005). According to EDHS 2016, pastoralist communities of Somali and Afar regions wasting is the most prevalent compared to other regions of the country which is 23% and 18% respectively. Similarly, EDHS 2011, wasting prevalence in Somali region is the highest among the other regions of the country which was 18%. Moreover, the Newborn and young child feeding practices in the region were stated to be poor as compared to the other regions of Ethiopia.

Nomadic pastoralist lifestyle is based on their animal products. However, seasonal variations affect their diet intake, where milk is consumed in a short wet seasons and people turn to cereals as pastoralists sell livestock (usually goats and sheep) to purchase cereal meal, sugar and tea, which yield little more than immediate calories and stimulant to avoid hunger (Galvin and Little, 1999).

2.13. Water, hygiene and sanitation in pastoralist community

Cairncross, *et al.,* (2010). suggested that a 48% reduction in the hazard of diarrhoeal disease is related with the use of soap for handwashing at key times and risk reductions of 17% and 36% from improved water quality and excreta disposal, respectively. Achieving health benefits through handwashing with soap in particular requires sustained behaviour change and remains a major challenge (Curtis, *et al.*, 2011).

Shortage of safe drinking Water and deprived Sanitization and Hygiene (WASH) practices are directly related to malnutrition through three different reasons: via diarrheal diseases, intestinal parasite infections and ecological enteropathy (Cumming, *et al.*, 2015). Walking long distances for finding water and hygiene services also distracts the care givers time absent from the child care later affecting negatively on their nutritional status (WHO, 2015). Adequate water, proper sanitation and hygiene have the ability to prevent atleast 9.1% of the global burden of diseases and 6.3% of all deaths (CDC, 2015). Deprived nutritional status of rural and mobile pastoralist communities is exacerbated by lack of drinkable water and unsanitary conditions, which increased parasitic infection rates, particularly among young children and their mothers (Bechir, *et al.*, 2011a, b).

Adequate amount of WASH facilities are very significant mechanisms in providing of crucial health services. Sufficient water, appropriate sanitation and hygiene facilitates improves the nutritional status in two main methods, the first reason is being reduction in the occurrence of diarrhea diseases and the second reason is the lessening of the pathogens load found in the environments with poor WASH status (USAID, 2015).

In Ethiopia improved source of drinking water and sanitation facility of rural areas including pastoralists are very low compared to urban areas. According to EDHS 2016, use of improved drinking water sources is more common among households in urban areas 97% than among those in rural areas 57%. In rural areas, the most common sources of drinking water are public tap or standpipe 19%, a tube well or borehole 13% and a protected spring 14%. More than 9 in 10 households 91% do not treat their drinking water; this is more common in rural than in urban areas 92% versus 88%. The most commonly used method of water treatment is adding bleach or chlorine 3%. Overall, 7 percent of households use an appropriate treatment method. Half of households in urban areas 50% use an unimproved toilet facility, compared with more than 94% of households in rural areas.

2. Material and methods

This chapter presents characteristics of study area, study design, sources population, sampling method and sample size determination, methods of data collection, analysis, and ethical consideration and study variables

3.1 Descriptiopn of study area

The study was carried out in pastoralist areas of Somali regional state, Ethiopia. The region is the second largest next to Oromiya in the country covering an area of about 350,000 km^2. The Region inhabits the eastern and south eastern part of Ethiopia and lies between 7^0 and 26'19.43" N latitude and 44^0 and 17'48.75"E longitude. The region has 11 administrative zones containing 93 woredas (districts). It shares borders with Somalia to the east and south east, Kenya to the south and Djibouti to the north. It also shares borders with the regions in the country like Oromia to the west and Afar to the northwest. According to the CSA, (2017) report, the population is estimated 5.7 million; among of this only 13.9% reside in urban areas.

3.2 Study design and sampling technique

A cross sectional community based design was used primarily; four woredas (Danan, Gursum, Ararso and Babili) from three different zones (Shabele, Fafan and Jarar) of Somali region were purposively selected. Then one village from every selected woreda were purposively selected based on a prehand information on the type of livestock they have thus type of predominatly milk consmuned.House to house visit was conducted to recruit 6-59 mo old children. Child's age was obtained from the parents or the caregivers.

3.3. Source population

All children aged 6-59 mo living in pastoralist areas of Somali region

3.4. Study population

All 6-59 mo children from Danan, Gursum, Ararso and Babili woredas of Somali region

3.5. Sample size determination

Sample size was determined by the following formula. Single population proportion formula was used to determine standard sample size for the study. According to the EDHS (2016), Prevalence of anemia in Somali region was 82.6% thus; the study population can be calculated as follows:

$$n_o = \frac{\left(Z_{\alpha/2}\right)^2 \times P(1-P)}{d^2}$$

$$n_o = \frac{(1.96)^2 \times 0.826\,(1-0.826)}{(0.05)^2}$$

$$n_o = 221$$

Where, n_o = estimated number of representative sample size

z= standard normal variable at 1.96 and confidence level 95%

p= population proportion of anemic children

d= Margin error

α=0.05

Using Design Effect (DEFF) as a default values to enlarge the sample size = 221×1.5= 332

Therefore; the total sample size of the study population was = **332**

3.6. Inclusion criteria

- All children between 6-59 mo of age who lived the selected *kebeles* within the period of blood and data collection and drinks predominantly cow's milk or camel's milk were included in the study.

3.7. Exclusion criteria

- Children who were sick during blood collection

- Children who were difficult to measure their height (disabled children) were also excluded in the study.

3.8. Anthropometric measurement’s

Body weight was measured using a digital scale provided by UNICEF, while children wore light cloths and barefooted. The scale was adjusted to read zero before starting the measurements. The weight reading was recorded twice. The length/ height of children were measured using a wooden board attached to a measuring tape using stadiometer. Mid-Upper-Arm Circumference (MUAC) was also measured by measuring at the mid-point between the tip of the shoulder and the tip of the elbow (Talc Ltd, St. Albans, UK).

3.9. Data collection

This study was based on 332 children living in a pastoralist area of Somali region, eastern Ethiopia. The study subject was divided in to 2 groups based on the type of milk they predominantly consumed 166(50%) children predominantly consumed camel’s milk and most of them was carried out in Danan and Babili woredas which is in shabele and fafan zones respectively. Because camel milk consuming children was largely available in this woredas and 166(50%) children predominantly consumed cow’s milk and majority of them was recruited from Ararso and Gursum woredas which is in jarar and fafan zones respectively, because mostly cow’s milk predominantly consuming community was presented in this zones. Teachers and nurses from the woredas (districts) were recruited to collect data. One day training was given to the data collectors. Variables such as socio-demographic and economic characterstics of households were collected by applying interview technique. In addition, informations related to water and sanitation of the households or the study children were collected by observation and interview. The questionnaire was prepared in English and translated to Somali language then back translated to English for consistence. The questionnaire was pretested in households in neibouring kebeles.

Hb concentration was determined on site by Hemo Cue [HaemogloBinometer (HB) 301]. This system comprises of battery operated photometer and disposal microcuvatee, coated with a dried reagent that serves as the blood collection device. After the investigator wears a gloves for protection the child’s middle finger or ring finger was cleaned with sterile cotton immersed in

70% alcohol before pricking and then was pricked with a sterile disposal lancet, the first 1-2 drops of blood was wiped off with a cotton wool, to keep the accuracy and finger pressured again to get another continuous and a full drop of blood and allowed to enter the testing micro cuvette and then when the hemocue shows the three dashes, the micro cuvette was placed in to the hemocue and the result of Hb level was recorded (Kejo, *et al.*, 2018). Hb level was measured as g/dl, according to EDHS (2016), children with Hb level <11.0 g/dl were considered anemic and graded as mild anemic (10.0-10.9 g/dl), moderate anemic (7-9.9 g/dl) and sever (<7 g/dl).

3.10. Dietary assessment

Dietary intake was assessed by 24 hr recall method. Caretakers were asked to report the type of food and drinks the child consumed 24 hrs preceeding the survey. However, serving sizes of food items were not collected, except for milk

Caregivers were asked to report the type of milk the children were predominatly consumed. In addition, the mothers were asked to estimate the average volume of daily milk consumption. Different containers commonly used by the children to consume milk were used to help the mothers estimate the quantity of milk consumption. The quantity was estimated by transferring water from the local containers in to a measuring cylinder (Swindale and Bilinsky, 2006).

3.11. Statistical analysis

Statistical analysis was conducted using SPSS software version 20. Descriptive statistics was used to present the percentage and frequency of the result. The Odds Ratio (OR) was perfomed to test the association of camel's milk or cow's milk consumption and anemia prevalence and important health variables. Stepwise backward binary logistic regression model was applied to test the association of Hb with various socio demographic and important health variables and also all other varaibles. $P < 0.05$ was considered to determine statistical significance. Before applying binary logistic regression, the presences of multicollinearity among the independent variables were diagnosed using Variance Inflation Factor (VIF) and Condition Index (CI). Independent samples t-test was also used to test whether the variances (variation) of scores for the two groups (camel or cow milk consuming children) are the same or different significance in the mean scores. The anthropometric data was converted into standar dized Z-score; Weight for Age Z-score (WAZ), Height for Age Z-score (HAZ) and Weight for Height Z-scores (WHZ) using WHO Anthrosoft ware and the data were used to classify the study participants children into categories of nutritional status, using WHO reference arcs (WHO, 2006), children WAZ <-2, HAZ <-2 and WHZ <-2 were regarded as underweight, stunted and wasted respectively. Wealth is substantially livestock-based in pastoralist communities. Therefore, the number of household cattle, camels, and small livestock were calculated into livestock units for sub-Saharan Africa, a measurement developed by FAO, to adjust for the feed requirements of different types of livestock (FAO, 2003). Under this arrangement, individual cattle are multiplied by 0.5, sheep and goats by 0.1, and camels by 1.10 and the total added together. FAO guidline for measuring individual dietary diversity was used to assess diversity of childrens food intake (Kennedy et al., 2011). The dietary diversity score (DDS) was formed by summing the diverse food groups (grains, roots or tubers, legumes, nuts or seeds, dark green leafy vegetables, other vitamin A rich fruits and vegetables, other fruits and vegetables, organ meats, meat and fish, milk and milk products, eggs) expended for the last 24 hrs recall period. DDS was assigned 1 point if the child was consumed one or more food items in a group and 0 if not consumed foods from the food groups. The childrens DDS was further classified into three intake levels as low (1-2 food groups), medium (3-4 food groups) and high (5-8 food groups). The Hb values were adjusted for altitude according to the formula through Sullivan *et al.*, (2008).

3.12. Equation of the model varaibles

Y=βi + β1 HH farm land + β2 HH Waste disposal + β3 HH Type of Toilet+ β4 HH source of water+ β5 Age of the children + β6 WAZ+ β7 HAZ + β8 DDS+ β9 Child camel milk+ β10 Child cow milk+ β HH number of livestock

Where:

HH	House Hold
WAZ	Weight for Age Z score
HAZ	Hieght for Age Z score
DDS	Dietary Diversity Score

3.13. Ethical consideration

Ethical approval was obtained from Addis Ababa University, Institutional Ethical Review committee for College of Natural and computational Science. Support letter was also obtained from Somali Regional State, Health Bureau. The purpose, benefit, potential harm and confidentiality of the study were explained to the parents of the study children. Written consent was obtained from mothers or gardians children. .

3.14. Study variables

- Independent variables of the study were socio-demographic and economic characterstics, anthropometery, water, sanitation and hygiene, and dietary characterstics. Hb concentration was considered as a dependant variable.

4. Results

4.1. Socio-demographic characterstics

A summary of socio-demographic and economic characterstics of the study participants is indictaed in Table 1. Children were in the age range of 6 to 59 mo with mean value of 33.3±17.1.Almost all participants in this study (99.4%) were Somali. In general, household heads had low educational status.

Majority of the participant's posse's farm lands (62.0%) and produce both sorghum and maize (27.7%) or maize alone (23.2%) or sorghum only 10.5% and 0.6% produced nuts.

Table1. Socio-demographic and economic characteristics of children (n=332) from pastoralist community of Somali region, Ethiopia 2018.

Variable		n	%
Sex	Male	145	43.7
Ethnicity	Somali	330	99.4
	Oromo	2	0.6
Father's job	Herdsman	129	38.9
	Farmer	107	32.2
	Un employed	77	23.2
	Others*	19	5.7
Mothers job	House wife	300	90.4
	Un employed	32	9.6
Fathers formal education	Yes	31	9.3
Mothers formal education	Yes	4	1.2
Possession of farm land	Yes	206	62.0
Common crop production	Maize and sorghum	92	27.7
	Maize	77	23.2
	Sorghum	35	10.5
	Nuts	2	0.6

*merchant, civil servant, private employee, daily laborer and fathers who were died, n indicated frequency % indicated percentage.

4.2. Water, sanitation and hygienic practices

Summary of water, sanitation and hygeine in the study participants is showed Table 2. Majority of the study households (88.6%) used unprotected dug well, and only few (4.8%) had access to pipe water.

In addition**,** 63.6% of housholds dispose household wastes improper places. Almost all house holds (96.1%) used natural places for defecation. Nearly half of the mothers or guardians 48.2% used hand washing with soap before feeding the children.

Table2. Water, sanitation and hygeine in apstoralist children (n=332) of Somali region, Ethiopia 2018.

Variable		n	%
Source of water	*dug well	294	88.6
	*Birka (borehole)	22	6.6
	A pipe water	16	4.8
Place used for Waste disposal	Every where	211	63.6
	Burned	121	36.4
Type of toilets	open air defecation	319	96.1
	defecate home toilet	13	3.9
Hand washing with soap	Yes	160	48.2

*indicated unprotected

4.3. Nutritional status of the study children

According the proportion of prevalence of malnutrition by its degree of severity in the current study indicated 16.9% and 22% were moderately and severely underweight respectively, 16.3% and 16.9% were moderately and severely stunted correspondingly, 19% and 17.5% were moderately and severely wasted separately. As shown in Table 3.

Table 3: Nutritional status of the study children (n=332) from pastoralist community of Somali region, Ethiopia 2018

Variables	Category	%
Weight for age	Moderate under weight	16.9
	Severe under weight	22
Height for age	Moderate stunting	16.3
	Severe stunting	16.9
Weight for height	Moderate wasting	19
	Severe wasting	17.5

4.4. Anthropometric and Hb characterstics of the study children

Table 4 summarizes the anthropometeric and Hb characteristics of the study children. The minimum weight of the study children were 3kg, the maximum wer 22.3kg with their mean were 11.3kg and the minimum height of the children were 52 cm the maximum were 120cm and their mean was 87.4cm and the minimum MUAC was 11cm, maximum were 13cm with their mean were 11.45cm.

The percentage degree of anemia prevalence in the current study, presented 16.9%, 45.8% and 14.8% were mild, moderate and severe anemic in that order.

Table4. Anthropometric characteristics and Hb of children (n=332) from pastoralist community of Somali region, Ethiopia 2018.

Variable	Minimum	Maximum	Mean	Std. Deviation
Weight (kg)	3.0	22.3	11.3	3.9
Height (cm)	52.0	120.0	87.4	15.3
MUAC measurement of the child	11	13	11.45	.544
Weight for age Z score	-7.8	4.1	-1.5	1.8
Height for age Z score	-8.5	7.5	-1.2	2.1
Weight for height Z score	-8.1	12.0	-1.2	2.2
Hemoglobin (g/dl)	3.2	13.9	9.2	2.0

4.5. Dietary characterstics

Maize, wheat, sorghum and rice are the foods commonly consumed in the study households. There was no meat, fish and eggs consumtption and there was low consumption of other animal products (0.3%) legumes (0.6%), and fruits (40.7%). This finding revealed that there were low dietary characteristics in the study children. (As Table 5 showed)

Table5. Dietary characteristics of children (n=332) from pastoralist community of Somali region, Ethiopia 2018.

Food item	n	%
Maize	216	56.1
Rice	63	19.0
Wheat	209	63.0
Sorghum	191	57.5
Potato	14	4.2
Onion	204	61.4
Garlic	9	2.7
Tomato	131	39.5
Lemon	4	1.2
Peas	1	0.3
Lentil	1	0.3
Cheese	1	0.3
Tea	307	92.5
Edible Oil	239	72

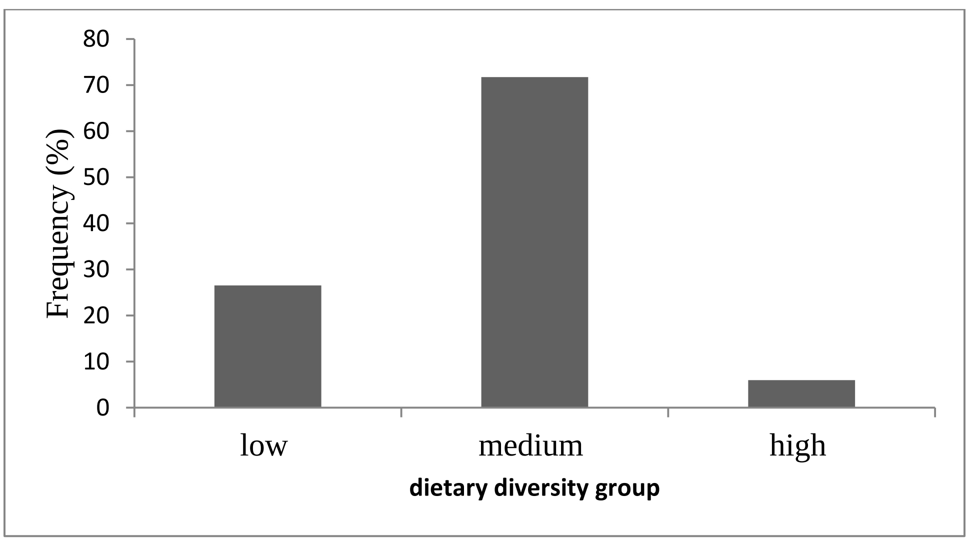
4.6. Dietary diversity score

Summary of dietary diversity score of children (showed) in Table 6. almost all children (100%) consumed milk and milk products, than the other food groups that the children mostly consumed was like cereals, tubers or roots (86.7%), edible oils (72.6%) and other vegetables (61.4%) and the lowest food groups were legumes (0.6%) and other fruits (1.5%).

Table6: Dietary diversity score of children (n=332) from pastoralist community of Somali region, Ethiopia 2018.

Food groups	n	%
Cereals, tubers or roots	288	86.7
Other vegetables	204	61.4
Other fruits	5	1.5
Legumes	2	0.6
Milk and milk products	332	100

Figure1: Dietary diversity groups



We can see in the above Figure that 71.7% of the children lie in the medium dietary diversity followed by 26.5% in the range of low dietary diversity goup and 6% in a high dietary diversity groups. There was lower dietary diversity in pastoralist community of Somali region.

4.7. Age of the children and prevalence of anemia

Table 7 sumarizes the age of the children compared with anemia prevalence of the study participants children. As the age of the children increase the percentage of anemia decreases from high of 92.7% amongst the children aged 6-12 mo to low of 53.3% at the age of 49-59.

Table7: Age and prevalence of anemia of children (n=332) from pastoralist community of Somali region Ethiopia 2018.

Age	n	% of Anemia prevalence
6-12 mo	82	92.7
13-24 mo	57	87.7
25-36 mo	76	81.6
37-48 mo	72	62.5
49-59 mo	45	53.3

Table 8: Group Statistics

Dependent variable	What type of milk does the child drinks?	N	Mean	Std. Deviation	Std. Error Mean
Hb	Camel's milk	166	9.3063	1.86758	.14495
	Cow's milk	166	9.2440	2.25713	.17519

Table 9: Independent samples test

		levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig	t	df	sig.(2-tailed)	mean difference	std.Error difference	95% C.I. of the Difference	
									Lower	Upper
Hb	Equal variances assumed	6.347	.012	.274	330	.784	.06230	.22738	-.38500	.50960
	Equal variances not assumed			.274	318.826	.784	.06230	.22738	-.38505	.50966

Interpretation of output from independent-samples t-test

Step 1: checking the information about the groups

In the group statistics Table 8 showed the mean and standard deviation for each of the group (in the case of camel's/cow's milk consumption)**.** It also gives the number of children participated in each group (N).

Step 2: checking assumptions

The first section of the independent variable samples test output Table 9 gives the results of the Leven's test for equality of variances. This tests whether the variances (variation) of scores for the two groups (camel or cow milk consuming children) are the same or different significance in the mean scores. So Table 9 revealed that significance level of Levene's test is P=0.01 this is less than the cut-off of 0.05. This means that the assumption of equal variances has been violated. Therefore, Equal variances not assumed.

Step 3: Assessing differences between the groups

In Table 9 presented that the sig. (2-tailed) value is 0.784. As this value is above the required cut-off of 0.05 there is not statistically significant difference in the mean of Hb concentration scores between camel/cow milk consuming childre.

Step 4: calculating the effect size for independent samples t-test

There are a number of different effect size statistics, the most common used being eta Squared and Cohen's d. Eta squared can be calculated using the information provided in table 9.

The formula for eta squared is as follows:

Eta squared = $t^2/t^2 + (N1+N2-2)$

Replacing with the appropriate values from the examples of table 8 and 9

Eta squared = $0.274^2/0.274^2 + (166+166-2) = 0.0002$

According the guidelines proposed by Cohen (1988) for interpreting this value is:

0.01= small effect

0.06 = moderate effect

0.14 = large effect

For the current example the effect size of 0.0002 is very small. Expressed as a percentage of 0.02% of the variance in Hb explained by camel's or cow's milk consuming children.

Table 10: Relation ship between independent varaibles and dependent variable

Variables	β	S.E.	Wald	Df	Sig.	Exp(β)	95% C.I. for Exp(β)	
							Lower	Upper
HH farmland(not having farm=2)	.658	.290	5.136	1	.023	1.930	1.093	3.410
Waste disposal (impoper place=2)	.750	.299	6.307	1	.012	2.118	.263	.848
Type of toilets (open air places=1)	.490	.780	.394	1	.530	1.632	.354	7.531
Source of water(pipe water=1)	-.243	.818	.088	1	.767	.785	.158	3.899
Age of the child	.051	.009	31.086	1	.000	1.052	1.034	1.071
Wieght for Age Z score	.251	.079	10.080	1	.001	1.285	1.101	1.500
Hieght for Age Z score	.254	.067	14.419	1	.000	1.289	1.131	1.470
DDS	.186	.125	2.226	1	.136	1.205	.943	1.540
Child camel milk perday	.000	.000	.097	1	.755	1.000	.999	1.001
Child cow milk perday	.000	.001	.037	1	.847	1.000	.999	1.001
number of livestock	.008	.017	.225	1	.635	1.008	.975	1.042

a. Variable(s) entered: Child age, HouseHold (HH) farmland, child camel milk per day, child cow milk per day, Weight for age z score, Height for age z score, DDS, Waste disposal, Type of toilets, Source of water, number of livestock tha the households has.

4.8. Summary of the logistic regression results

Direct binary logistic regression was performed to assess the impact of a number of factors on the likelihood that may contribute to anemia. The model contained elevan independent variables (age of the children,house hold farmland, waste disposal, type of toilets, source of water, weight for age Z score, height for age Z score, Dietary Diversity Score, camel's milk consumption, cow's milk consumption, number of livestock that the household owns). As a result, five of the independent variables made a unique statistically significant to the model (age of the children, house hold farmland, waste disposal, weight for age z score and height for age z score). And the rest of the explanatory variables were not statistically significant contributors to the model.

5. Discussion

Acommunity based cross sectional study revealed that households not having farmland were significantly, but positively associated to Hb concentration. Therefore, as the household's having farmland increased the likelihood of children to be non-anemic increases by 1.930 times.

A previous study by Welch, et al. (1997) stated that agriculture is the primary source of all micronutrients that human feeds, in addition, agricultural system contributes functional foods that satisfied the nutritional needs of evey one. Additionally, Welch, (2001) reported that limiting food crop diversity and producing cereal monocultural system and traditional foods appear to contribute micronutrient malnutrition. Modern agriculture can contribute to increase the out put of micronutrients to staple food crops from farming system (Welch, 2001). In recent decades in east Africa the shifting from formerly pure pastoral families to agro-pastoralism on farms to pursue alternate economic strategies including cultivation, increases the economic resource base, that allows them to relieve seasonal fluctuation of food availability and endure during periods of severe drought (Little et al. 2001; McPeak and Little 2005). Pastoralist communites are highly vulnerable to food insecurity and the settings are worsened by fundamental causes, external shocks such as recurrent drought, floods etc this is very much associated and internal competences to cope, this is very much associated with structural conditions, rendering some populations more vulnerable to acute food shortages, such as poverty, lack of basic services, etc. (UNICEF, WHO, UNESCO *et al.,* 2010). Another study in southern Ethiopia, by Lindtjorn, (1993) observed a more quick improvement in nutritional status of pastoralist Boran children after the start of rains compared to children living in a Boran agricultural community. He found that outside of drought years, the pastoral livelihood is more resilient to seasonal variations as milk yields increase much more quickly than food production from cereals once rains arrive.

The current Study revealed that waste disposal to improper places was significantly associated with Hb concentration on the regression model. Compared the children whom their households waste disposal in everywere or in apropriate places, the odds of non anemic were 2.118 times increased to those children whom their households wastes the disposal in apropriate places.

Because throwing wastes in everywhere spoils the environments and causes pathogens and intestinal parasites that can contribute to diarrhea as well as anemia.

Previous Study by Dewey and Adu-Afarwuah, (2008) stated that even though stunting and anemia are mutually obviously linked to malnutrition, dietary interventions alone have not normalized growth in children from low-income environments. The primary causal path way from poor sanitation and hygiene to stunting is environmental enteropathy over increasing permeability inflammatory and modest malabsorptive and impairs absorptive and barrier functions of the small intestinal mucosa lining, causing growth retardation (Haghighi and Wolf, 1997). Chronic immune stimulation arising from environmental enteropathy may also be the underlying cause of anemia (Weiss and Goodnough, 2005). Inflammation disturbs iron homeostasis by decreasing iron absorption and by diversion of iron from the circulation into storage sites of the reticuloendothelial system; consequently inflamation limits the availability of iron for the erythropoiesis and also reduces plasma (Weiss and Goodnough, 2005)

The current Study shows that most households obtained unprotected water and defecate natural places. However, in the current study source of water and the type of toilets were statisticaly not significant with Hb. The reason can be sample difference with the previous studies.

According to the Ethiopian Ministery of Health, (MOH, 1998/99), Ethiopia has sub-obtimal social conditions including WASH, housing, education and under the poverty line, the level of communicable diseases is found to be the highest magnitude. Shortages of WASH practices are directly related to malnutrition and anemia through three different reasons: via diarrheal diseases, intestinal parasite infections and ecological enteropathy (Cumming *et al.*, 2015). House holds who have access to safe drinking water and latrines are considered to be safe from pathogenic micro-organisms that can be the risk factor for diarrhea and anemia (WHO, 2000). Many risk factors potential to poor hygiene in developing countries have bean explored and identified to cause inadequate cognitive stimulation, stunting, iodine deficiency, and iron-deficiency anemia as key risks that prevent children from achieving their developmental potential (Engle, et al., 2007; Walker, et al., 2007). EDHS, (2016), stated that improved source of drinking water and sanitation facilities of rural areas in Ethiopia are very low. Consequently, deprived conditions of WASH are associated with 6.6% of the global burden of disease and disability, and 2.4 million deaths annually due to diarrhea, subsequent malnutrition and their consequences (Pruss-Ustun, *et* *al.*, 2008). Besides, contamination of the domestic environment with animal and human feces in poor households is universal. Human and animal feet carry feces deposited in the open air places, bringing diverse microbes and pathogens into the domestic environment and the immediate neighborhood of infants and young children (Curtis, *et al.*, 2000). Fecal contamination of children's play and feeding environments is a constant and cumulative health risk during the critical window of a child's growth and development (Ngure, *et al.*, 2013).

This Study revealed that as the age of the children increased, the odds to be non-anemic increased by 1.052 times, therefore, as the children gets older their ability of adapting the household food as well as their Hb concentration increased and their vulnerability to anemia decrease.

The current finding were similar to EDHS, (2016), which showed the prevalence of any anemia decreases with the age of the child increases after 6 months of age from a high of 77% among children age 6-11 months to a low of 40% among children age 48-59 months. Another observation by Silva, *et al.*, (2001) stated that children aged 6 to 24 months present greater vulnerability to anemia, due to their rapid growth. In addition Osorio, et al., (2001) also described that the situation is even more serious in the 6 to 11 months age group with prevalence rates that reach up to 79% in rural areas. The fact that, these age periods corresponds with the maximal risk of iron deficiency, due to support of their body growth the iron requirements during this period are greater than at any other time of life (Rawat, *et al.*, 2013). Children above two years are intelligent to eat more variety of foods, which makes them at less risk of being anemic (Elkishawi, *et al.*, 2015). Complementary foods are started when the children reach 6 months, if nutritionally poor complementary foods were introduced children were more likely to be anemic (Tatala, *et al.*, 1998).

According the the overall malnutrition prevalence among under five children in the study area was 38.9%, 33.2% and 36.5% in underweight, stunting and wasting respectively. Hence, under weight was the highest form of malnutrition recorded in this study (38.9%) and stunting was the lowest prevalence 33.2%. In addition, the number of stunting was similar with the finding of EDHS, (2011) in Somali region that the prevalence of underweight, stunting and wasting were

33.5%, 33% and 22.2% correspondingly. Inconclusion, the current study showed higher prevalence of malnutrition compared to the EDHS, (2016) finding from Somali region that the prevalence of underweight, stunting and wasting were 22.7%, 27.4% and 28.7% respectively. Besides, the current finding prevalence was lower with the study done by Demissie and Worku, (2013) and carried out in a pastoralist community of Dolo Ado woreda Somali region, found that the prevalence of wasting, underweight and stunting was 42.3%, 47.7% and 34.4% respectively.

Generally, anemia prevalence in this study finding was 77.4%, this is higher than the national average 57% (EDHS, 2016). But lower than the EDHS, (2016) finding in Somali region, which showed 82.6%. However, similar with the EDHS, (2016) finding from pastoralist community of Afar region which was 73.2%. In addition, similar another study in Mwanza Tanzania, which showed 77.2% prevalence rate of anemia (Simbauranga, *et al.*, 2015).

This Study indicated that DDS were not significant (p=.136) to Hb concentration. The reason can be because of socioeconomical and being rare the availability of foods. In these study participants there was not consumption of meat, fish, and poultry, and there was very low consumption of fruits, vegetables and legumes. This current study agrees with that of Olumakaiye (2013), found that the least food groups that under five pastoralist children consumed were fruits and vegetables. Fruits and vegetable foods contain certain organic acids such as fumerate, ascorpic acid, citrate and malate that enhance the bioavailability of micronutrient particularly iron and zinc (Forssurd, et al., 2000; Welch, 2001). WHO stated that it is incredible to supply enough iron from unmodified plant-based complementary foods to meet the recommended daily intake of iron for under-fives without adding animal products such as liver, fish, beef, and eggs. Apart from other risk factors of anemia like blood loss, diseases, vitamin A, and folate deficiency (Olivares, 1999). Moving from a monotonous diet to one containing a more varied range of foods has been shown to raise intake of energy as well as micronutrients in developing countries (Kennedy *et al*., 2007).

According to Food and Nutrition Technical Assisstance (FANTA, 2006), the individual’s dietary diversity has been shown to be related to increased nutrient adequacy of the diet, increased mean micronutrient density adequacy of complementary foods. Lack of access to enough nutritious food is the main features of malnutrition (Lang’o, 2011).

Other reason can be because the feeding of young children was vey low in the study area only 6% have high DDS. Similarly EDHS, (2016), the newborn and young child feeding practices in Somali region were stated to be poor as compared to the other regions of Ethiopia. thi is disagrees the FAO, (2011) recommendations; It's advisable that children under five years to consume atleast 4 food groups out of the 8 food groups per day to meet diversified diets. Similar with the finding of Levine, (2011) stated that chronic food insecurity in pastoral drylands, strengthened by the supposition of pastoralism's structural low-productivity and endemic vulnerability. Moreover, Sub-Saharan Africa, where problems around food security are supposed to be more alarming (World Bank, 2009). In addition to non-breast fed young children, breast feed kids who are 6-23 months old must obtain animal source foods and vitamin A rich fruits and vegetables (PAHO/WHO, 2001).

Zlotkin, *et al.,* (1996) found that early introduction of cow's milk has adverse influence on Hb concentration in both infants and toddlers. The facts that, cow's milk has low iron bioavailable and can cause occult bleeding and anemia when introduced before 9 to 12 months of age (Dallman, *et al.,* 1993) Moreover, several studies showed that high Consumption of cow's milk has a negative influence on iron status as it reduces bioavailability of iron provided by other foods and has been shown to have a negative effect on non-heme and heme iron absorption (Hallberg, *et al.,* 1992; Wilson, *et al.*, 1999; Adu-Afarwuah, *et al.,* 2008; Levy-Costa and Monteiro, 2004; Hurrell and Egli, 2010; Silva, *et al.,* 2007; Persson, *et al.,* 2001; Vanderhoof, 2015). However, the current study cow's milk was not significant to Hb. The reason was because the study was cross-sectional study and the time that the data collection carried out was a dry season and most of the pastoralist households tend their food to cereals. Therefore, most of the study participants (94.6%) did not consume pure cow's milk; instead they consume cow's milk together with other foods. Similarly, a study done by Hallberg, *et al.,* (1992), indicated that, cow's milk together with complementary foods is not challenging for the prevalence and predictors of anemia but it should not be used as the main meal before 12 months and should not replace iron-rich foods.

Camel milk has high vitamin C (Haddadin, *et al.,* 2008). Camel milk contains 30 times more vitamin C than cow milk does, this is highly important in desert areas, where fruits and vegetables are scarce. Therefore, camel milk is often the only source of vitamin C in the diet of of Somali and Afar regions (park, *et al.,* 2007; Haddadin, *et al.,* 2008). However, the current study does not show significant with camel milk associated to Hb. The first reason, there was a common consumption of tea together with camel milk (90.4%) of study participant's children consumed mixed camel milk with tea. since tea contains polyphenols which bind iron to form an insoluble complex which cannot be absorbed. Nelson and Poulter, (2004); Ma, *et al.,* (2011) stated that: Polyphenol in tea binds to iron and form nonhydrolyzable complexes which are then excreted in the feces. The second reason; there was no consumption of Meat, Fish and poultry in this study participants children. In addition; there was very low consumption of fruits and vegetables. Hurrell, (2006), reported that good source of iron like fish, meat and poultry contains not only the well absorbed heme iron but also a peptide called MFP factor that promotes the non heme iron from other foods eaten at the same meal.

The third reason was; the method of the study was cross-sectional study, so the time that data collection carried out was dry season (*jiilaal)* and the amount of milk that the children consumed was very low. Most of them consumed only milk mixed with tea. Galvin and Little (1999) reported that there is noticeable seasonal distinction in the consumption of milk for pastoralist community; Milk is consumed mainly in the short wet seasons and people turn to cereals as pastoralists sell their livestock to purchase cereals, sugar, tea, and tobacco, which yield little micronutrient and stimulant to avoid hunger. However, Sellen (1996) described that milk consumption of pastoralist's increases dramatically during wet season substituting the grains.

In the current Study numbers of livestock as a wealth index were not significantly associated with Hb; the reason was that because number of livestock in the pastoralist community did not contribute any nutrient differences.

This is similar with another observation done in northern Kenyan pastoralist by Miller, (2010), reported that the number of livestock that the household owns are not influenced by Hb levels. Other studies done by, Fratkin and Roth (1990); Sellen (2003) and Fratkin (2004) Reported that wealth differences within the number of livestock keeping pastoralist communities have no nutritional status differences, a fact attributed to a “moral economy” where wealthier households share milk and livestock with poorer relatives in nomadic communities.

Another reason was because of seasonal variation. It is certain that seasonal variation increases the vulnerability of pastoralist to malnutrition when livestock pasture becomes scarce, in turn limiting both drinking water and milk availability for human consumption (Fujita, *et al.*, 2004). A more significant decline in nutritional status by season has been noted among the Somali pastoralists in Ethiopia (SCUK, 2007).

6. Limitations of the study

One of the limitations of this study that may have affected the results is the cross-sectional nature of the study that disqualifies identifying seasonal patterns. At the time of this study, it was the dry season, which most of the pastoralist faced shortage of milk consumption and may have also contributed to higher levels of childhood anemia and unavailable/expensive foods. Future researches should be carried out in wet season.

7. Conclusion and Recommendations

7.1 Conclusions

Anemia is asignificant public health problem worldwide and the magnitude of the problem is particularly higher in populations from developing countries. The extent is mostly in younger children and reproducdtive age women. Pastoral communities in Somali and Afar regions are the highest anemia affected societies in the country. Anemia is associated with several health risks and social and economic complications by reducing the cognitive development in children, and decreasing overall productivity of adults. Early introduction of cow's milk, as a substitute for breast milk can cause certain health disorders like anemia due to its very low capacities of iron and vitamin C and lower bioavailability due to higher calcium and casein. However, camels' milk can be used efficiently as a good source of vitamin C. The objective of the study was to determine haemoglobin concentration among children consuming predominantly camel's milk or cow's milk and identifies associated factors. Binary logistic regression model was applied to test the association of Hb with various socio demographic and important health variables. This study revealed that several variables were significance ($p<0.05\%$) with hemoglobin; age of the children, household having farm land, households waste the disposal improper places, weight of the children, height of the children, weight for age and height for age of the children.

Consumption of camels' milk and cow's milk has no effec on hemoglobin concentration of the children in pastoralist community of Somali region. Anyhow, features that this community is having and contributes to anemia includes; food insecurity and vulnerability to seasonal variation due to low farming, poor WASH, low dietary diversity, no consumption of meat, eggs and fish and restricted ingestion of fruits and vegetables, which means that the pastoralist children of Somali region are lacking adequate supply of micronutrients.

7.2. Recommendations

The following recommendations are made based on the conclusion of this study.

Community based nutrition-specific interventions particularly iron through food fortication in the generall people and supplementation as well as deworming to vulnerable groups of people targeting to underfive children and pregnant womens.

WASH program interventions focused on proper waste disposal, hand washing, toilets at home and availability of clean water.

Community awereness to reduce foods rich with iron absorption inhibitors like tea intake together with milk or immediately after a meal and to replace iron rich foods like fruits and vegetables.

Households need to be sustained to establish home gardens as a way of implementing dietary diversification which is likely to improve the micronutrient intakes of the households including that of children under five ages.

Sensitive nutrition interventions like nutrition education, implementing of safe water, campaign of hygiene and sanitation practice should be also incorporated with the existing programs and directed to the mothers and other caregivers to enhance on their nutritional responsiveness. Moreover, building primary health care services and nutritional/health education or community mobilization should be conducted in particularly mothers or caregivers to realize the common etiology of anemia and to encourage frequently monitoring the nutritional status of their children by visiting health services like health posts for children routine growth checking.

Additional researches concerning milk consumption and anemia on the pastoralist community of Somali region is also reccomded to carry out during wet seasons.

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Appendix

Annex I. consent form and information sheet in an English version

This sheet will read for the parents/guardians of the participants of the study. Good morning/afternoon mom/father my name is----------------- and I am one of the data collectors for the study being conducted by Addis Ababa University, college of natural science, center of food science and nutrition in a program of community nutrition. Your child is selected to be a participant of this study. After you have understood the following information if you give me a consent.

Title of the study: does camel milk consumption improve hemoglobin concentration? a comparison of anemia prevalence among camel milk and cow milk consuming pastoralist communities of Ethiopian Somali region.

Introduction: nutrition and health status of children are so important to influence the child's growth, cognitive, behavioral development and learning ability of the child who lack certain nutrient in their diet specially iron and iodine or those who suffer from protein energy malnutrition, hunger or other diseases, who don't have the same potential for health growth and development. Weak health and poor nutrition among children reduces their cognitive development either through physiological changes or by reducing their ability to prevent infectious diseases and to participate learning experience.

Procedures: the study involves children who is their age is between 6 months to 5 years in a predominantly camel milk or cow milk consuming pastoralist community of Ethiopian Somali region. Your child is selected to be one of the study participants if you are willing to participate we are so happy. Finally we are kindly requesting you to give us your genuine response to the questionnaire based on your child's information and food intake. We would like to ask your permission to know the type and amount of milk consumed in your child per day and also other dietary habits of your child and to measure also your child's weight, height and hemoglobin concentration by taking a drop of blood in the finger of the child.

Benefits of the study: the participant will not get any direct benefit for being participant, but

- The result can be used to play a great role in signifying the rate of the problems in pastoralist communities of Somali region to provide a figurative data about the association between camel's milk or cow's milk consumption and anemia.
- The result can be used to know if camel milk improves hemoglobin concentration or not and which group of children is so highly prevalent in anemia based on the type and quantity of milk they consumed (the camel or the cow milk consuming)
- The result can be used as a baseline for further studies that can be done in this area.
- The result will be used to the governmental organization or non-governmental organizations, stake holders and policy makers to develop an intervention and prevention mechanism to alleviate the problems regarding anemia among the pastoralist communities of the region and the country.

Potential harm: the study has no any harm except that participant will spend up to 30 minutes in the interview and taking one drop of blood from the child's finger prick.

Rights of the participant: participant has a full right to

- Not to participate if the parents of child is not willing to do so.
- The parents of the participant can skip any question which she/he does not want to answer
- The parents of the participant can stop participating in the study at any time
- During the interview the parents of the participant can ask any question which is not clear

Confidentiality: the secrecy of any information forwarded will be maintained and we assure you that whatever answers you give us will be kept strictly secret.

Person to contact: if you have any question, don't hesitate to ask me at any time. For additional questions or any other concern about the study you may contact to

The principle investigator: Ahmed Abdurahman.

Cell phone: +251915238030

Email: ahmedabdurahman.2015@gmail.com

After understanding the above information if you agree that your child to participate in the study, please sign at the space provided below and I would like to thank you for your participation, if you are not agreeing thank you and by.

Name and signature of the Person obtained for consent; ______________________________ Date____/____/2018

Interviewers name and signature; ___________________________Date/____/____/2018
Name of the child: _________________________________
Region: **Somali**
Zone: ___________
Woreda: _________
Kebale: _________

Annex II. Somali language version

Lifaaqa

Lifaaqa I. foomka wada ogolka warbixinta

Foomkaan waxaa loo akhrin doonaa waalidka ama ilaaliyaha ilmaha kuwaas oo kaqayb qaadan doona cilmi baadhistan.

Subax wanaagsan/galabwanaagsan hooyo/aabe magacaygu waa -------- waxaan kamid ahay dadka uruurin haya xogta cilmi baadhista ay samayn hayso jaamacada Addis Ababa, kuli yada saynsiga dabiiciga ah, waax deeda sayniska cuntada iyo nafaqada programka nafaqada bulshada. Ilmahaaga waxaan udooranay inuu kaqayb qaato cilmi baadhistan. Kadib Markaad fahanto warbixintan hadii aad nala ogolaato.

Ciwaanka darasaadka: dhamitaanka caanaha geelu miyay hagaajiyaan wadaha unuga dhiiga? Isbar bar dhiga caruurta dhanta caanaha geela iyo caruurta dhanta caanaha lo'da kuwa kubadan dhiig yaraanta ee bulshada xoola dhaqatada dowlada deegaanka soomaalida itooboya.

Hordhac: heerka nafaqada iyo caafimaadka ilmuhu waxuu saamayn wayn kuleeyahay koritaanka ilmaha, garaadkiisa, koritaanka dabeecadiisa iyo awoodiisa waxbarashada. Ilmaha ay kamaqan tahay waxoogaa nafaqa ah cuntadiisa gaar ahaana ironta iyo iodhinta ama kuwaas oo ay kudhacday nafaqo xumada loo yaqaano (protein energy malnutrition), gaajada ama xanuunada kale, kuwaas oo aan haysan awood dheeli tiran oo ah caafimaadkooda iyo koritaankooda. Caafimaad xumo iyo nafaqo xumo ciyaalka ay yaraysay kobaca waxgaradkooda is badalka jidhkooda awoodiisa uu iskaga difaaci lahaa cudurada faafa iyo tan uu kaga qayb qaadan lahaa waayo aragnimadiisa waxbarashada.

Hababka daraasadka: cilmi baadhistan waxaa lagu samayn hayaa ciyaalka ay dadoodu udhaxayso 6 bilood ilaa 5 sano, kuwaas oo badanaa dhama caano geel ama caano lo aad ee bulshada xoolo dhaqatada dowlad deegaanka somalida itoobiya. Ilmahaaga waxan udooranay inuu ka mid noqdo kaqayb qaatayaasha cilmi baadhistan hadii aad nala qaadato aad ayaan ugu faraxsanahay. Ugu danbayn waxaan si naxariis leh kaaga codsan haynaa inaad si daacad ah noo siiso jawaabta su aalahan ee kussabsan warbixinta iyo cunto qaadashada ilmahaaga. Waxaan jecel nahay inaan kuwaydiisano ogo laan sha haaga si aan u ogaano nooca iyo qadarka caanaha ah ee uu ilmahaagu dhamo maalinkasta iyo sidoo kale cuntooyinka kale ee uu cuno ilmahaagu iyo inaan cabiro miisaanka, dheerarka iyo wada ha unuga dhiiga anaga oo kaqaadayna dhibic dhiig ah ilmaha fartiisa.

Faa iidooyinka daraasadka: ka qayb qaata yaasha cilmi baadhistan faa iido toos ah kama hela yaan ee laakiin.

- Natiijada waxaa loo isticmaali doonaa in ay door muhiim ah ka ciyaarto in la ogaado heerka dhibaatada bulshada xoolo dhaqada ah ee dowlada deegaanka somalida itoobiya si loo soosaaro xog kusaabsan xidhiidhka udhaxeeya cabitaanka caanaha geela ama ku wa lo da iyo dhiig yaraanta.
- Natiijada waxaa loo isticmaali doonaa in lagu ogaado in ay caanaha geelu hagaajiyaan unuga wadaha dhiiga iyo inkale iyo kooxda ciyaalka ah ee ay dhiig yaraantu ku badan tahay iyada oo la eegayo nooca iyo qadar ka caanaha ah ee ay cabaan.
- Natiijada waxaa loo istic maali doonaa in ay gundhig unoqo to in cilmi baadhis dheeraad ah meeshan laga sameeyo.
- Natiijada waxaa isticmaali doona dowlada ama haayadaha, daneeya yaasha iyo siyaasad sameeyayaasha si ay usameeyaan farsamo wax kaqabasho iyo ka hortag ah oo lagu

yarayn hayo dhibaatadan kusaabsan dhiig yaraanta ciyaal ka xoolo dhaqatada ah ee deegaanka iyo wadanka.

Wax yeelada daraasadka: cilmi baadhistani wax wax yeela ah malaha aanka ahayn in kaqayb qaataha su aalo waydiinta lagaga lumiyo mudo 30 daqiiqo ah iyo in laga qaado dhibic dhiig ah ilmaha fartiisa.

Xuquuqda kaqayb qaataha darasadkan: kaqayb qaatuhu wuxuu xuquuq buuxda uleeyahay in Uu joojiyo kaqayb qaadashadiisa hadii waalidku uu amro saas.Waalidku waxay xuquuq uleeyihiin in ay kaboodaan/ka aamusaan su aal kasta oo ayna rabin in ay ka jawaabaan. Waalidku waxay iska joojin karaan kaqayb qaadashada xili kasta oo ay rabaan. Xiliga su aala waydiinta waalidku waxay na waydiin karaan su aal kasta oo ayna fahmin.

Sirta: sirta xogtani aad noo soo gudbiseen waan ilaalin doonaa waxaana idiin balan qaadaynaa sikasta oo ay yihiin jawaabihiinu in aan u ilaalin doono si haboon.

Qofka lala soo xidhiidhi: hadii aad haysaan wax su aal ah haka labalabaynina in aad isoo waydiisaan xili kasta ama wixii kale ee khuseeya cilmi baadhistan hadaad rabtaan waxaad la soo xidhiidhi kartaan

Hogaamiyaha baadhayaasha: Ahmed Abdurahman Ahmed

Telfoon numberkiisa: +251915238030

Email: ahmedabdurahman.2015@gmail.com

Kadib markad fahanto xogtan kore Hadii aad ogosha hay in ilmahaagu kaqayb qaato cilmi baadhistan fadlan waxaad ku qortaa magacaaga sixiixdaana meeshan banaan ee hoose waanad ku mahadsan tahay kaqayb qaadashadaada. Hadii kale oodan karaali ahayn waad mahadsan tahay hayehna.

Magaca iyo sixiixa qofka laga helay ogolaanshaha; ______________________________ taarikhda____/____/2018

Magaca iyo sixiixa baadhaha;___________________________taariikhda/____/____/2018

Magaca ilmaha: ________________________________

Deegaanka (Region): **Somali**

Gobolka (Zone): ___________

Dagmada (District): _________

Qabalaha (Kebele): __________

NOTE: English questions and answers are in the bracket

Lifaaqa II. Xog ururinta laxidhiidha hab dhaqanka bulshada, Dhaqaalaha iyo heerka waxbarashada waalidka ilmaha.

(Annex II. Socio demography, economic and educational status of parents/guardians of the child)

Lamberka Sr.No	Su aalaha (Questions)	Sumada iyo jawabta (Code and Response)
101	Dada ilmaha (Age of the child)	_____________
102	Dada hooyada ilmaha (Age of the child's mother)	_________sano (years)
103	Jinsiga ilmaha (Sex of the child)	1) Lab (Male) 2) Dhadig (Female)
104	Qoomiyada ilmaha (Ethnicity of the child)	1) Somali (Somali) 2) Axmaaro (Ahmaro) 3) Oromo (Oromo) 99) Wixiikale cadee (specify others)___________
105	Diinta ilmaha (Religion of the child)	1) Muslim (Muslim) 2) Kiristiyaan (Christian) 3) Wixiikale cadee (specify

		others) ___________
106	Saraynta meesha uu ilmuhu kunool yahay? (What is the altitude of the place that the child lives?)	________mitir (metre)
107	Meesha uu ilmuhu dagan yahay (Place of residence)	1) Baadiyaha (Rural) 2) Magaalada (Urban)
108	Heerka waxbarashada aabaha ilmaha? (father's educational level)	1) Umi (Illiterate) 2) Qori kara akhrina kara (Read and write) 3) Fasalka (Grade) ________
109	Heerka wax barashada hooyada ilmaha? (Mothers educational level)	1) Umi (Illiterate) 2) Qori karta akhrina karta (Read and write) 3) Fasalka (Grade)_________
110	Shaqada aabaha (Father's job)	1) Beeralay (Farmer) 2) Xoolo raac (Herdsman) 3) Ganacsade (Merchant) 4) Shaqaledowladeed (government employee) 5) shaqale gar ah (private employee) 6) muruq maal (daily labourer) 7) aan shaqo haysan (un employed) 8) Waxiikale cadee (specify others)________
111	Shaqada hooyada (mothers job)	1) Guri jog (house wife) 2) Beeralay (farmer) 3) Ganacsato (merchant) 4) Shaqaale dowladeed (government employee) 5) Shaqaale gaar ah

<table>
<tr><td></td><td colspan="2"></td><td colspan="3">(private employee)
6) Muruq maal
(daily labourer)
7) Aan shaqo haysan
(un employed)
8) Wixiikalecadee
(specify others)________</td></tr>
<tr><td>112</td><td colspan="2">Imisa geel ah ayaad leedihiin?

(How many camels do you have?)</td><td colspan="3">

_________geel ah (camel)</td></tr>
<tr><td>113</td><td colspan="2">Imisa lo’ah ayaad leedihiin?

(How many cows do you have?)</td><td colspan="3">

________lo’ ah (cow’s)</td></tr>
<tr><td>114</td><td colspan="2">Imisa adhi ah ayaad leedihiin?

(How many goats do you have?)</td><td colspan="3">

__________adhi ah (goats)</td></tr>
<tr><td>115</td><td colspan="2">Aslaax maleedihiin?

(Do you have farm land?)</td><td colspan="3">1) Haa (yes)
2) Maya (no)</td></tr>
<tr><td>116</td><td colspan="2">Hadii jawaabta su aashan kore ay tahay haa intee buu la egyahay?

(If your answer is yes for the above question what is the size of your farm land?)</td><td colspan="3">_____________</td></tr>
<tr><td>117</td><td colspan="2">Maxaa kabaxa aslaaxiina?

(What does grow with your farm land?)</td><td colspan="3">

______________</td></tr>
<tr><td>118</td><td colspan="2">Tirada qoyskiina

(Family size)</td><td colspan="3">

_____________</td></tr>
<tr><td>119</td><td colspan="2">Imisa qol ayuu kakooban yahay gurigiinu?

(How many rooms does your house have?)</td><td colspan="3">

_____________</td></tr>
<tr><td></td><td>Su aasha (Question)</td><td colspan="2">Sumada iyo jawabta (Code and response)</td><td>Maya=0 Haa=1 haa lkn</td><td>Hadii jwbtu tahay haa imisa</td></tr>
</table>

			mashaqeyan=2 (No=0 yes=1 yes but doesn't work=2)	midkiiba (If yes what is the no in each)
120	Alaabtan gurigiina ma idiin yaalan? (Do you have the following assets in your house hold?	1) sariir (Bed)		
		2) kursi (Chair)		
		3) miis (Table)		
		4) sacada gidarka (Whatch)		
		5) Radiyow (Radio)		
		6) Mobayl (Mobile phone)		
		7) Telefonka xafada (Non-mobile phone)		
		8) Faynuus (Gas working lamp)		

Lifaaqa III. Dhamida caanaha

Annex III. Consumption of milk

Lamberka (Sr.no.)	Su aalaha (Questions)	Sumada iyo jawabta (Code and Response)
201	Ilmuhu caano ma dhamaa? (Does the child drinks milk?)	1) Haa (Yes) 2) Maya (No)
202	Hadii jawaabta su aashan kore ay tahay haa Caano intee la eg ayuu dhamaa maalinkii? Waana noocma? (If the answer of the above question is yes how much of milk does the child drinks per day? And from what type of animal?)	1) ______ml/maalinkii oo geel ah (ml/day of camel milk) 2) _______ml/malinkii oo lo' ah (ml/day of cow milk) 3) _______ml/malinkii oo riya ah (ml/day of goat milk)
203	Badanaa caano nooc ma ah ayuu ilmuhu dhamaa maalinkii? (What type of animal milk does the child predominantly drinks?)	1) Caano geel (Camels milk) 2) Caano lo aad (Cow's milk) 3) Caano Riyaad (Goat's milk)
204	Naaska maad siisaa ilmaha? Do you give breast milk for the child?	1) Haa (Yes) 2) Maya (No)
205	Hadii jawaabta su aashan kore ay tahay haa imisa jeer maalinkii? If your answer is yes for the above question how many times per day?	1) 1mar maalinkii (Once a day) 2) 2jeer maalinkii (Twice a day) 3) 3jeer maalinkii (Three times a day) 4) 4jeer maalinkii (Four times a day) 5) > 4 jeer maalinkii (More than 4 times a day)

Lifaaqa IV: xaalada caafimaad

(Annex IV: medical history)

Lamberka (sr.no)	Su aalaha (questions)	Sumada iyo Jawaababaha (code and response)
301	Ilmuhu miyuu lakulmay shaqaale caafimaad 14 kii cisho ee ugu danbaysay? (Has the child seen a health worker during the last 14 days?)	1) Haa (yes) 2) Maya (no)
302	Hadii jawaabtaada su aashan kore ay tahay haa miyaa laseexiyay 14 kii cisho ee ugu danbaysay? (If your answer is yes for the above question has the child been hospitalized for the last 14 days?)	1) Haa (yes) 2) Maya (no)

Lifaaqa V: cabiraada jidhka ilmaha

(Annex V: anthropometric measurements of the child)

Lamberka (Sr.no.)	Su aalaha (questions)	Nooca cabirka (type of measuring)
401	Culayska ilmaha (Weight of the child)	______Kg _____kg ______kg average __________kg
402	Dheerarka ilmaha (Height of the child)	_____________cm
403	Cabirka MUAC ga ilmaha (MUAC measurement of the child)	________cm

Lifaaqa VI: cabitaanka shaaha ama bunka iyo nadaafada ilmaha

(**Annex VI: drinking of tea or coffee and the sanitation of the child)**

Lamberka (Sr.no.)	Su aalaha (questions)	Sumada iyo Jawaabta (code and response)
501	Shaah ama bun ilmaha maad siisaa? (Do you give tea or coffee for the child?)	1) Haa (yes) 2) Maya (no)

502	Hadii jawaabta su aashan kore ay tahay haa goorma ayaad siisaa? (If your answer is yes for the above question what time do you give the tea or the coffee for the child?)	1) Cuntada ka hor (Before a meal) 2) Cuntada kadib (After a meal)
503	Hadii jawaabta su aashan kore ay tahay cuntada kadib xili intee la eg ayaa udhaxeeya? (If your answer for the above question is after a meal. What is the time gap between eating a meal and drinking coffee or tea?)	1) > 1 saacad (>1 hr) 2) < 1 saacad (<1 hr)
504	Biyaha xageed ka dhaansataan? (Where do you get from the source of water?)	1) Qasabad (A pipe water) 2) Ceel (Dug well) 3) Biyo Wabi (River Water) 4) Xareed (Rain water) 5) Biyo barkad, gidhib IWM (Birka or Borehole) 6) Wixiikale cadee (specify others) _____________
505	Qashinka xageed ku daadisaan? (Where do you waste the disposal?)	1) Meel haboon (Proper place) 2) Meel kasta (Improper place or everywhere)
506	Saxarada xageed u isticmaashaan? (Where do you use for defecation?)	1) Meel iska banaan ah (Open air defecation) 2) Suuli xaafada noogudhax yaala (Defecate presence of a toilets

		at the home) 3) Suuli dadka kawada dhaxeeya (latrine) 99) Wixii kale cadee (specify others) ______________
507	Saabuun maku maydhaa gacmahaaga ama gacmaha ilmaha hadii uu kaligii saxaroodo saxarada kadib? (Do you wash with soap your hands or the hands of the child if he/she defecates alone after defecation?)	1) Haa (yes) 2) Maya (no)
508	Saabuun maku maydhaa gacmahaaga ama gacmaha ilmaha hadii uu kaligii wax cuno cuntada kahor? (Do you wash your hands or the hands of the child if he/she eats alone with soap before eating food?)	1) Haa (yes) 2) Maya (no)

Lifaaqa VII: su aalaha ku saabsan isticmaalka cuntooyinka kala duwan ee muda dii 24 kii saacadood ee tagay.

(Annex VII: dietary diversity questionnaire using for 24 hour recall period.)

Lamberka (Sr.no.)	Nooca cuntooyinka (types of food items)	1) ilmuhu macunay ----- 24kii saac ee lasoo dhafay? Haa=1 maya=0 (1) Did the child eat ------- for the past 24hr? Yes=1 No=0	2) Hadii jawaabta su ashan 1 ay tahay haa ilmuhu maalinkasta ma cuna cuntadan? Haa=1 Maya=0 (2) If yes for question 1 did the child eats this food daily? Yes=1 No=0	3) Hadii su asha 1 ay tahay haa tan 2 ay tahay maya imisa jer ayuu 24saac ee tagay cunay? 3) If the 1 question is yes and the 2 question is no how many times the child eat the food in the past 24hr?
601	Galay/xasiid (Corn/maize)	☐	☐	
602	Bariis (Rice)	☐	☐	

603	Qamadi (Wheat)	☐	☐	
604	Hadhuudh (Sorghum)	☐	☐	
605	Masago (Millet)	☐	☐	
606	Heed (Barley)	☐	☐	
607	Sareen (Oats)	☐	☐	
608	Daafi (Teff)	☐	☐	
609	Waxii kale ee rashin ah cadee (Specify other cereals related) ___________	☐	☐	
610	Baradho (White potato)	☐	☐	
611	Baradho macaan (Sweet potato)	☐	☐	
612	Kasafaha cad (White cassava)	☐	☐	
613	Kaarot (Carrot)	☐	☐	
614	Bocorka (Pumpkin)	☐	☐	
615	Caleenta kasafaha (Cassava leafs)	☐	☐	
616	Isbinaajka (Spinach)	☐	☐	
617	Qajaar (Cucumber)	☐	☐	
618	Kaabish (Cabbage)	☐	☐	
619	Saladh (Salad)	☐	☐	
620	Basal (Onion)	☐	☐	
621	Toon (Garlic)	☐	☐	
622	Wixii kale ee khudar ah cadee (Specify	☐	☐	

	Other vegetables related) ________			
623	Muus (Banana)	☐	☐	
624	Timatim (Tomato)	☐	☐	
625	Afokaadho (Avocado)	☐	☐	
626	Burtukhaan (Orange)	☐	☐	
627	Liin dhanaan (Lemon)	☐	☐	
628	Cinab (Grapes)	☐	☐	
629	Maango (Mango)	☐	☐	
630	Babaay (Papaya)	☐	☐	
631	Cananaaska (Pineapple)	☐	☐	
632	Xabxab (Water melon)	☐	☐	
633	Istarow bari (Strawberry)	☐	☐	
634	Wixii kale ee midha ah cadee (Specify other fruits related) __________	☐	☐	
635	Beer (Liver)	☐	☐	
636	Kalli (Kidney)	☐	☐	
637	Wadne (Heart)	☐	☐	
638	Wax kale oo Dhiig laxidhidha (Other organ meat or blood)	☐	☐	

☐

639	Hilib lo aad (Beef)		☐	
640	Hilib ideed (Lamb)	☐	☐	
641	Hilib riyaad (Goat's meat)	☐	☐	
642	Ukun (Eggs)	☐	☐	
643	Kaluun (Fish)	☐	☐	
644	Digir (Beans)	☐	☐	
645	Anter (Peas)	☐	☐	
646	Loos (Nuts)	☐	☐	
647	Misir (Lentil)	☐	☐	
648	Shunburo (Chick pea)	☐	☐	
649	Cadee wixi kale (Specify others related to meats/legumes) __________	☐	☐	
650	Subag (Cheese)	☐	☐	
651	Saliid (Oil)	☐	☐	
652	Subag ibaad ama xoolaad cunto lagu daray ama lagu kariyay (Fats or butter added to food or used for cooking)	☐	☐	
653	Sonkor (Sugar)	☐	☐	
654	Malab (Honey)	☐	☐	
655	Sharaabka ashatada leh ama kan lamacaaneeyey (Sweetened soda or	☐	☐	

	sweetened juice drinks)			
656	Cuntooyinka macmacaanka ah sida jokoleetada ninaca (Sugary foods such as chocolates, candies, cookies and cakes)	☐	☐	
657	Qaji (Red pepper)	☐	☐	
658	Cusbo (Salt)	☐	☐	
659	Qorfe (Cinnamon)	☐	☐	
660	Majones (Mayonnaise)	☐	☐	
661	Kajab (Ketchup)	☐	☐	
662	Sharabka guriga lagu qasto (Homemade non-alcoholic beverages)	☐	☐	
663	Wixii kale cadee ee laxidhiidha cuntoyinkan kore (Specify others related to the above foods) _________	☐	☐	

Lifaaqa VIII. Baadhitanka wadaha unuga dhiiga

(Annex VIII. Hemoglobin testing)

Q701. __________g/dl caadi ah aan dhiig yaran haynin hadii wadaha unuga dhiga ilmuhu ≥11.0g/dl

[g/dl normal or non-anemic if hemoglobin level is ≥11.0g/dl]

Q702. __________g/dl dhiig yaraan khafiif ah hadi ay wadaha unuga dhigu udhaxeyo 10.0---10.9g/dl

[g/dl   mild anemic if hemoglobin level is between 10.0----10.9g/dl]

Q703. __________g/dl dhiig yaraan dhax dhaxaad ah hadi wadaha unuga dhigu udhaxeeyo 7.0----9.9g/dl

[g/dl moderate anemic if hemoglobin level is 7.0-----9.9g/dl]

Q704. _________g/dl dhiig yaraan daran hadii wadaha unuga dhiigu <7.0g/dl

[g/dl sever anemic if hemoglobin level is <7.0g/dl]