ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

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MICRONUTREINT ADEQUACY OF HOME MADE COMPLEMENTARY FOODS IN MEKET DISTRICT, WOLLO, NORTH ETHIOPIA

By: Menber Adugnaw

Advisor: Dawd Gashu, PhD

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A Thesis Submitted to the School of graduate studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Food Science and Nutrition (Community Nutrition)

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I declare that I wrote the graduate thesis by myself under the guidance of my supervisor, Dr. Dawd Gashu. All used sources are acknowledged in the text and in the list of references.

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List of abbreviations/Acronyms

AAS	Atomic Absorption Spectrophotometry
ASF	Animal Source Foods
AOAC	Association of Official Analytical Chemists
BF	Breast Feeding
CSA	Central Statistical Agency
DDS	Dietary diversity score
EDHS	Ethiopian Demographic Health Survey
ENA	Emergency Nutrition Assessment
FAO	Food and Agricultural Organization
FFQ	Food Frequency Questionnaire
FMOH	Federal Ministry Of Health
FVS	Food variety score
HAZ	Height for age z-score
IQ	Intelligence Quotient
LAZ	Length for age z-score
NHMRC	National Health and Medical Research Council
PAHO	Pan American Health Organization
PEM	Protein Energy Malnutrition
RNI	Recommended nutrient intake
SD	Standard deviation
UNICEF	Unite Nations Children's Emergency Fund
USAD	United States Agricultural Department
USAID	United States Agency for International Development
WAZ	Weight for age z-score
WHO	World Health Organization
WHZ	Weight for length z-score
WLZ	Weight for length z-score

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Abstract

Undernutrition is a serious problem worldwide due to unbalanced diet or infection. Children during the first two years of life are vulnerable to several nutrition related problems including micronutrient deficiencies. Due to limited education of mother's, poor resource availability and access to different micronutrient rich food items, achieving better nutrition seems to be difficult. In resource poor environments, the habit of low quality monotonous diets leads to low vitamin and mineral intake. Women's education, access to nutrient-rich foods and household food security are the determinants of nutritional status of children. The present study was designed to determine the micronutrient adequacy of homemade complementary foods in Meket district, North Wollo, Ethiopia. A cross sectional quantitative 24-hour recall was used to assess the micronutrient intake of children (6-23 mo). From two randomly selected kebeles, 78 children (6 to 23 mo) were the subject of the study. Undernutrition was high among the children. About 45.5% of the children were stunted. Majority (92.3%) of the children's diet was cereal based and none of the children had animal source foods in the 24 hrs preceding the survey; only eight (8.97%) children were given cow milk. Dietary diversity was very low; on average, the children consumed 2.52±0.78 food groups and 3.32±1.23 food varieties. Feeding practices were very poor (initiation of complementary feeding was practiced at 10 months on 33 (42.3%), at 11mo on 35 (44.9%) and at 12 on 10 (12.8%) of children, frequency of complementary feeding was two –three times in 59.5% children). The nutrient intakes of the children in a group indicated that mean energy intake 199.08±115.91, Iron intake (for 9-11 mo ages) 3.37±2.13, Zinc intake 1.76±1.45 Calcium intake 19.8±9.28 and Vitamin A intake 30.8±17.3 and Iron intake (for 12-23 mo age) 4.3±2.12, Zinc intake 1.8±0.8, Calcium intake 15.6±4.83 and Vitamin A 34.41±18.46 were below the WHO recommendations. Lack of mothers awareness on appropriate complementary feeding and child caring practices, high cost of ASF foods and time constraints of the mother counts poor consumption and limited intake of nutrient. Generally due to low dietary intake, the nutrient intake of the children did not meet the recommended level (346, 5.6 and 3.8 is estimated daily intake of Ca, iron and zinc respectively).

Key words: complementary foods, micronutrient, mothers'/caregivers' perspective, infant feeding practice.

1. Introduction

1.1. Background

Micronutrient deficiency is a serious problem in resource poor countries. One-third of the world's populations suffer from micronutrient deficiency mainly due to inadequate dietary intake (Fielder and Macdonald, 2009). Deficiencies in vitamins A, folic acid, iron, and zinc, are preventable causes of poor childhood growth and school performance. Micronutrient deficiency causes birth defects, mental retardation, learning difficulties, compromised immune systems, low work capacity, blindness and death. In most developing countries, these nutrition-related problems then results in less social and economic achievement (Northstone *et al.*, 2010).

The interval between 6- 23 mo of age is the largest part of the "first 1000 days" encompassing pregnancy and the first 2 years after birth. Therefore, this period is regarded as the key window of opportunity for preventing under nutrition and its long-term adverse consequences. The age between 6-23 mo is the time at which growth faltering occurs, suggesting the need for proper attention for safe and adequate complementary feeding (Dewey, 2013).

Exclusive breast-feeding is necessary for optimal health, growth, and development (WHO, 2002). As infants grow and become more active following the first 6 months of life, however, breast milk alone falls short of providing the full nutritional requirements where the gap keeps expanding with increasing age (WHO, 2003; Dewey, 2001). In order to provide infants with additional nutrients and to cover these gaps, complementary foods (foods other than breast milk or infant formula) should be introduced (USAID, 2009).

The target age range for complementary feeding is between the age of 6-23mo, where most infants reach a general and neurological stage of development (chewing, swallowing, and digestion) (WHO, 2003; Monte & Giugliani, 2004). For this reason, complementary foods need to have high energy density and should be micronutrient-rich. Iron and zinc are generally the most problematic nutrients during the period of complementary feeding (Dewey & Brown, 2003; Vossenaar & Solomons, 2012), mainly because their concentration in human milk is low. In addition, raw ingredients to complementary foods often fail to provide the required micronutrient concentration.

In several parts of the developing world, delivery of nutrient dense and safe complementary feeding continues to be a challenge (WH0, 1998). The challenges are however, context specific,

but many are common across settings. They are often characterized by poor feeding practices and poor dietary quality of homemade complementary foods (Krebs *et al.*, 2011; Dewey, 2008; Plessis *et al.*, 2013). Poor feeding practices are characterized by untimely production of complementary foods, number of serving times (infrequent feeding), and poor feeding methods, hygiene, and child-care practices (WHO, 2003; WHO, 2001). In addition, poor dietary quality of the foods served is characterized as too little variety; inappropriate consistency (food is too thin or too thick); low vitamins and minerals content, too few essential fatty acids; and too few calories among non-breastfed infants (Dewey, 2008). In developing countries, complementary foods are low in vitamin A and make minor contribution to total intake (Baye *et al.*, 2013; Gibson *et al.*, 2009). And it is estimated that children could get 40 to 60% of their daily vitamin A requirement from breast milk during the complementary feeding period (Ross & Harvey, 2003).The poor quality and lack of diversity in foods adversely affects the children's growth and nutritional status (Onyango, 2014).

1.2 Statement of the problem

In Ethiopia, micronutrient deficiency spreads widely. A report of 2011's Ethiopian Demographic Health Survey (EDHS) shows that 12%, 44% and 33% of children were wasted, stunted and underweight, respectively. Iron, vitamin A, zinc, calcium, folate and vitamin B_{12} are the major problematic micronutrients (EDHS, 2011). In Ethiopia, complementary foods predominantly depend on cereals, legumes and tubers. Low quality monotonous diets are the common norms. Complementary foods made from single or limited number of food item is small enough to cover the required amount. According to EDHS data, complementary foods in Ethiopia lack diversity and quality.

In developing countries homemade complementary foods are composed of staple crops typically, cereal and legumes. The nutrient requirement of children increase with age consequently diets from such staples fail to provide nutrients in the recommended amount. Consumption of micronutrient rich foods such as animal source foods, fish, and eggs is occasional. Several factors could contribute to this low intake however; lack of knowledge on the proper use and preparation of complementary foods is among the prominent ones. In other words, they produce foods rich in micronutrients, but they are not the beneficiaries. They have different farming activities and can produce cereals, grains, legumes and to some extent vegetables and fruits which all are plentiful source of micronutrients. They are also the owner of cattle and chickens. However, they do not use

their properties in a proper way and they easily exposes to micronutrient deficiencies. Literatures suggest that unfortified complementary foods that are predominantly plant-based generally provide insufficient amount of certain key nutrients (iron, zinc, and calcium) to meet the recommended nutrient intake during 6–23 mo (WHO, 1998; Dewey & Brown, 2003; Gibson *et al.*, 1998). Fulfilling the nutrient requirement of these key nutrients from complementary foods is a challenge (WHO, 1999). Although it requires the availability and access to different types of micronutrient rich food sources, increasing the diversity of the diet is the desired option to fill the gap between complementary foods and the nutrient requirement of the nutrient. In resource poor areas where increasing dietary diversity appears to challenge, using micronutrient powder (MNP) is another option to improve the nutritional adequacy of complementary foods (WHO, 2000).

If breast-fed infants are given family foods, there is likely to be a shortfall in intake of certain key nutrients even though it is nutritionally adequate for the rest of the family. This is because the first two years of life is the critical period that nutrient needs per unit body weight of children and infants become very high. This suggests that transitioning directly to "family foods" as the single source of complementary foods may put the infant at risk of multiple micronutrient deficiencies (Gibson *et al.*, 2010). However, such feeding practice is very common in rural areas of developing nations.

Time constraint is another factor that limits better complementary feeding practices of children particularly in rural parts of the country. As a habit several responsibilities inside and outside of the home are looking for mothers than fathers. These numerous workloads lag the mother to prepare complementary foods timely, safe, adequate and frequently to their child.

High phytate content of cereal and legume-based diets is another factor for micronutrient inadequacy of complementary foods (Gibson *et al.*, 2010; Mamiro, 2004). Antinutritional factors such as phytates bind minerals thus limit their bioavailability in the human body system. The research determined the adequacy of micronutrient in homemade complementary foods and examined the association between maternal perspective and nutritional status of the children in Meket District, North Ethiopia.

1.3. Objectives

1.3.1General objective

- To determine the micronutrient adequacy of homemade complementary foods in Meket District, North Ethiopia

1.3.2 Specific objectives

- To determine the micronutrient content of complementary foods in Meket District, North Ethiopia
- To assess knowledge, attitude and practices of mothers and caregivers on complementary food in Meket District, North Ethiopia
- To assess the composition and diversity of complementary food from Meket District, North Ethiopia

1.4 Research questions

1. What are the staple foods commonly consumed in the household?
2. What is the relation between mother's perspective and complementary feeding practices?
3. What are the constraints for appropriate complementary feeding practices?

2. Literature review

2.1. Child Undernutrition

Micronutrient deficiency is a major global public health problem. More than 2 billion people in the world are estimated to be deficient in key vitamins and minerals, particularly vitamin A, iodine, iron and zinc (UNICEF, 2009) primarily due to inadequate dietary intake (Fielder and Macdonald, 2009). Micronutrient deficiency is a serious child hood dietary problem in developing nations. Recent scientific evidence shows that malnutrition has been, directly or indirectly, responsible for 60% deaths of infants and under five children. According to the report by Reva Nayyar, (2004) in the Indian guideline of infant and young child feeding, two third of this occasion is due to inappropriate feeding practices and occurs during the first year of their life stage. In addition, the report also shows that poor feeding practices result in malnutrition and had significant contribution to impaired cognitive growth and social development, poor school performance and reduced productivity in later life of the child.

2.2. Causes of undernutrition

Undernutrition in young children is widely distributed in developing regions of the world. Multidimensional motives can cause to under nutrition and they fall on three levels. Inadequate dietary intake, poor dietary diversification and high rate of infectious diseases are found from the immediate causes (Black *et al.*, 2013). Children from poor family have low nutritional status than that of from wealth children. Poor breast-feeding, early weaning (short period of exclusively breast-feeding), late introduction of complementary foods, limited amount of nutrients in the diet are causes for insufficient dietary consumption of infants and children. On the other hand, infected children cannot able to receive enough food to cover the required nutrient. Diarrhea and vomiting causes to loss nutrient from the body as well. Insufficient access to food, inadequate mother, childcare, poor environment, and inadequate health services are the underlying causes and directly or indirectly affect the nutritional status of the infants and children. Poor availability of economic and human resources and organizational (ideological, social and political) structure are the basic or root causes that results under nutrition (UNICEF, 2003).

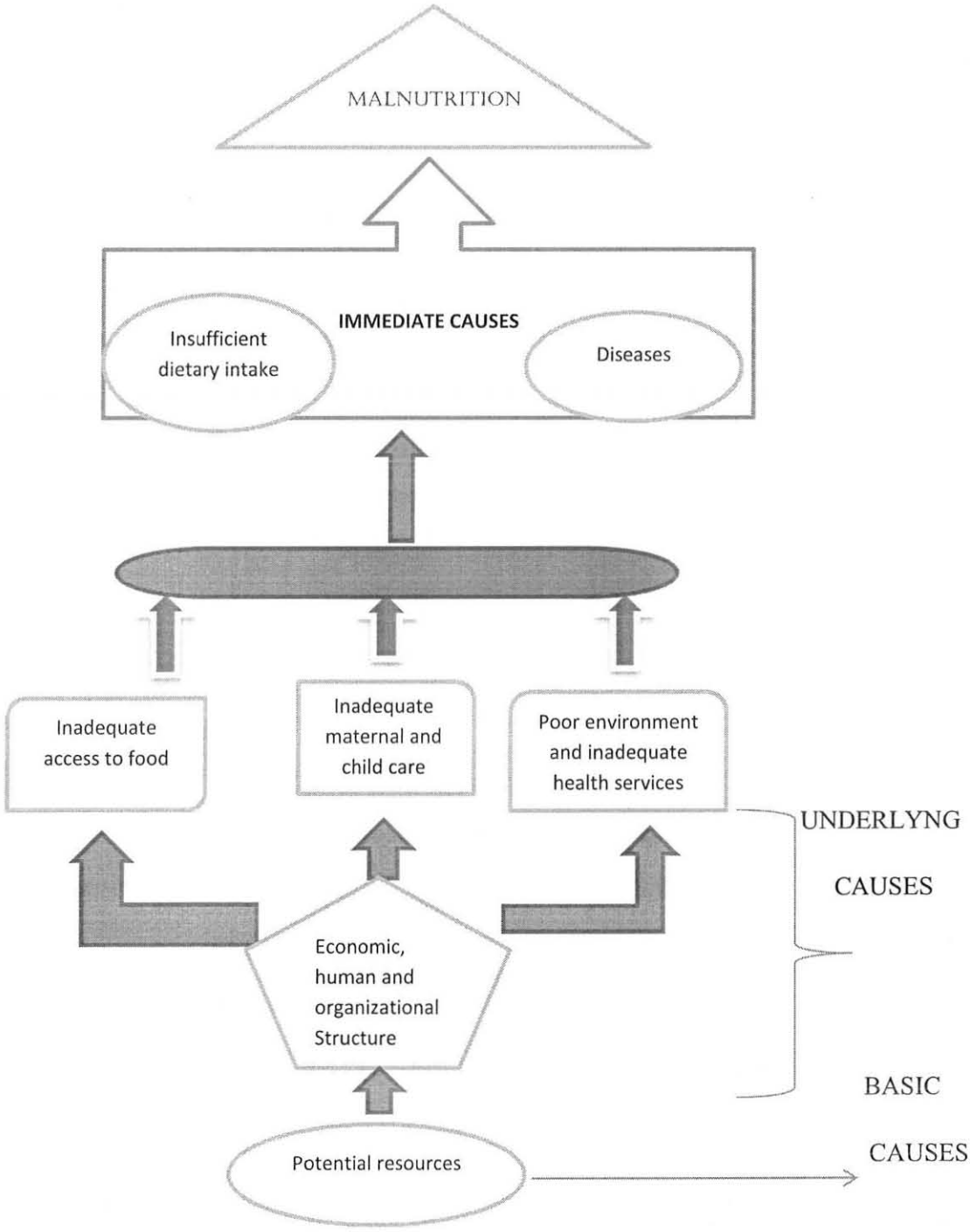

Figure 1: Conceptual framework for determinant of nutritional status; UNICEF/WHO/1998

2.3. Breast milk

No food is as good as breast milk in the provision of important nutrients needed by the child. Exclusive BF is the only alternative to get enough nutrients. Breast milk makes significant contribution to the total nutrient intakes. In well-nourished mothers, breast milk contains generous amounts vitamin A, B, C, folate, iodine, and selenium. As a result, the amount needed from complementary foods before 12 months is 0 (or close to 0) (Dewey, 2001; Dewey & Brown, 2003).However, the consistent provision of these necessary nutrients is under consideration. In the long run, the two contrary situations would be come out; declining of breast milk nutrient content relating with eating pattern of the mother and increasing of infants' micronutrient requirement at high rate. Therefore, to bridge this gap introduction of adequate amount of complementary food becomes an alternative way.

2.3.1. Breast milk nutrient composition

Breast milk contains large amounts of nutrients, which are crucial for infant growth and health guarantee.

Table 1: Nutrient composition of breast milk, National Health and Medical Research Council (NHMRC, 2003).

Nutrients	Nutrient amounts in the breast milk
Energy (kJ)	280.0
Protein (g)	1.3
Fat (g)	4.2
Carbohydrate (g)	7.0
Sodium (mg)	15.0
Calcium (mg)	35.0
Phosphorus (mg)	15.0
Iron (mcg)	76.0
Vitamin A (mcg)	60.0
Vitamin C (mg)	3.8
Vitamin D (mcg)	0.01

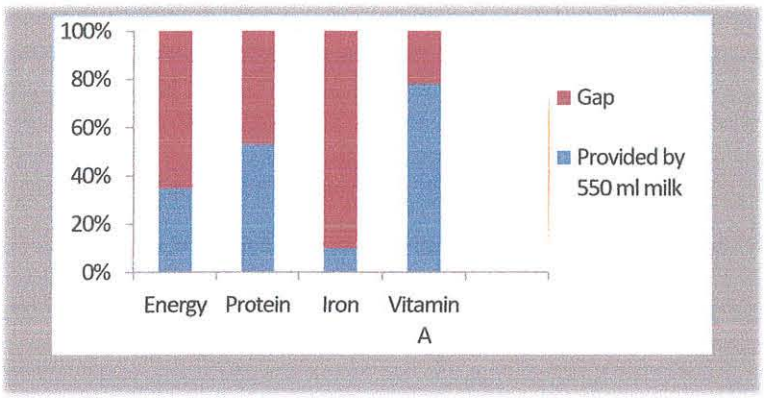

Figure 2: Gaps to be filled by complementary foods for a breast-fed child 12-23 months (Abeshu *et al.*, 2016).

2.4 Complementary foods

Complementary food is any food other than breast milk given in the complementary feeding period (from 6 to 24 months) (WHO, 1998; Dewey and Adu-Afarwuah, 2008). Sometimes complementary foods can be derived from family foods by some modification of its color, thickness or taste of the original food. In addition, complementary foods can be especially prepared for infants or can be the same foods available for family members, modified in order to meet the eating skills and needs of the infant. In the first case, they are called transitional foods, and in the second case, there is no specific nomenclature (WHO, 1998).

2.4.1 Age of introduction of complementary foods

The age at which complementary feeding begins at six months. The time and delivering practice of complementary foods have effects on the physical and cognitive development and may be cause of infants' mortality and morbidity. There is high risk of harmful effects (possibility of choking, food allergies, and decrease in breast milk intake or formula) through the early introduction of complementary foods. Several studies conducted both in developing and industrialized countries shows that early introduction of complementary food increases infant morbidity and mortality, because of the reduced ingestion of protective factors present in breast milk, in addition to the fact that complementary foods are also important source of contamination for infants (Dewey *et al.*, 2001). Early introduction of complementary foods shortens the duration of breastfeeding, delays

the uptake of important nutrients found in breast milk and the chance of the mother to get pregnancy may be high (McNeilly *et al.*, 1985).Complementary foods have a lower nutritional value, than breast milk, and to fill the intake requirement is high. Thus, result in loss of important nutrient from breast milk since it replaces part of breast milk (WHO/UNICEF, 2001). A shorter duration of exclusive breastfeeding does not protect health of infants and neither does it improve it (Kohen *et al.*, 1994; Dewey *et al.*, 1999). After the sixth month, the replacement of breast milk with complementary foods becomes less problematic (WHO/UNICEF, 2001; PAHO / W HO, 2003). The early introduction of complementary foods has been associated with the development of atopic diseases. On the other hand, exclusive breastfeeding minimizes the risk of asthma and this protective effect seems to persist for at least during the first decade of life, which is particularly evident in children with a family history of atopic diseases (van Odjik *et al.*, 2003). Exclusive breastfeeding also seems to protect against the development of type one diabetes mellitus (Gerstein, 1994). It has been described that early exposure to cow's milk (before the fourth month) can be an important determinant factor for this disease and that it can increase the risk of diabetes by 50% (Gerstein, 1994).

The late introduction of complementary foods is also disadvantageous causing growth faltering, energy and micronutrient deficiency (WHO UNICEF, 2001; PAHO / WHO, 2003). Delayed introduction may miss developmental readiness of infants (and difficulties learning to eat at later ages) while risking malnutrition at the same time (USDA, 2009; Cohen *et al.*, 1994). Readiness in most infants and the ability to tolerate foods consumed would occur around 4 and 6 months of age (USDA, 2009; Issaka *et al.*, 2015). During this period, the intestinal tract have well-developed defense system that minimizes or averts risk of allergic reaction in infants following intake of foods containing foreign proteins, while its ability to utilize proteins, fats, and carbohydrates improves. Similarly, the infant's kidney develops to a state where it can successfully eliminate waste products emanating from foods such as meat with characteristic high renal load. Furthermore, their neuromuscular system matures enough leading into development of abilities for recognizing food, accepting spoons, masticating and swallowing foods, and, even, distinguishing and appreciating varieties in food tastes and colors (Cohen *et al.*, 1994; Health Service Executive, 2008).

In Ethiopia, the introduction of liquids other than breast milk, such as water, juice, and animal milk takes place earlier than the recommended age of about 6 months (Tizazu, 2009). Many Ethiopian mothers do not realize the importance of giving special foods to their children. Not only the matter of knowing about the importance of special foods, their perspective on feeding practices also has the contribution on successful achievement of recommended intakes. But most of the mothers in Ethiopia are far from such awareness. There are several culture-based viewpoints that bring variations on the introduction of complementary foods. For example, cow milk is given first than other foods. However, in the urban areas where milk is purchased, it has additional problem. From the source, the subjects could dilute it with water and hygienically is unsafe. Consequently, loss of nutrients and milk contamination are common. Usually complementary foods based on cereal gruel and porridges are given until family food is introduced. Use of infant formula is not a common practice in Ethiopia. EDHS of 2005 shows that only 0.8% of infants 6-11 mo old and 0.9 % of children 12-23 mo old were given infant formula and 49% of children under six mo of age exclusively breast feed (CSA and ORC Macro, 2006).

Why infants should start complementary foods at six?

As stated by literatures at this age developmental changes occur as stated below; (Alvisi *et al*, 2015)

- The infant's intestinal tract develops immunologically with defense mechanisms to protect the infant from foreign proteins (thus, the risk of hypersensitive (allergic) reactions to the proteins in complementary foods is reduced).
- The infant's ability to digest and absorb proteins, fats, and carbohydrates, other than those in breast milk and formula, increases rapidly.
- The infant's kidneys develop the ability to excrete the waste products from foods with a high renal solute load, such as meat.
- The infant develops the neuromuscular mechanisms needed for recognizing and accepting a spoon, masticating, swallowing non-liquid foods, and appreciating variation in the taste and color of foods.

2.6 Mothers' role in complementary feeding

Mothers should receive greater attention because they play an essential role in the complementary feeding process. For example, they decide the time the infant should receive the complementary food, preparing the meals and thereby determining their nutritional quality and level of hygiene, look after the children's health; earning and managing the budget to spend for complementary food (Silja Nousiainen, 2014). Therefore, aspects such as education of the mother, awareness on child caring and feeding practices, time and household food security helps the mother to maintain proper feeding and child caring practices. Researches shows that the higher a mother's educational level, the greater her aptitude to adopt healthy complementary feeding practices, continue breastfeeding despite social constraints, eliminate unsatisfactory food practices, and ignore the effects of harmful advice from her family, friends, or the media(Lisa C. *et al*, 2004).

Time constraints: because of the demands of family and work, mothers often have little time to offer to their children. Mothers who do have spare time could vary their children's meals by cooking vegetables. They should also follow basic roles of hygiene when preparing meals, feed their children under the best possible conditions and, respecting their child's rhythm, prepare meals several times a day rather than just once. This would not only increase the number of meals, but also avoid keeping food under conditions that make it prone to contamination. Nevertheless, it is important to provide children with a complementary food that is easily prepared, of high nutritional quality, based on locally available products, inexpensive, and acceptable to both mother and child (WHO, 1998).

2.7 Energy and micronutrient composition of complementary foods

Complementary foods are expected to bridge the gaps in energy and nutrients between daily requirements for infants and young children and the amount consumed through breastfeeding. As such, the diets should be energy dense, and provide the required vitamins and minerals (iron, folic acid, and calcium), while supplying reduced or no anti nutritional factors. (UNICEF, 2011).

2.7.1. Energy Requirement of children

Complementary foods are expected to have sufficient energy to provide a growing child with adequate daily energy requirement. Breast milk contains an energy density of about 0.7 kcal/ml (WHO, 2002). The recommended minimum energy density in complementary foods is 0.8 kcal/g higher compared to that of breast milk. In reality, the energy density in complementary foods usually is between 0.6 and 1.0 kcal/g and may even drop to as low as 0.3 kcal/g in watery and dilute foods. Consequently, the amount of complementary food required to cover the energy gap corresponds to the level of energy density in the diets served (WHO, 2009). Energy-dense foods are most important for children with wasting, as they have an increased energy need for catch-up growth. Low energy density complementary foods have long been implicated in protein energy malnutrition (PEM) (Daelmans & Saadeh, 2003). The total energy requirement estimated for healthy breastfed infants is approximately 615 kcal/day at 6–8 mo, 686 kcal/ day at 9–11 mo, and 894 kcal/day at 12–23 mo (Dewey, 2001). For infants in developing countries with "average" breast milk intake, the energy need from complementary food is 200 kcal/day at 6–8 mo 300 kcal/day at 9-11 mo and 500 kcal/day at 12–23 mo. These accounts for 33, 45, and 61% of total daily energy needs, respectively, coinciding with the decreased intake of human milk at older ages (Dewey and Adu-Afarwuah, 2008). These values could vary based on the level of breast milk intake per day (Dewey, 2001; WHO, 2001).

The amount of food needed per day to satisfy their energy requirement is a function of amount of energy needed from complementary foods and the energy density of the foods (WHO, 2009; Caballero *et al.*, 2005). For complementary foods with energy density in the range of 0.6–1 kcal/g, the amount (gram or volume) of food needed to provide energy requirement is 200–333 g/ day for 6- to 8-month-old, 300–500 g/day for 9- to 11-month-old, and 550-917 g/day for 12- to 23-month-old children. Energy dense foods have energy density of 1.07–1.46 kcal/g. For such foods, the approximate quantity of complementary food that would meet the energy needs described above is 137–187 g/day for 6–8, 206–281 g/day for 9–11, and 378–515 g/day for 12- to 23-month-old children (WHO, 2001).The number of meals per day is dependent on the energy gap for stated age, gastric capacity of the child, and energy density of the meal (kcal/g). For foods containing recommended minimum energy density (0.8 kcal/g), assuming gastric capacity of 30 g/kg body weight, the meal frequency expected to provide adequate daily energy requirement is two to three

times for 6–8, and three to four times for 9–11 and 12- to 24-month-old children, with one to two nutritious snacks (WHO, 2001).

Therefore, energy intake among young children is often limited because of gastric capacity and the types of foods young children are usually fed, which are too high in volume and low in energy density. If foods replace breast milk (which has about 50% of energy from fat and is high in many micronutrients such as vitamin A), the total energy and nutrient intake might be reduced. For children 6-23 months of age, large volumes of food can displace breast milk from the child's diet, and can interfere with consumption of local foods, thereby decreasing diet diversity (Giugliani and Victora, 2000).

2.7.2. Micronutrient requirement of children

Micronutrients are essential for growth, development, and prevention of illness in young children (WHO, 2009). Adequate intakes of micronutrients, such as iron, zinc, and calcium are important for ensuring optimal health, growth, and development of infants and young children (Caballero *et al*, 2005; Rolfes *et al*, 2008).

Iron deficiency anemia becomes prevalent in developing countries as early as the first year of life, and even in industrialized countries fortification of infant foods with iron is believed to be essential for preventing anemia in child hood (Filer, 1989; WHO, 1998). Breast milk does not supply enough iron to meet iron requirements after 6-9 mo of age or earlier in infants who are premature or of low birth weight. Because iron deficiency anemia causes delays in neuropsychomotor development (Walter, 1993), impaired cognitive performance and reduced working capacity (Muller and Krawinkel, 2005; Filer, 1989; Vyas & Chandra, 1984), the provision of adequate amounts of iron through complementary foods is an important concern.

The percentage of total daily requirement for micronutrients needed from complementary foods ranges from 30-97%. For instance, 97% of iron, 86% of zinc, 81% of phosphorus, 76% of magnesium, 73% of sodium, and 72% of calcium during 9–11 months are expected from complementary foods (Dewey, 2001; WHO, 2001; Dewey & Brown, 2003). Thus, added to the fact that infants allow only limited gastric capacity to consume adequate quantity of food, the diets need to have very high nutrient density (WHO, 2001).

Table 2. Nutrient requirements during first 2 year of life (WHO/FAO, 1988)

Nutrient	Recommended nutrient intake		
	Age in month		
	6-8	9-11	12-23
Vitamin A (μg RE/d)	350	350	400
Vitamin B12 (μg/d)	0.4	0.4	0.5
Calcium (mg/d)	525	525	350
Iodine (μg/d)	60	60	70
Iron (mg/d) :			
Low bioav	21	21	12
Mid bioav	11	11	6
High bioav	7	7	4
Zinc (mg/d)	5.0	5.0	6.5

Source: (FAO/WHO, 1988) estimates for basal requirement including variability and assuming iron bioavailability as low (5%), intermediate (10%) and high (15%).

Dietary sources of important micronutrients

Micronutrients are mostly found in large quantities from animal, fruit and vegetable sources. On the other hand, as reported by several researchers, the content of plant-based diets are limited in one or more micronutrients (WHO, 1998; Dewey and Brown, 2003). The table below shows list of diets that are plentiful sources of micronutrients.

Table 3: Dietary sources of important micronutrients (Source: WHO, 2009, 1998 & 2003; FAO, 2011; FMOH, 2006).

	Micronutrients			
Sources	Iron	Vitamin A	Zinc	Calcium
	Meat; liver; legumes; whole-grain breads, cereals, or fortified or enriched grain products; and dark green vegetables.	Egg yolks, yellow and dark green leafy vegetables and fruits (e.g., spinach, greens, sweet potatoes, apricots, cantaloupe, peaches), and liver, organ meat, red palm oil.	Infant formula; meat; poultry; liver; egg yolks; cheese; yogurt; legumes; and whole-grain breads, cereals, and other fortified or enriched grain product	egg yolks; poultry; meat; fish; and whole-grain breads, cereals, and fortified or enriched grain products

2.8. Homemade complementary foods

Homemade complementary foods are food item that can be made at home from locally available food sources predominantly plant-based foods or from the market. Most of the time they are cheaper, easier to prepare and healthier than fortified or other fast foods. Way of preparation and types of foods (dishes) might differ across the environments even within individuals. Availability of foods, abilities of mothers (skill, capacities and aptitudes), culture and season are some of the factors that make homemade complementary foods different. Unlike fortified and processed foods homemade complementary foods do not keep longer (Abeshu *et al.*, 2016).

For infants and young children of 6–11 mo, for instance, provision of thick porridge made of maize, cassava, millet; to which milk, soy, ground nuts, or sugar is added; or mixtures of pureed foods made out of potatoes, cassava, posho (maize or millet), or rice, being mixed with fish, beans or pounded groundnuts, and green vegetables added would allow consumption of nutritious foods. Addition of nutritious snacks, such as egg, banana, bread, papaya, avocado, mango, other fruits, yogurt, milk, and puddings made with milk, biscuits or crackers, bread or chapatti with butter, margarine, groundnut paste or honey, bean cakes, and cooked potatoes, would sufficient their nutritional needs (WHO, 2009, 1998 & 2003; FAO, 2011; FMOH, 2006). For children of 12–23 months, provision of adequate servings of mixtures of mashed or finely cut family foods made out of potatoes, cassava, or rice; mix with fish or beans or pounded groundnuts; add green vegetables or thick porridge made out of maize, cassava, and millet; add milk, soy, ground nuts, or sugar, would allow consumption of nutritious foods.

In many developing countries, commercial fortified food products are often beyond the reach of the poor. As a result, homemade complementary foods are frequently used during child feeding (Abeshu *et al.*, 2016). The basic recipe food items used for the preparation of the complementary food commonly base on locally available staples, while the choice of specific food item differs considerably between populations, owing to tradition, availability, and ease of access (Kuyper *et al.*, 2013). Carbohydrate rich foods such as cereals, roots and starchy fruits are major staples that consumed largely by developing countries (Abeshu *et al.*, 2016). Different sources of homemade complementary foods have different micronutrient contents. For example, homemade complementary foods from starchy roots and tubers are low in calcium, zinc and iron. On the other

hand, foods from maize, cereals and legumes are rich in iron and zinc contents (Abeshu *et al.*, 2016).

2.8.1. Ethiopian homemade complementary foods

Homemade complementary foods in Ethiopia predominantly are made from staple cereals or starchy tubers such as maize, sorghum, millet, oat, teff, rice, potato, barley and yam. The usual complementary foods are served as gruel, porridge, *fitfit* (the scrambled *enjera* in shiro), *kitta* (unleavened flat pancake) and bread. Consumption of animal-source foods as well as fruits and vegetables is very low (only 5.5% and 7.1% of infant 6-11 mo old and 13% and 17.7% of children12-23mo old were given meat and meat products and fruits and vitamins rich in vitamin A respectively)(EDHS, 2005; Temesgen, 2013; Baye *et al.*, 2012).

Literatures suggest that unfortified complementary foods that are predominantly plant-based generally provide insufficient amounts of certain key nutrients (particularly iron, zinc, and calcium) to meet the recommended nutrient intakes during 6–23 months of age (WHO, 1998; Dewey & Brown, 2003; Gibson *et al.*, 1998). Animal-source foods are rich in protein, fat, and micronutrients and their inclusion can therefore meet the gap in some cases. However, this might be impractical for lower income groups, given their high cost. Even when availed, the amount of food from animal sources that children can consume at ages of 6–12 months would become insufficient to facilitate intake of adequate nutrients as iron, calcium, and, seldom, zinc – in comparison to the nutrient gaps (WHO, 2009). Because during this period (first phase) the young children consumes in small amount since they would not be matured to crash enough. If they eat more then it begins to replace breast milk. Gibson *et al.* (1998) evaluated 23 different complementary food mixtures used in developing countries, including in Ethiopia, some of which included animal-source foods. None of the complementary foods achieved the desired nutrient density for iron, and while few achieved the desired level for calcium or zinc. As has been observed in most other developing countries, the traditional complementary foods have been reported to be grossly inadequate when compared to estimated needs. Existing literature for the nutrient density, energy levels, and adequacy of the amount consumed in comparison to their nutritional requirement are not consistent (Temesgen, 2013; Baye *et al.*, 2012; Abebe *et al.*, 2006).

Iron, zinc, and calcium are limiting nutrients in unfortified plant-based complementary foods commonly used in developing countries (W HO, 1998; Dewey & Brown, 2003; Gibson *et al.*, 1998). According to Baye *et al.* (2012), calcium in the complementary foods collected from North Wollo was below the desired values. However, the nutrient density for iron meets the desired values even under the assumption of low bioavailability, while zinc meets the nutrient density requirement when accounting for a moderate bioavailability. While the children consumed sufficient amount of protein and iron, they fell short of their calcium and zinc needs from complementary foods. In contrast to this, Gibson et al. (1998) reported that the complementary foods under study failed to meet the desirable level for Ca, Zn, and Fe, even if moderate bioavailability is assumed for iron and zinc, and would not satisfy the estimated daily requirement for these nutrients for children of 9–11 months, even if ideal serving sizes are provided.

Generally, Ethiopian homemade complementary foods are micronutrient deficient, since in most areas, the staple foods are cereals and there is limited access to improve these diets by including animal source foods, the reason may arise from different directions. Mother's perspective and limited knowledge and availability of these micronutrient rich foods are most commonly registered.

2.9 Dietary diversity

Dietary diversification is a recommended approach to overcome nutritional problems resulting from food insecurity and inadequate intake of micronutrients. It is essential to diversify food intake to meet nutrient adequacy, as there is no single food, other than breast milk for the first six months of life containing all the nutrients required to maintain good health and nutritional status (FAO, 2002). Dietary diversity is therefore a key element of high quality diets and the recommendation to consume a variety of foods appears in many nutritional guidelines. Monotonous diets, based mainly on grains, roots and tubers are common in areas of high food insecurity and contribute to the burden of malnutrition. Dietary diversification is an element of diet-based strategies that can be used to increase intake of multiple micronutrients (Boy *et al*, 2009; FAO, 2002).There is a direct relationship between dietary diversity and micronutrient intake (Hoddinott and Yohannes, 2002; Acham *et al*, 2011). Dietary diversity can be measured by using different proxy of food consumptions. DDS (individual dietary diversity score) and FVS (Food variety score) are the two common measurements of dietary diversity (Arimond and Ruel, 2004).

3: Materials and Methods

3.1 Study setting

Study design

A community based cross sectional study was conducted from February to March 2018 in rural communities of Meket district in North Wollo, among two randomly selected kebeles. Meket district is located 657 km North of Addis Ababa, in the North Wollo zone of Amhara region.

Description of study area

The landscape of North Wollo is vast and very rugged. The terrain is composed of mountains whose peaks rise to over 3,500 meters above sea level, surrounded by steep gorges and broad valley escarpments, and high plateau dissected by deep valleys. Meket is bordered by Wadla and Dawunt on the south, on the west by the Debub Gondar Zone, on the northwest by Bugna, on the north by Lasta, on the northeast by Gidan, and on the east by Guba Lafto. The administrative center of Meket is Filakit Geregera; other settlements include Agrit, Arbit, Gashena and Debre Zebit. Agriculture is the major source of income for the district, the major crops produce includes wheat, teff, barely, and legumes are common. The community practices of farming, trading, and livestock production and in rare areas home gardening is accomplished. In this Woreda, the diet is mainly composed of cereals and legumes and the consumption of animal source foods is very limited. High rate of infectious diseases, low access to food, and to improve water sources and sanitations are major factors contributing to micronutrient deficiencies. Meket, as well as the other seven rural woredas of this Zone, has been grouped amongst the 8 woredas identified as the most drought prone and food insecure in the Amhara Region (Yassin, 2011).

3.2 Sample size and recruitment of study participants

Sample size

The sample size was determined based on the previous studies conducted on different areas in related concepts and methods (Abeshu *et al.*, 2016) 68 samples and (Baye *et al.*, 2012)76 samples, the total numbers of sample in this research were 78 mothers-child (6-23 month) pair.

Recruitment

A record of name of legible households with children (6-23 mo ages) in the villages was obtained from the health post with the support of health extension workers. Continuous numbers were assigned to legible households then households were selected randomly with random number generator computer program. All data collectors were at least high school graduates from the local area. Data collectors were trained for two days on interview technique and dietary data collection. Then trained interviewers started to conduct at the home of the subjects.

3.3 Data collection

A. Interview on maternal KAP and socio-demographic characteristics

A semi-structured questionnaire inquiring about socio demographic characteristics, child caring practices, knowledge and attitudes of mothers about complementary feeding practices was prepared. The socio demographic statuses of the participants and feeding practice, knowledge and attitudes of mother to complementary feeding were assessed by using a pre-tested structured questionnaire in neighboring villages. Question on educational levels of the parents, mother and child age, religion, marital status, family size, head of the house hold, income source , land size, products produced from their lands, products used for consumption and serve to the market were included on the questionnaire. Mothers were interviewed about their knowledge, experience and attitudes concerning with child feeding practices and methods of complementary food preparation.

The questionnaire was developed in English version, translated to Amharic, and then back translated to English for consistency. Before intake assessment, collecting information about the name and number of child (6-23 mo) that lives in the study area from the available health center was the first movement. All the interviews were conducted in the respondents' residence. The study was including children between the intervals of 6 and 24 months. However, no child was the subject of our study with the age of 6 to 9 month.

B. Dietary data collection

A qualitative 24-hour dietary recall method was used to dietary data collection. Seventy-eight total samples and twenty-five food items was collected. All list of meals, food items and beverages consumed the previous 24 hrs were recorded by the interviewers. Mothers/caregivers asked for the

description of ingredients, preparations and amounts eaten. Local household measurements (cups, plates and spoons) were used for the estimation of the amounts eaten by the children. Samples from individual households were put on plastic bags and bottles. Then the samples kept under refrigerator until transferred to lab analysis. Samples collected from households were transfer to Addis Ababa for laboratory analysis to determine the moisture and mineral content.

C. *Anthropometric measurement*

Nutritional status of all the selected children was assessed by measuring body length (cm) and weight (kg) and compared with the WHO Growth Reference (WHO, 2002). The same and skilled person did the anthropometric status. To measure the child length children were with light clothes and no shoes. Then the measuring board placed on the ground and the child was setting on the middle. Length was read to the nearest 0.1 cm. The child weight was also measured with children light cloths and no shoes. The weight was recorded to the nearest 0.1 kg. Z-score; WLZ, WAZ and LAZ were calculated based on ENA and with the reference of WHO.

The measurement was then converted into standard Z scores: weight for age, length for age and weight for length. Weight for age (WAZ), length for age (LAZ) and weight for length (WLZ) less than -3SD shows severe underweight, severe stunting and severe wasting respectively. WAZ, HAZ and WHZ between -3SD to -2SD is classified as moderately underweight, moderately stunted and moderately wasted respectively. Children with WAZ, LAZ and WLZ $\leq$-2SD was classified as undernourished.

3.4 Sample analysis

From each sample, some portions (5 gram) were measure and placed on the cleaned crucible for further analysis. The sample was charred on hot plate under a fume-hood with increasing the temperature slowly until the smoke ends. The sample was converted into ash in muffle furnace at 550°C for 5 hours until a whitish ash was found. This was a pre stage for mineral determination.

3.4.1 Moisture content analysis

Moisture content of the samples was determining by using oven drying according to the procedures proposed by AOAC, (2000). A crucible dish was cleaned and placed in an oven at 105 ^{0}C for an hour for drying. The dried dish then placed in desiccators to cool down for 30 minute. The weight of the crucible dish was measure and represented as (W_1) and 5g of sample was measure on the

crucible (W_2). The sample then dried at 105 °C until the moisture from the sample had completely runs off, the moisture content then recorded or read from the instrument.

3.4.3 Determination of calcium, iron and zinc

Mineral content was determined by atomic absorption spectrophotometer (AAS) using the method proposed by AOAC (2000). The ash was wetted completely with 7ml of 6N HCl and dried on a low temperature hot plate. Then 10ml of 3NHCl was added to dried ash and heated again on hot plate until the solution boiled. The solution was cooled to room temperature in a hood and was filtered into a 50ml graduated flask using filter paper. Then 10ml of 3N HCl was added into each crucible dishes and was heated until a solution boiled then cooled and was filtered into the flask. The crucible dishes were again washed three times with deionized water, the washing was filtered into a flask .Then the solution was cooled and diluted 50 ml with de-ionized water. Finally, Iron, zinc and calcium content was quantified using AAS at Arba Minch University.

Quality control

Before the survey, all questionnaire and consent forms were translated in to Amharic and then back translated to English version. The data collectors were at least grade 12 completed students and a two-day intensive training was given. Pre-testing questionnaire was conducted in the neighboring villages before the actual interview.

3.5 Statistical Analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS 2013, version 15). Descriptive statistics for frequencies of all the socio-demographic information was used. Mean, median and standard deviation for nutrient intake were used and micronutrient intakes were evaluated in accordance with WHO recommendations. Binary logistic regression was used to test the relationship between maternal education and feeding practices (cooking complementary foods different from family foods). Pearson correlation was used to test the relationship between anthropometric status and mineral concentration of the children. The relationship between maternal education and feeding practices (introduction time and dietary diversity) were also tested by Pearson correlation test.

The relationship amongst the variables then examined. Estimated needs from complementary foods were used to evaluate the adequacy of micronutrient intake from the complementary foods; means and SD for nutrient intakes were used. A p-value of 0.05 was regarded as the level at which tests were significantly measured.

Ethical consideration

A letter of ethical approval was received from Institutional Review Board of Addis Ababa University. Support letter was also obtained from Meket Woreda health offices. Informed oral consent was obtained from study participants after clarifying the purpose of the study and the potential risk and benefits of participating in the study.

4: Results

4.1. Socio demographic characteristics

Seventy-eight mother child pairs participated in the study. The mean age of the participating mothers were 27.67±5.29 and the highest number of the mothers was in age group of 23 to 29 years. The socio demographic information of the respondents is summarized in table 4.

Table 4: Socio-demographic characteristics of the respondents in Meket district of North Wollo, Ethiopia.

Variables	N	Percent
Marital status of mothers/caregivers		
Married	70	88.6
Widowed	3	3.8
Divorced	5	6.3
Educational status of mothers/caregivers		
Illiterate	40	51.9
Read and write only	17	21.5
Primary school	18	22.8
Secondary school	3	3.8
Educational status of household head		
Illiterate	26	33.3
Read and write	24	30.8
Primary school	18	23.1
Secondary school	10	12.8
Religion		
Orthodox	75	96.2
Muslim	3	3.8
Occupation of household head		
Farmer	59	75.64
Trading	18	23.06
Driver	1	1.3
House hold head		
Male	70	88.6

Family size		
1-4	35	44.9
5-8	43	55.1
Land size/ha		
No	19	24.1
≤1/2	6	7.6
>1/2	43	65.1
Types of crops grown		
Cereals only	11	27.8
Cereals and legumes	37	46.8
Cereals and vegetables	5	6.3
Cereals, legumes and vegetables	9	11.4
Have commodities for exchange		
Yes	9	11.4
No	69	87.3
Ownership of cattle		
None	4	5.1
1	5	6.3
2-4	48	60.8
≥ 5	21	26.6

About 51.9% of mothers were unable to read and write and 21.5% were those who had secondary level education. Agricultural activities are their major income sources for this 75.4% were dependent on these farming practices and 23.06% were on both agriculture and some trading activities. As their lively-hood depended on agricultural practices the majority of them are the owner of land size of above a hectare of ½ and few respondents have not land, they consider them landless even if they have a piece of land less than a quarter. A cereal gets the first rank on production level than other grains, although there is a mixed farming practices and production. A lesser of them produces all types of cultivars who are the owner of huge land areas to fully cover all the required amount and types of cultivars. Respondent produce products that could cover enough only for daily consumption, in other word they have no products that can be serve to the market, if there it could be a type of vegetables and oil seeds. Above 60% of the respondents were the owners of cattle. Despite nearly to none of them were beneficiaries of their properties rather they used them

as income source, transporting services and for accomplishments of agricultural doings. This intends that involvement of ASF to the usual intake gets too low. Perhaps, when there is a ceremony, wedding, and special holidays; ASF seems to be consume with their diets. The point that we understand from this is that shortage being not taken as the only cause to undernutrition, awareness and other non-financial problem should get consideration.

4.2. Mothers and caregivers perspective on complementary foods

A knowledge gap among mothers was evident with respect to time of introduction of complementary food, preparation of complementary foods, adequacy and frequency of complementary foods and diversification of complementary foods. For example, 12.8 5 of the children received their complementary feeding at 12 mo which is too late, give limited time to their child, did not prepare special baby foods to their child, did not improve the consistency of complementary foods and prepare small number foods from small group of food sources.

There were a gap between the information obtained from the mothers and the actual feeding practices (observed). The practice of starting complementary feeding at the recommended age of the time low. In the present study, 57.7% of the participants responded that the time for introduction of complementary foods to their child was at 11and 12 month. In addition, 42.3% started to feed complementary food to their children starting from 10 months age. All the children (100%) continued breastfeeding to more than two years along with their complementary foods.

Most of the respondents had information about child feeding and caring practices from their local health extensions workers. However, the application was limited attributed to workloads. In addition, economic problem was another limitation hindering the present study mothers to provide proper care for their children.

Table 5: KAP of mothers and caregivers on complementary food preparation and child caring practices in Meket district, Wollo, North Ethiopia.

Feeding behavior	Percent
Exclusively breast-feed	
< six month	0
For six month	0
> six month	100%
Timely introduction to complementary foods	
Before six month	0
At six month	0
Seven to nine	0
Ten to twelve	100 %
Optimal time of continued complementary food along with breast feed	
For six month	0
For one year	0
For two years	0
Above two years	100%
Number of cooking and serving times per day	
Two times	31.1%
Two-three times	59.5%
Four times	9.9%
Children consuming family foods	
Yes	83.5
No	16.5

Timely introduction of complementary foods

Timely introduction of complementary foods was below the expected amount. From this study, about 12.8% of the mothers started complementary foods at 12 months to their child. Due to numerous workloads of mothers inside (child caring, family looking, food preparation for the whole families, house cleaning, washing clothes, looking cattle) and outside the house hold (farming practices, trading activities, home gardening practices, fetching water, wood collecting) proper complementary food preparation and timely introduction of those foods was too poor. Furthermore, fathers left so many responsibilities including looking after their child, for mothers; they consider it

the only mandatory for mothers or caregivers. So covering such and related activities alone becomes too challenging. Subsequently children become exposed to undernutrition and related factors (effect on their mental, physical and psychological development which results in low school performance reduced IQ intelligence, low cognitive and thinking effect). Habitually feeding was done by the rest of the families or siblings for the purpose of keeping silent the children from crying or other disturbing when their mother are busy with several activities or when she would far away from the house (farming activities, market, other social concerns). Moreover, mothers' education has relationship with proper complementary food preparation and good child caring practices. Mothers that are more educated are better able to process information, attain skill, use health-care facilities, communicate effectively with health-care providers, keeping their environment clean and positive caring behaviors (Lisa C et al., 2004). Even though maternal education predicts better complementary feeding practices and good nutritional status of children, it can be occur when economic condition and living standard is worthy. Likewise, significant differences were not observed between literate and illiterate mothers on complementary feeding practices from the study. There was a little difference in preparation of separate food for their children and serving frequency; mothers who had education were 2.93 times more likely to prepare complementary foods different from family dishes (AOR=2.93: 95% CI: 1.56, 5.50) and 1.72 times more likely to serve foods more frequently than non-educated mothers (AOR=1.72: 95% CI: 0.14,3.2). There were no significant differences in the introduction of complementary food between educated and non-educated mothers; all are the late starter of complementary feeding. Diet diversification was similar in all mothers/caregivers. Therefore, besides formal education, adequate knowledge about caring and feeding practices, access to food and enough time brings change on better complementary feeding practices and good nutritional status.

Table 6: Association between complementary feeding practices and its determinants (maternal education)

Feeding practices	AOR (CI, 95%)	P-value
Preparing complementary foods different from family dishes	2.93(1.56, 5.5)	0.23
Feeding frequency	1.72(0.14, 3.2)	0.48

In this study, all of the mothers had information on complementary food preparation and child caring practices from their local health extension workers. However, this does not ensure that proper child feeding practice will get better. Because there is a matter of time and other numerous duties on the mothers even if they are aware, enough on child caring practice and proper feeding practices. The study conducted in Bangladesh reported that, women's' time constraints and time schedule varies accordingly agricultural activities. During harvesting season women becomes busy to complete their daily tasks, in turn, difficulty to cooking enough for their child and the entire families (Levinson *et al.*, 2002). Some mothers reported that they are the first on sharing of their children's pleasure or irritation, besides this they said there are much more complications that defend them not to do such schedules for their children. Social life connections also other factors to spent their time and reduce child caring practices (Levinson *et al.*, 2002).

4.3. Nutritional status

From the total 41.8 % were male and 57 % were female. Small numbers (21.8 %) of the subjects were within the age of 6-12 mo and 78.2% (61) were 13-23 mo age.

Table 7: Anthropometric status of children (6-23 months age) in Meket district, North Wollo, North Ethiopia, 2019.

Nutritional status	N	Percent
Stunted		
Moderate	22	27.8
Severe	14	17.7
Wasting		
Moderate	25	32.1
Severe	13	16.7
Underweight		
Moderate	21	26.9
Severe	13	16.7

4.4. Feeding practices

Feeding practices of the children do not meet the requirement; timely, adequate, safe and proper fed (WHO, 2002). Feeding practices (safety, timely introduction, adequacy and frequency of complementary foods) was not at the desired level. From the observation, very small numbers (3 were the maximum) of food groups were consumed per day. Injera composed from *teff* and wheat was a staple food commonly consumed (92.3%). Legumes (pea, and grass pea) with spices were major legumes used to made stew (*shiro*) (73%). In addition to this; bean, check pea, pea and lentile cooked with different condiments were frequently consumed. In most cases, no specific food was prepared for their child rather than they transit directly to family foods. These family foods may be enough to meet the required amount of nutrients for the rest of the families but could not meet the children's need. From the study above 95% were depend on cereal-based foods and legumes.

Sometimes they prepared fermented (leavened) and unfermented (unleavened) foods (locally they call it *kita*) for their child and they gave it in an informal way, they just hold with their hand and after a certain time they lost it or they lie down it on unclean floor. Raw milk obtained from their own cow was provided for their children who were not start well to eat family foods. Some of the children were raw milk beneficiaries. Other liquids such as beso, solid and semisolid porridge and tea with bread were prepared in small amounts. Some children received such types of liquids in inconsistent way. Enjeera was provide in different forms like in the form of *fitifit*, enjeera with unboiled shiro, enjeera with bean stew, enjeera with check pea stew and enjeera with roasted ground flaxseed stew. There were other feeding practices that could not be representative for other days since they prepared based on special days and exceptional cases like wedding, ceremony, baptism, tezkar and other holydays. Vegetables, meat products and other special foods, well known by their culture, were oddly consumed. From the total, 85% of mothers cook and provide foods to their child 2-3 times per day. Nevertheless, they did not prepare foods to their child purposely, as an alternative; they tried to end the child's hunger by offering breast milk instead of complementary foods. Mothers/caregivers were less responsive to end child's hunger by complementary foods. Moreover this, the diversity of the food that prepare either for the child or the rest of the family was discontented. Which means only one type food item was served repeatedly throughout the day (DDS=2.52). They did not use more food alternatives to increase their appetite even if different food sources were there. In some cases, less food diversity should not always take for of economic

problem. From the study, 87% of respondents were the owner of different cattle species and 34% were undergone home garden practices but they never add it to their usual consumption by any means. They just use it as an income source, for that matter they sold it, and in return, they bring other household supplies and goods. This is why they do not have enough income sources to fulfill extra requests than foods to the entire family (shelter, clothes, and other social needs). Surprisingly there are farmers who sell cereals, which are not enough to the fully coverage of feeding them throughout the year, and then finally they turn to bought it.

Table 8: Selected nutrient intake of children (6-23mo age) in Meket district of North Wollo, North Ethiopia in comparison with estimated needs.

Mineral	**9-11 mo**					**12-23 mo**				
	N=17					**N=61**				
	Min	Max	Mean	SD	Estimated needs	Min	Max	Mean	SD	Estimated needs
Iron	1.08	7.77	3.37	2.13	9.3	1.53	10.85	4.36	2.12	5.6
Calcium	8.8	36.9	19.8	9.28	400	8.44	31.63	15.6	4.83	346
Zinc	0.44	5.41	1.76	1.49	4.1	0.43	4.64	1.8	0.84	3.8
Vitamin A	10.6	67.8	30.8	17.3	350	9.78	87.37	34.41	18.46	400

Estimated needs from complementary foods are determined assuming average breast milk intake and composition proposed by (Dewey and Brown 2003).

Their mothers feed most of the children. However, serving time was do when they (family) gets sensation to eat. Children's appetite had the negative contribution to poor consumption and involvement of different types of foods in their diet. Generally serving time and preparation was done depending on families' circumstances. Provide nutritious foods; let the children to choose the preferable foods and the amount they need, choose enjoyable environment and mealtime helps to encourage the children to eat the food sufficiently and safely.

Table 9: Correlation between nutritional status and mineral intake of the children in Meket district, North Wollo, Ethiopia

	WAZ		HAZ		WHZ	
	Correlation coffi.	P-value	Correlation coffi.	P-value	Correlation coffi.	P-value
Iron	0.108	0.336	0.538**	0.001	0.428**	0.001
Calcium	0.042	0.716	0.080	0.488	0.074	0.52
Zinc	0.085	0.459	0.063	0.582	0.051	0.137

**, correlation is significant at 0.01 levels

5. Discussion

In the sample of 78 children (6-23 ages) in North Ethiopia, the micronutrient adequacies of homemade complementary foods were examined and mothers/caregivers perspective on those foods and child caring practices was assessed. As a whole, none of the subjects did meet the expected amount of nutrient either qualitatively or quantitatively. Feeding practices and child caring practices were not in accordance with WHO recommendations. Relatively, iron intake of the children was better than other nutrients (35.5% of children have >5 mg of iron intake). However, it does not mean that all the children receive sufficient amount of iron from their usual diet. On the other hand, the intake of calcium, Zinc and vitamin A is below the recommendation. According to WHO explanation, to be healthier, appropriate growth, strengthen muscle; young children specially who fall in the age between 6 months to 2 years old should get enough food rich in essential nutrients. Adequate intakes of micronutrients, such as iron, zinc, and calcium, are important for ensuring optimal health, growth, and development of infants and young children (Caballero *et al.*, 2005; Rolfes *et al.*, 2008). According to WHO, (2009, 1998 & 2003); FAO, (2011) and FMOH, (2006) micronutrients have their own food/dietary sources and with the increasing of the food diversity, the content of micronutrients in diet increases. Fruit, vegetables, and animal source foods are the predominant sources of these important micronutrients. In this study area, cereals are the staple foods in which micronutrients are get in lesser amount. The involvement of micronutrient source foods in the diet takes effort and gets far from their feeding habits. In other words, vitamin source foods were hardly consumed thereby the coverage of vitamins is lacking. More than half of the respondents have their own cattle and less of them have kitchen garden, but surprisingly none of them are beneficiaries from their products.

Almost all the children appropriately received exclusively breast-feeding and keep it along with complementary foods beyond two years of their first life and most of them were in breast-feeding until the time of the survey. Breast milk makes significant contribution to the total nutrient intakes (Dewey, 2001; Dewey & Brown, 2003). Breast-feeding beyond two years was so practiced finely. It is better, in which breast feed makes significant contribution for the total intake of nutrition. But in the study area breast feed was used as an alternative to delayed feel of child's hunger by most of the mothers; significantly the interest to complementary foods becomes decreased thereby low intake of nutrient be real on the children. Inadequate and inappropriate nutrient intake results in low

nutritional status of the children. Foods with insufficient amounts of crucial micronutrient; particularly zinc, iron, calcium and vitamin A: causes to poor nutrition, and greatly results on stunting, wasting and underweight. In this study about 45 % of the subjects were stunted which were resulted from low consumption of micronutrient rich foods.

Cow milk, meat products, fruits, and vegetables on the usual diet play the major role on the improvement of good nutrition and better health. In the present study near to all of the children's food was far from the inclusion of such basic foods. In most literatures financial problem considered as a cause to less consumption of milk and meat product foods and for the introduction of fruits and vegetables in the common diets. Now that might not be the only reason, ''awareness about child caring practice and appropriate food preparation'' should be taken as the main problem on the caregivers and the community. Caregiver feeding behaviour has the major role on infant feeding practices and better health life. None of the children consumed ASF and fruit and vegetables foods except eight children who had milk on their diet.

Table 10: Dietary diversity score (DDS)

Food group	Children consuming %
Cereals	92.3
Meat, poultry and fish	0.0
Fruits	0.0
Vegetables	0.0
Dairy	8.97
Eggs	0.0
Legumes, Pulses/nuts	73.0
Oils	80.7
Dietary diversity score (DDS)	**=2.52**

This is in line with the study conducted in Lasta district that shows only 5% of children get meat, fish and meat products (Menberu *et al.*, 2017). Similarly, Baye *et al.*, (2012), in North Wollo found that only 6% of children were consuming ASF, fruit, and vegetables. Another study in Southern Ethiopia (Sidama and Wolayta zone), also had similar results; none of the participants consumed

ASF and fruits and vegetables. In the contrary, 52.1 % of meat consumption and 32% of grain and tuber, consumption was observed at the same site but in different time of study (Henry *et al.*, 2015).

Most (59.5%) children get their diet two to three times per day. However, the coverage of energy needed was below the recommendation since they consume in small amount per each meal of the day. This result is similar with the previous studies conducted in North Wollo by Baye *et al.*, (2012). Low intake can results from several reasons (mothers/caregiver's approach to the child feeding practices, loss of appetite, infection etc.). Warm relationship between caregivers and child is crucial to the child's survival and healthy development as the provision of food, childcare, stimulation and discipline (WHO, 2004). In most rural areas there are always a burden of numerous activities on the mothers' apart from child caring practices. Looking after their child in a proper way remains the additional assignment. In this study, countless workloads of mothers' directly associated with poor feeding practices of children and their poor growth. During cultivating and harvesting seasons mothers become the busiest among the rest of the families' since such farming activities needs time allocation and they meet with their child for only few times even minutes per day. They get tired and the time goes to dark quickly to prepared well necessary foods there after the alternative should be eating homely available foods that were cook before or at morning, they do before streaming to the farm.

A study conducted in Bangladesh showed that most of the women stress in completing their daily task during harvesting times and work hard with less rest and less self-care; then give less time to their child and take less care for their child during these harvesting time being the result of these burdens (Levinson.M, *et al*, 2002). Likewise nearly all women in this study area reported that they are busier than their husband to pursue daily home need. They faced multi-functional activities including buying and selling goods for the fulfillment of household demands, farming activities (seasonal), looking after cattle, wood gathering, fetching water after traveling long distance away from their home, looking child and the whole family by all means besides social affairs have their own contribution to make their time tight too. Characteristics of mothers/caregivers from this study were not different among themselves since they get up from the community who have common norms, habits, customs even religion (97 %). However, there are minor differences between caregivers on the awareness of child caring practices and appropriate child food preparation. There is no doubt on the role of women's education to bring the wished awareness of mothers/caregivers

child feeding practices and complementary food preparation. However, in such areas mothers' workload and time constraints have the numerous effects on child caring and feeding practices than their perspectives. Nearly all mothers in rural area obey numerous tasks than fathers.

To our knowledge, this is the study that determines the adequacy of micronutrients and in details KAP of mothers on complementary foods in Meket district of Wollo, North Ethiopia. However, the study has some limitations. In a cross-sectional nature of the study, seasonal variations and fasting periods did not take in to account during data collection periods. Further studies that prolong over a single period are needed to validate the effect of seasonality on feeding practices and nutritional status of children in the study area. A single 24 hour dietary recall method conducted by this study, is not accurately representative to the subjects' usual intake which may affected by day-to-day variations. Therefore, use of repeated 24-hour recalls conducted on non-consecutive days is recommended to estimate usual intake of foods.

6: Conclusions and Recommendation

6.1. Conclusions

The traditional complementary feeding pattern in the study area looks like a direct transition from breast-feeding to family foods, with too late introduction and insufficient nutritional contents of the introduced food. Cereal based foods (poor micronutrients contents) are the staples that commonly consumed in that area. Shortly, feeding practices was not in accordance with WHO recommendations. Knowing about appropriate complementary food preparation and feeding practices by mothers/caregivers was poor. Unfamiliar to proper use of locally available foods, not being benefited from own products and countless duties on mothers/caregivers (time constraints) were the observed concerns for these inappropriate feeding and caring practice of children at the side of financial problems and women education.

6.2. Recommendations

Mothers should not miss locally available ASF, fruits, and vegetables during preparation of complementary foods for their child and should give first for their child. There would be an additional expectation from local health extension workers on the advising and counseling of mothers about appropriate complementary food preparation and better time allocation on their child. The government should ensure on simplicity of rural mother's workload than promotion about good complementary feeding practices.

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ANNEXES

Annex 1: Information sheet and Consent form

A. Information sheet

Dear Sir/Madame, how are you?

I am here on behalf of Addis Ababa university center for food science and nutrition, as a main investigator in this study. The study assesses the adequacy of micronutrient on homemade complementary foods and the knowledge, practices and attitudes of mothers/caregivers in Meket district, North Wollo. This booklet contains four sections and under each section, there are number of questions. The results obtained from this questionnaire will be wholly used for research purpose to be conducted in partial fulfillment of Master's Degree in Community Nutrition. If you are willing to participate in this study, the questions are regarding on the complementary feeding status of the children and caregivers knowledge (perspective) on complementary feeding practices. In related to this the weight and height/length of your child will be measured. Your responses are completely confidential and you are free to accept or refuse. However, your honest response to these questions will help us for better understand and to give information for those who are interested for further study. **1.** If yes, name of the interviewer signature

2. If not, skip to the other participant

B. Consent form

I_____ informed on study to be conducted by Masters Student in AAU, center for food science and nutrition. The objective of the study is to assess the adequacy of micronutrient on homemade complementary foods and the knowledge, practices and attitudes of mothers/caregivers. This study is voluntary no obligation to answer any questioner there is no harm by not answering the questions and no special benefit by answering the question and also the interview will take 30-40 minutes. I heard all the information mentioned above and willing to participate in the interview.

1. Signature of the study subject agreed to participant as per the above stated information

_____ _____

2. Name of interviewer _____ Signature _____

በጥናትና ምርምር ላይ ለመሳተፍ ፈቃደኝነትን መጠየቂያ የስምምነት ቅጽ፤

ሰላም ነሽ/ህ

እኔ ከአዲስ አበባ ዩኒቨርሲቲ የምግብ ሳይንስ እና ኒውትሪሽን ማዕከል ትምህርት ክፍል ውስጥ ለሚያደርገው የማስተርስ ዲግሪ የማሟያ የጥናትና የምርመር ስራ እየሰራሁ ነው ::

የዚህ ጥናት ዋና አላማ ከስድስት ወር እስከ ሁለት ዓመት ላሉ ሕጻናት በቤት ውስጥ በሚዘጋጅ ምግብ ላይ የትንንሽ ንጥረ-ነገሮችን መጠን ማጥናት ነው፡፡ ከዚህም በተጨማሪ የእናቶች ወይም የአሳዳጊዎች በህፃናት ምግብ አዘገጃጀት ላይ ያላቸውን ዕውቀት እና የህጻናትን የሰውነት መጠንም ይለካል፡፡ ይህ የመረጃ ወረቀት አራት ክፍሎችን የያዘ ሲሆን በእያንዳንዱ ክፍል ስር ዝርዝር ጥያቄዎች ይገኙበታል፡፡ ስለዚህ እርስዎ ፈቃደኛ ከሆኑ በዚህ ጥናት ላይ ተሳታፊ እንዲሆኑ ተጋብዘዋል፡፡ የሚሰጡን መረጃዎች ከጥናቱ ባለፈ ለሌላ አገልግሎት እዳይውሉ እና ምስጢራዊ በሆነ መልኩ እንደሚጠበቁ ላረጋገጥለዎት እወዳለሁ፡፡ በመጠይቁ ላይ ያልተስማሙበት ወይም ግልጽ ያልሆነ ነገር ካለ ማለፍ ይችላሉ፡፡ የእርስዎ ቀና መልስ እና ትብብር ለጥናታችን አስፈላጊ ስለሆነ የሚሰጡኝ ምላሽ በቅንነት እንደሚሆን ተስፋ አደርጋለሁ፡፡ ለምታደርጉልኝ መልካም ነገር ሁሉ ከወዲሁ ልባዊ ምስጋናየን ልገልጽ እወዳለሁ፡፡

ከላይ በተገለጸውን ቅጽ መስማማትዎን በፊርማዎ ያረጋግጡ _____

መረጃው የተሰጠበት ቀ _____

የአጥኚው ፊርማ _____

Annex 2: Questionnaires

Name of the kebele: ---------- Name of the interviewer: _____

Name of the child: ---------- Sex: 1=male 2=female

Start of the interview: _____ end of the interview: ____

Section 1: Socio-demographic variables

No	Questions	Responses
1	Age of the respondent	
2	Marital status of the respondent	1.Married 2.Divorced 3. Widowed
3	Educational status of the respondent	1.Illiterate 2.Read and write 3.Elementary 4.High School 5.Above high school
4	Religion	1)Orthodox 2) Catholic 3) Muslim 4) Protestant 5) Other (specify) ….
5	Family size	
6	Primary source of income	
7	Land size	
8	Products produced in your land area	1) Cereals 2) F& Vegetable 3) Legumes 4) Oil seeds

9	Products used in the household consumption	1) Cereals 2) F and Vegetable 3) Legumes 5) Oil seeds
10	Products serve to the market	1) Cereals 2) Fruits 3) Vegetables 4) Legumes 5) Oil seeds
11	Sex of house hold head	1) Male 2) Female
12	Educational status of the house hold head	1.Illiterate 2.Read and write 3.Elementary 4.High School 5.Above high school

Section 2: Knowledge, attitude and practices (KAP) of mothers/caregivers on complementary foods

No	Questions	Responses
1	Name of the mother/caregiver	
2	What is your relation with the child?	1) Mother 2) Father 3) Grandmother 4) Other
3	For how long should the child exclusively breast-feed?	1) Four mo 2) Six mo 3) More than six mo
4	What is the optimal time of continued breast-feeding?	1) For six mo 2) For one year 3) For two year 4) Above two
5	At what age do you start to develop complementary foods for your child?	1) Before six month 2) At six month 3) After six month
6	What are the components include during the preparation of complementary foods?	
7	What kind of food sources do you use to diverse your diet?	
8	Do you think that all diet sources offer equal benefit in terms of nutrient content?	1) Yes 2) No
9	How many times do you serve for the child per day?	1.Two times 2. Two-three times 3. Four times 4. More than four

10	How many times do you cook per day?	1. Two times 2. Two-three times 3. Four times 4. More than four
11	Who should feed the child?	1. Mother 2. Father 3. Siblings 4. Other
12	Do you have any information regarding to this from health extension workers?	1. Yes 2. No

Section 3: Anthropometric status of the children

Name of the child	Age	Sex	Weight in (kg)	Length in (m)

Section 4: quantitative 24-hour recall questionnaire

Food /drink	Meal time	Description of cooking method	Amount	Weight of the meal	Meal code

Proportion of mixed dish

Food type	**Ingredients**	**Cooking method**	**Amount of ingredients**

አማርኛ ቃለ መጠይቅ

ክፍል አንድ፡ ስለ ስነ-ሕዝብ እና ማህበራዊ ሁኔታ

የቀበሌ ስም..... የጠያቂው ስም፡.....

የተጠያቂው ስም.....

የህፃኑ ስም..... ጾታ: ወ..... ሴ.....

ተ.ቁ	ጥያቄዎች	መልስ
1	ዕድሜዎት ስንት ነው	
2	የጋብቻ ሁኔታ	1. ያገባ/ች 2. የፈታ/ች 3. የሞተበት/ባት
3	የትምህርት ሁኔታ	1. ያልተማረ 2. መጻፍና ማንበብ ብቻ 3. የመጀመሪያ ደረጃ 4. የሁለተኛ ደረጃ 5. ከሁለተኛ ደረጃ በላይ
4	ሃይማኖት	1. አርቶዶክስ 2. ሙስሊም 3. ፕሮቴስታንት 4. ካቶሊክ 5. ሌላ
5	የቤተሰብ ብዛት	
6	መሰረታዊ የገቢ ምንጭ	
7	የእርሻ መሬት ስፋት	
8	በእርሻ መሬቱ ላይ የሚመረቱ ምርቶች	1. ጥራጥሬ 2. አትክልትና ፍራፍሬ 3. የባቄላ ዝርያዎች 4. የቅባት እህሎች

9	ከምርቶች መካከል ለፍጆታ የሚዉሉት የትኞቹ ናቸዉ;	1. ጥራጥሬ 2. አትክልትና ፍራፍሬ 3. የባቄላ ዝርያዎች 4. የቅባት እህሎች
10	ለገበያ የሚቀርቡትስ	1. ጥራጥሬ 2. አትክልትና ፍራፍሬ 3. የባቄላ ዝርያዎች 4. የቅባት እህሎች
11	የቤቱ የበላይ አካል ጾታ	1. ወንድ 2. ሴት
12	የትምህርት ሁኔታ	1.ያልተማረ 2. መጻፍና ማንበብ ብቻ 3. የመጀመሪያ ደረጃ ትምህርት 4. የሁለተኛ ደረጃ ትምህርት 5. ከሁለተኛ ደረጃ ትምህርት በላይ

ክፍል ሁለት፡ እናቶች ወይም አሳዳጊዎች በሕጻናት ምግብ አዘገጃጀት እና አመጋገብ ላይ ያላቸውን እውቀት እና አመለካከት በተመለከተ

ተ.ቁ	ጥያቄዎች	መልስ
1	እናት ወይም የአሳዳጊ ስም	
2	ከህጻኑ ጋር ያለዎት ዝምድና	1. እናት 2. አባት 3. አያት 4. ሌላ
3	ልጅዎት ለምን ያህል ጊዜ የእናት ጡት ብቻ መመገብ አለበት ብለው ያስባሉ	1. 4 ወር 2. 6 ወር 3. ከ6 ወር በላይ
4	ህጻኑ ከሌሎች ተጨማሪ ምግቦች ጋር የእናት ጡት እስከመቼ መጥባት አለበት	1. ለ6 ወር 2. ለ1 ዓመት 3. ለ2 ዓመት 4. ከ2 ዓመት በላይ
5	ለህጻኑ ተጨማሪ ምግቦች መዘጋጀት ያለባቸው ከስንት ወር በኋላ ነው ብለው ያስባሉ	1. ከ6 ወር በፊት 2. 6 ወር ላይ 3. ከ6 ወር በኋላ
6	የትኞቹን የምግብ ምንጮችስ ይጠቀማሉ	
7	ለልጅዎ በቀን ምን ያህል ጊዜ ምግብ ያቀርቡለታል	1. ሁለት ጊዜ 2. ከሁለት-ሦስት ጊዜ 3. አራት ጊዜ 4. ከዚያ በላይ
8	ምን ያህል ጊዜስ ያዘጋጃሉ/ያበስላሉ	1. ሁለት ጊዜ 2. ከሁለት-ሦስት ጊዜ 3. አራት ጊዜ 4. ከዚያ በላይ
9	ህጻኑን መመገብ ያለበት ማን ነው	1. እናት 2. አባት 3. እህት/ወንድም 4. ሌላ
10	በህጻናት ተጨማሪ ምግብ አዘገጃጀት ዙሪያ ከጤና ሰራተኞች ያገኙት መረጃ አለ?	1. አዎ 2. የለም

ክፍል ሶስት፡ የልጆች የሰውነት ክብደት እና ቁመት መጠን ሁኔታ

የልጁ ስም	እድሜ	ጾታ	ክብደት በኪ.ግ	ቁመት በሜ.	መለያ

ክፍል አራት፡ በ24 ሰዓት ውስጥ የተወሰዱ ምግቦች መጠንና ዓይነትን በተመለከተ

የምግብ ዓይነት	የተመገቡበት ሰዓት	የምግቡ አዘገጃጀት	የምግቡ መጠን	ክብደት በኪ.ግ	መለያ

የቅልቅል ምግቦች መጠን

የምግብ ዓይነት	የቅመማ ቅመሞች ዝርዝር	አዘገጃጀት	የቅመማ ቅመሞች መጠን