Dietary Intake and Vitamin A Status of Children 3-5 Years in Orange Fleshed Sweet Potato Growing Area of Southern Ethiopia

By

Meseret W/yohannes

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Masters of Science in Food Science and Nutrition

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CENTER FOR FOOD SCIENCE AND NUTRITION

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Under the supervision of Dr. Kaleab Baye (PhD)

A Thesis Presented to the School of Graduate Studies of the Addis Ababa University in Partial Fulfilment of the Requirement for the Degree of Master of Science in Food Science and Nutrition

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This is to declare that the thesis entitled **"Dietary Intake and Vitamin A Status of Children 3-5 Years in Orange Fleshed Sweet Potato Growing Area of Southern Ethiopia"** submitted in partial fulfillment of the requirements of MSc. degree in food science and Nutrition, to the school of Graduate, studies food science and nutrition program, Food Science and nutrition center is a record of original research carried out by Meseret W/Yohannes Kebede under my supervision and no part of the thesis has been submitted for any other degree or diploma. The assistance and help received during the course of this study have been properly acknowledged. Therefore, I recommend that it be accepted as fulfilling the thesis requirements.

The Thesis has been approved for submission by:

Dr. Kaleab Baye (PhD)		November, 2017
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FINAL THESIS APPROVAL FORM

As participants of the Board of Examiners of the final MSc. open defense, we declare that we have read and evaluated the thesis prepared by Meseret W/yohannes under the title allowed "**Dietary Intake and Vitamin A Status of Children 3-5 Years in Orange Fleshed Sweet Potato Growing Area of Southern Ethiopia**" and recommend for the degree of Master of science in Food science and Nutrition.

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List of Acronyms

AGP - Alpha- 1- acid glycoprotein

AFS - Animal Source Food

BCC- Behavioral Change Communication

CIP – International Potato Center

CRP - C - reactive protein

DDS - Dietary Diversity Score

EPHI - Ethiopian Public Health Institute

EAR - Estimated Average Requirement

EDHS – Ethiopian Demographic and Health Survey

FAO - Food and Agricultural Organizations

FFQ – Food Frequency Questionnaires

HAZ - Height for age

Hb - Hemoglobin

HPLC - High Performance Liquid Chromatography

IMAPP -Intake Monitoring Assessment and Planning Program

MUAC - Middle upper Arm Cercunfrance

OFSP - Orange Fleshed Sweet Potato

RAE – Retinol Active Equivalent

RDA- Recommended Daily Allowance

SD - Standard Deviation

SNNPR - Southern Nations Nationalities People Region

VAD - Vitamin A Deficiency

WAZ – Weight for Age

WHO - World Health Organization

ABSTRACT

Vitamin A deficiency is a worldwide public health nutrition problem among preschool-aged children in developing countries, with the maximum number of cases in the Sub-Saharan African Region. The aim of the present study was Investigate whether orange-fleshed sweet potato (OFSP) consumption is associated with higher vitamin A intake and serum retinol concentration among preschool children in Wolayita zone, Ethiopia

A cross-sectional study was conducted from November 2016 to February 2017 to assess the Dietary adequacy and Vitamin A status of preschool children in two districts, Wolayita Sodo zone, Southern Ethiopia. Two-stage cluster sampling technique was used to select adequately representative samples of 142 preschool children from four kebeles of each district. Dietary intakes have been measured using quantitative 24-hour recall method that was repeated on a non-consecutive day. The usual intake and the percentage of inadequate intake was estimated. Blood sample was drawn and analyzed for serum retinol, C-reactive protein, alpha-1-glycoprotein, hemoglobin, serum ferritin. Substitution of white-fleshed sweet potato by orange-fleshed ones (15-75%) was simulated using intake monitoring assessment and planning program.

The dietary diversity score of the study participants showed that 51% of children had dietary diversity scores less than three food groups. The children in all age had energy intakes lower than the estimated need; whereas, protein and iron intakes were adequate for all age. Median vitamin A, calcium, zinc and vitamin C intakes were below estimated needs. The prevalence of inadequate vitamin A intake was 96.5%, but only 22% had confirmed deficiency based on serum retinol values. Substitution of white-fleshed sweet potato by the biofortified orange-fleshed sweet potato reduced the prevalence of inadequate vitamin A intake to 7%.

Our study highlights that promotion of orange-fleshed sweet potato in areas where consumption of sweet-potato is common can lead to improved vitamin A intake and thus may constitute a feasible nutrition-sensitive intervention.

Key words- *Vitamin A; serum retinol; biofortification, dietary intake; orange fleshed sweet potato; Ethiopia*

1. INTRODUCTION

1.1. Background

Micronutrient deficiencies are a main public health problem widespread in developing countries (World Health Organization, 2009). Among the most common deficiencies include that of vitamin A, a fat-soluble vitamin that is required for several essential functions in the body. It supports the vision system, growth, reproduction, and immune function (Cribb et al., 2013). The main cause of vitamin A deficiency is poor diet (Tanumihardjo, 2015). Vitamin A deficiency is estimated to affect 190 million preschool children in the world or approximately one-third of young children in the developing countries (Palmer et al., 2016; World Health Organization, 2009).

Ethiopia is the second most populous country in sub-Saharan Africa. Inadequate dietary intake and poor nutritional status of children and women continue to be a serious problem (Teferra et al., 2012), contributing to about 57% of child deaths in Ethiopia (Amare, 2013). Diets are predominantly cereal based with little or no consumption of fruits, vegetables and animal source foods; hence, putting at risk children to vitamin A deficiency (Gebremedhin et al., 2017; Nazrul et al., 2016; Tessema et al., 2013) morbidity that would have otherwise been averted, and mortality.

Among strategies that can effectively address micronutrient deficiencies, food-based approaches such as dietary diversification, food fortification, and biofortification are considered to be the most sustainable (Martin-Prevel et al., 2016). Considering that in developing countries, much of the energy intake is from starchy staples, biofortification of these staples with micronutrients have been found promising. For example, orange-fleshed sweet potato (OFSP), developed through biofortification, contains significantly higher amount of provitamin A than white-fleshed-traditional varieties. Therefore, promotion of OFSP could be an effective strategy that if consumed frequently could supply adequate amounts of vitamin A to cover daily requirements. However, this will depend on the bioconversion (bioavailability) of β-carotene into vitamin A, which depends on the food matrices, food preparation, and the fat content of the meal (Nazrul et al., 2016). Besides, OFSP also contains protein, fat, carbohydrate, dietary fiber, other micronutrients and some phytonutrients that are also important (Nazrul et al., 2016).

The effectiveness of OFSP in improving vitamin A status can be measured in various ways. Liver stores of vitamin A are the best indicator for vitamin A status, but cannot be used routinely to assess vitamin A status of the population. Intake of vitamin A and its precursors can be used to estimate the risk of vitamin A deficiency. However, this approach does not take into account host-related factors that may affect bioavailability of vitamin A. Currently, the most common method for assessing vitamin A status is based on changes in serum retinol concentration, which is homeostatically controlled and negatively affected by subclinical infections and inflammation (Tanumihardjo, 2011). The most common method to analyze vitamin A status is serum retinol by using high performance liquid chromatography (HPLC) assessment method that provides a quantitative estimate of vitamin A status across the range from the following categories ≤ 0.7, 0.7-1.05, and > 1.05 μmol/L deficient to excessive vitamin A based on guidelines from the World Health Organization (Hanson et al., 2016; Tanumihardjo, 2011).

1.2. Statement of the problem

Vitamin A deficiency is a serious public health problem in Ethiopia. National incidence rates of Bitot's spots and night-blindness was 1.7% and 0.8% respectively among preschool children. According to Ethiopian national survey report, 37.7% of children (95% CI, 35.6% to 39.9%) had VAD (less than 0.7µmol/L serum retinol levels) (Demissie et al., 2010). Recently (2016) Ethiopian public health institute (EPHI) reported the prevalence of vitamin A deficiency estimated based on serum retinol adjusted for inflammation among preschool children was found 13.9%. This shows still the VAD is a public health problem and to solve this problem (EPHI, 2016).

Dietary modification through bio-fortification is one of the main strategies which have been adopted by the Ethiopian government to control and eliminate vitamin A deficiencies. However, there is an absence of information on the contribution of bio-fortified orange-fleshed sweet potato on vitamin A status at a community level, especially in rural areas where cultivation and consumption is a predominant practice.

Hence, the aim of this study was to determine the nutrient intake, and vitamin A status of 36-59 months old children based on 24-hour recall and serum retinol in a rural area in Wolayita, where production of orange-fleshed sweet potato is common. The results were interpreted as proportions of sampled children with low, normal or high vitamin A status, how inflammation affects vitamin A status using serum retinol measurement, and how their dietary intake differ. Finally, the prevalence of inadequate intake of vitamin A was estimated by simulating the consumption of white sweet potato with OFSP value in different retinol equivalent value.

1.3. Significance of the study

Vitamin A deficiency is one of the public health problems in Ethiopian. The prevalence of vitamin A deficiency (VAD) increasing at high rate and children are the most vulnerable group to VAD due to inadequate intake of vitamin A reach food. The study is important to examine the contribution of the consumption of OFSP to reduce the severity of the VAD the amount of retinol equivalent taken from biofortified OFSP through the simulation modeling.

This study generates information on the magnitude of vitamin A status and how biofortification of orange-fleshed sweet potato (OFSP) prevent and control VAD. It helps the decision makers to focus on the effort at reducing inadequate intake of vitamin A reach food conception with OFSP and introducing food products bio-fortified with vitamin A. This researcher will help to develop other option for the prevention and control of VAD to the vulnerable groups. This may be useful in formulating strategic policies to address Vitamin A deficiency and child nutrition and healthcare education. The finding from this study may contribute to knowledge on maternal and child nutritional intervention programs in the country and may provide an insight of the impact that OFSP may have in preventing Vitamin A deficiency.

1.4. Objectives

1.4.1. General Objective

Investigate whether orange-fleshed sweet potato (OFSP) consumption is associated with higher vitamin A intake and serum retinol concentration among preschool children in Wolayita zone, Ethiopia

1.4.2. Specific objectives

1. To estimate the average nutrients intake and dietary diversity score of preschool children (36-59 months).
2. To estimate the prevalence of inadequate intake of vitamin A, iron, zinc and calcium.
3. To estimate prevalence of serum retinol (vitamin A) status of children.
4. To simulate the impact of replacing consumption of white by orange-fleshed sweet potato at levels of 15 %, 25 %, 50 %and 75 % in reducing the prevalence of inadequate vitamin A intake.

2. LITERATURE REVIEW

The children are considered as the nutritionally susceptible group especially in the developing countries of the world. Due to Inadequate dietary intakes and frequent infections are well-known causes of growth retardation (Black et al., 2013). Micronutrient deficiencies are highly prevalent in low-income countries, and the most likely causes are low content in the diet and poor bioavailability (Herrador et al., 2014). More than half of preschool children are approximately 75 million and 140 million preschool children have clinical and subclinical vitamin A deficiencies (VAD), respectively (World Health Organization, 2009). Diets consumed by preschool children in Ethiopia are poor and lack in many nutrients. Thus special attention should be given to the diet of children (Demissie et al., 2009).

The nutrition needs of children are much more because the kind of nutrient in the child consume will determine the quality and quantity of diet that will affect the growth and health of the children (Naska et al., 2017). Children need for vitamin A during Infants (1–5 months of age) and preschool children (6–59 months of age) have increased need of vitamin A to support their rapid growth and to prevent infection (Ruel et al., 2013). Inadequate intake of vitamin A at this age can lead to vitamin A deficiency that, in turn, may cause night blindness and weaken growth and immune function. This also results in increased risk of morbidity and mortality, largely from measles, diarrhea and respiratory infections (Abrha et al., 2016).

2.1. Nutrient needs for preschool children

Lacking child feeding practices coupled with high rates of infections have a tending to cause harmful effect on health and growth of young children during the first 2 years of life (Baye et al., 2013). The first 24 months is thus recognized as being the most important of opportunity for establishing healthy growth through optimum feeding practice (Jones et al., 2014).

2.1.1. Energy

Adequate nutrient is critical to child growth in a children's life when the need for energy as well as macronutrients and micronutrients (vitamins and minerals) increases. Under normal circumstance, energy is required to sustain body's various functions, including respiration, circulation, physical work, protein synthesis. The energy requirement of preschool children is defined as the level of energy intake from food that will balance the energy needed to support a rate of growth and body composition consistent with good health (Food and Agricutural Organization, 2001).

2.1.2. Micronutrients

The dietary intakes preschool children in developing countries indicated inadequacies of several micronutrients, mainly iron, Vitamin A, Zinc, are common. Such inadequacies are often aggravated by poor bioavailability for some micronutrients, leading to a high prevalence of multiple micronutrient deficiencies. Minimal consumption of animal source and fortified foods also contribute to multiple deficiencies.

Vitamin A is important for normal vision, gene expression, reproduction, embryonic development, growth and immune function (Owusu & Ross, 2016). Animal source food especially milk and organ meat are an excellent source of pre-formed vitamin A (retinol), and dark green leafy vegetables and yellow-orange fruits and vegetables are a rich source of beta-carotene, a precursor of Vitamin A (Cribb et al., 2013).

2.2. Deficiency of vitamin A

In many developing countries worldwide, young children are at a high risk of vitamin A deficiency and iron deficiency (Suri & Kumar, 2015). Vitamin A deficiency affects an approximately 190 million preschool children worldwide. The effect of vitamin A deficiency includes growth failure, depressed immunity, higher risk of xerophthalmia and blindness, anemia, and increased morbidity and mortality from some infectious diseases (World Health Organization, 2009). Poor nutritional status, inadequate intake of vitamin A and infections such as diarrhea and measles are the most common causes leading to vitamin A deficiency (VAD) (Allen et al., 2006).

The consequence of VAD is magnified by poverty and the higher prevalence of infectious diseases and it is the major cause for almost one-fourth of global child mortality from measles, diarrhea, and malaria (Tariku et al., 2016). Nearly 44–50% of preschool children in South and Southeast Asia are affected by severe VAD (Akhtar et al., 2013). Vitamin A deficiency alone is responsible for almost 6 % of deaths among children under the age of 5 years in Africa. VAD along with measles is the main cause of preventable visual injury in children. Children begin their life with an urgent need for vitamin A. Infants (1–5 months of age) and preschool children (6–59 months of age) have increased need of vitamin A to support their rapid growth and to combat infection. Inadequate intake of vitamin A at this age can lead to vitamin A deficiency that, in turn, may cause night blindness and undermine growth and immune function. This also results in increased risk of morbidity and mortality, largely from measles, diarrhea and respiratory infections (Nazrul et al., 2016).

The resent findings of Ethiopian National micronutrient survey indicates the prevalence of Vitamin A deficiency among preschool children was found 13.9% at a national level. Hence based on WHO cutoff point, this prevalence can be categorized as a moderate public health problem in Ethiopia (EPHI, 2016).

2.3. Assessment method of vitamin A

There is four type of nutritional assessment method such as Anthropometry, biochemical, clinical and dietary can be used for assessing the nutritional status of individual and population group.

Among thus dietary and biochemical methods are used to assess the first stage of any vitamin A inadequacy or excess (Tanumihardjo et al., 2016).

2.3.1. Dietary assessment

This method includes the following dietary records: 24-h dietary recall, FFQs, brief dietary assessment tool, and diet history (Tanumihardjo et al., 2016).

Individual food intake method is used to assess estimate or usual intakes of an individual, depending on the number of measurement days. All food consumed over a defined period is weighed by the subject, caretaker or assistant (Hepburn, 2014). In some cases, the food samples may be saved individually, or as a composite, for nutrient analysis. Otherwise, nutrient intake can be calculated using food composition data. Although weighed food records have an advantage of being accurate, they are time-consuming and require a setting that permits weighing (Arsenault et al., 2010).

The 24-hour method asks respondents to remember and report all the foods and beverages consumed in the preceding 24 hours or the preceding day (FAO, 2010). In its clear form, a recall is controlled without prior notice, thus removing the issue of reactivity. The interviewer must administration with minimizes literacy barriers (Naska et al., 2017). The main problem with accuracy with the 24-hour is attention and memory. Many respondents are challenged with the individual between multiple pass questionnaires what they usually eat and what they ate yesterday, opening the possibility for excluding and intrusions foods reported, but not exact eaten (Pedroza-tob et al., 2016). The second days of information are collected to get accurate the usual dietary intake of an individual. Collecting dietary intake must take on non-consecutive days is preferred. Portion size estimation is also challenging as the amount consumed has to be both recalled and exactly estimated (Naska et al., 2017).

2.3.2. Biochemical assessment

The most common vitamin A status measured by serum retinol concentrations. For routine evaluation and classification of retinoids in biological samples, liquid chromatography is the good analytical method to determine the different chemical properties of the retinoid metabolites exact quantification of retinol, its isomers, retinal, retinyl esters, and retinoic acid in a single chromatographic run (Kane et al., 2008). The current method describes serum retinol is a reverse-phase high-performance liquid chromatography (HPLC) isocratic technique that allows the accurate extraction, separation, identification, and quantification of all-trans-retinol (Kim & Quadro, 2010). The cutoff used to define a public health problem for vitamin A deficiency have a serum retinol concentration less than 0.7µmol/L (Tanumihardjo et al., 2016).

2.4. Different strategies to prevent vitamin A deficiency

There are several strategies to prevent vitamin A deficiency it includes: dietary diversification, food fortification, and vitamin A supplementation. Dietary diversification includes the production of β-carotene-rich crops to increase vitamin A intake and supplementation with vitamin A capsules or tablets (Saeterdal et al., 2012). Food fortification is the addition of nutrients to foods that are generally consumed by all segments of the population is probably the most widespread intervention practiced and to be effective in improving vitamin A status, and significantly reducing infant and child mortality and morbidity (mainly diarrhea) in infants and children 6 to 59 months of age, living in developing countries (Miller & Welch, 2013).

2.4.1. High dose supplements

High-dose supplements of retinyl palmitate are still supported by WHO to preschool age children to prevent mortality and morbidity. A dose of 100 000 International Units (IU) in infants 6–11 months of age and 200 000 IU in children 12–59 months of age is considered to retinyl palmitate in the form of oil solution given twice per year to children (Tanumihardjo, 2015; World Health Organization, 2011).

Vitamin A supplementation in children 6–59 months of age was updated one review assessed the efficiency of vitamin A supplements in the prevention of morbidity and mortality in children 6–59 months of age (Batool & Zulfiqar, 2011). It indicated that giving vitamin A supplements to children decreases the quantity of mortality and some diseases. A meta-analysis of 17 trials (11 in Asia, 5 in Africa and 1 in Latin America) for all-cause mortality showed that vitamin A decreases the whole risk of death by 24% (risk ratio (RR) 0.76; 95% confidence interval (CI) 0.69–0.83) (World Health Organization, 2011).

Seven trials showed that vitamin A supplementation significantly decreases diarrhea-related mortality (RR 0.72; 95% CI 0.57–0.91), although mortality specifically due to measles (five trials: RR 0.80; 95% CI 0.51–1.24) or respiratory disease (seven trials: RR 0.78; 95% CI 0.54–1.14) was not reduced. The occurrence of new episodes of diarrhea decreased (13 trials: RR 0.85; 95% CI 0.82–0.87). There was no significant effect on the occurrence of respiratory disease (nine trials: RR 1.14; 95% CI 0.95–1.37), or hospitalizations due to diarrhea or pneumonia (World Health Organization, 2011).

In Ethiopia cohort study done in Boloso Sore Woreda, Wolayta Zone, SNNPR by Gebremedhin et al (2008) indicate vitamin A supplementation coverage among children (6-59 months) was 83.1%.This vitamin A supplementation status was not significantly associated with history of Fever [AOR=1.26 (95%CI 0.89-1.77)], Cough or rapid breathing/difficulty in breathing [AOR=1.15 (95%CI 0.77-1.72)], Eye infection [AOR=1.22 (95%CI 0.78-1.89)], and Diarrhea [AOR=0.98 (95%CI 0.64-1.52)] (Gebremedhin et al., 2009).

2.4.2. Food fortification

A second method for increasing the dietary intake of vitamin A is through fortification of a staple food with vitamin A. This has been the main strategy for decreasing VAD in many food items such as fats, oils, margarine, sugar and cereal products (flour) have long been fortified with vitamin A. It can be expected that this approach will gain as increasing numbers of possibly fortifiable foods become most important produced or processed under controlled conditions and penetrate markets of the poor in many countries (World Health Organization, 2009).

Food fortification is the practice increasing the content of important micronutrients in a food with the objective to increase the nutritional quality of the food supply and deliver a public health benefit with minimal risk to health (Allen et al., 2006). Three types of fortification methods are available: 1) mass fortification of one or more staple foods that are commonly consumed by the population in sufficient amounts; 2) voluntary, market-driven, fortification of one or more industry products; and 3) targeted fortification using specially designed fortified foods that are targeted to specific groups, such as preschool and school children. Fortification of staple foods with vitamin A may be a cost-effective intervention in settings where food variety for improved dietary quality is not possible, provided that the nutrient remains at sufficient levels in the fortified food at the time of consumption, and the food is consumed regularly in adequate amounts (Allen et al., 2006). Thus, the selection of suitable food or vehicle is an important element of the intervention and may differ among countries (Saeterdal et al., 2012).

2.4.3. Biofortification

Biofortification is an advanced strategy for addressing micronutrient malnutrition in a sustainable way. It involves the use of breeding nutrients into food crops, and agronomic (soil management) approaches such as micronutrient fertilizer applications to increase concentrations of main nutrients in staple food crops (Bouis et al., 2011). Biofortified staple foods cannot deliver as high a level of minerals and vitamins per day as supplements or industrially fortified foods, but they can help by improving the daily requirement of micronutrient intakes among individuals throughout the lifecycle. Biofortification, it is comparatively cost-effective, sustainable, and long-term means of delivering more micronutrients (Saltzman et al., 2013).

Biofortification programs are extending active development in regions around the world: the Harvest Plus program, the Biofort Brazil program (biofort.ctaa.embrapa.br) and the Harvest plus-China program (www.harvestplus-china.org).The programs include working with interdisciplinary global alliances of scientific institutions and implementing agencies in various regions around the world. Targeted crops for biofortification include rice, wheat, maize, beans, sweet potato, cassava and pearl millet. Foods from the biofortified crops are improved in provitamin A, iron, and/or zinc. Seeds for these crops are being distributed to several regions in Africa, Brazil, China and South Asia. Success of these biofortification programs is dependent on three principles: (1) biofortified crops must be high yielding and profitable to farmers to assure their adoption, (2) consuming the biofortified crops must significantly improve the nutritional health of people in target populations under controlled conditions, and (3) farmers must implement the crops and most consumers in target populations must accept and consume the crops in quantities sufficient to improve their nutritional health. This strategy is rural-based and designed to reach people in remote regions who typically suffer from higher rates of micronutrient malnutrition. When production surpluses are achieved, urban populations would also benefit if these crop surpluses were marketed in cities (Bouis et al., 2011)

Biofortification showing achievements in improving the micronutrient status of the rural poor in several countries. Orange flesh sweet potato (OFSP) varieties biofortified with pro-vitamin A carotenoids are being released in some countries in Africa (Jenkins et al., 2015). Countries that are Mozambique and Uganda released first verity of OFSP in 2002 and 2007, respectively. OFSP have been shown to be effective at improving the vitamin A status of villagers where they have been released, propagated and consumed. A recent study showed that biofortifying sweet potatoes with higher β-carotene levels are an effective way to improve the vitamin A status of target populations in Uganda (Hotz et al., 2012). The Brazilian study is also releasing a number of biofortified crops in that country and feeding school lunch program that encourages locally grown biofortified food crops in rural schools has been launched (Miller & Welch, 2013).

In Ethiopia International potato center (CIP) has implemented projects in two regions emphasizing improved agricultural production of root and tuber crops in Ethiopia. In 2010, with funding from Irish Aid, CIP initiated its first integrated program that integrated agriculture and nutrition in the Tigray region of northern Ethiopia with a goal of improving food security for smallholder farmers and their households. In 2012, CIP partnered with the University of Wisconsin–Madison and local stakeholders from agriculture, nutrition, and health in the SNNPR to strengthen food security for smallholder farmers and their households by improving the production and intake of potato and orange-fleshed sweet potato as part of nutritious, diversified diets. The project worked in 5 woredas (districts) in 2 SNNPR zones (H. A. Busse et al., 2017). That is Wolayita and Sidama Zone. From 2012 to 2014 the area and production of OFSP production in Ethiopia was 51,467 hectare and 1,889,791 tons respectively (Low et al., 2017).

2.4.4. Bioavailability of provitamin A carotenoids

Bioavailability is consumed nutrient that is accessible for use in normal physiological function and for storage, while bioaccessibility explains the entire of food released from the food matrix and accessible for absorption (Miller & Welch, 2013). The animal source vitamin A (esters) are absorbed and used or stored in the liver (Luo et al., 2006), but the variety for absorption of provitamin A carotenoids is much varied. Plant-source carotenoids can be found in either the cis- or trans-configuration. Between 35% and 88% of absorbed all-trans β-carotene is oxidatively cleaved by β-carotene 15,15'-dioxygenase 1 (BCO1) into 2 molecules of all-trans-retinal in the enterocyte (Dela Seña et al., 2014), which can be oxidized irreversibly to retinoic acid by 1 of 3 retinal dehydrogenases or reduced reversibly to retinol by a number of retinal reductases (Lietz et al., 2010). The cis isomers must be isomerized to the all-trans arrangement before BCO1 can cleave them, resulting in lower bioconversion efficiency (Bresnahan et al., 2014). Retinoic acid can also be formed by an excentric cleavage pathway facilitated by the enzyme β-carotene 9,10-oxygenase (BCO2). This, however, characterizes a minor pathway for β-carotene split (Kiefer et al., 2001).

Dietary one of factors that affect carotenoid bioavailability includes the food matrix, food processing, and others. Carotenoids are found in chloroplasts and are bound to pigment-protein complexes that consequence in low bioavailability. On the other hand, processing conditions influence such as heating and mechanical homogenization increase bioavailability by breaking cell walls, hydrolyzing carotenoid-protein complexes and decreasing particle size resulting in higher bioavailability (Tanumihardjo et al., 2010).

2.4.5. Vitamin A absorption

Sufficient levels of vitamin A and its derivatives in serum and tissues are important to keep the health of the body (Luo et al., 2006). Retinoid homeostasis is completed through a sequence of complex mechanisms that control absorption, storage, transport, and metabolism of this nutrient. Mammals get all vitamin A and its derivatives from the diet as animal products (retinyl esters, retinol, and very small amounts of retinoic acid) or as β-carotene from vegetables and fruits (Kim & Quadro, 2010). Within the intestinal mucosa, all retinol, regardless of its dietary origin, is enzymatically re-esterified with long-chain fatty acids and, together with other dietary lipids, packaged into chylomicrons and secreted into the lymphatic system (Riabroy & Tanumihardjo, 2014). About 75% of retinoids within chylomicron leftovers are cleared by the liver, the main site of vitamin A storage and metabolism, while the remaining can be reserved up by extrahepatic tissues (Kim & Quadro, 2010).

2.4.6. Retention of β-carotene

Retention is defined as the proportion of carotenoids remaining in the processed sweet potato root in relation to the amount of carotenoids originally present in the sweet potato. Nutrition research showed that provitamin A retention was greater than 80% after boiling or steaming and at least 75% after solar or sun drying, typical types of preparation (Aurélie Bechoff et al., 2010).

The effects of drying treatment and on provitamin A losses in OFSP were considered. Low levels of loss varying between 16 and 34% in trans-b-carotene were obtained for all the treatments. The sun-drying was not so damaging to provitamin A content compared to solar and hot air drying. Another was chip shape had an influence on retention: sun-dried samples showed significantly lower retention on chips but retention was greater with crimped slices. Crimped slice bulkiness or lesser degree of ‘‘shrinkage” may have protected them from damage from the sun’s rays and oxidation. These low levels of loss may be attributed by quick drying (8 h) due to the favorable dry, hot and windy climatic conditions. Contrary to expectations, there was not an increase in isomerization (formation of 9-cis and 13-cis-β-carotenes) due to drying (Bechoff et al., 2009; Kidmose et al., 2007).

Sweet potatoes are consumed after heating, it is important to take into account the loss of all-trans-β-carotene during household preparation. Boiling of the sweet potato roots seemed to result in a lower loss of all-trans-β-carotene than roasting. Preparation of chips by drying and preparation of flour from chips caused in high losses of all-trans-β-carotene and thus lower vitamin A contents in dried products such as chips and flour compared to raw roots. Since the vitamin A intake depends on both the amount of sweet potato roots being consumed as well as the content of vitamin A in the prepared roots of sweet potato, the choice of sweet potato variety for consumption and the method used for household preparation can have a large impact on the vitamin A intake (Kidmose et al., 2007).

3. MATERIALS AND METHODS

3.1. Study design

Community-based cross-sectional survey was conducted from November 2016 to February 2017.

3.2. Study area

The study was conducted in two districts of Wolayita zone: Damot Weydie and Offa. The area is 380 km far from the capital city of (Addis Ababa) in the southern part of Ethiopia and 160 km from the regional capital city (Hawassa). Wolayita is bordered on the South by Gamo Gofa; on the west by the Omo River, which separates it from Dawro; on the northwest by Kembata Tembaro; on the North by Hadiya; on the northeast by the Oromia Region; on the east by the Bilate River which separates it from Sidama and on the south-east by the Lake Abaya which separates it from Oromia Region. Wolayita has 15 woredas; the administrative center of Wolayita is Sodo. Based on the Wolayita zone health office statistical data, this Zone has a total population of 1,928,196 of whom 954,457 are men and 973,739 women; with an area of 4,208.64 square kilometers (Zema et al., 2015).

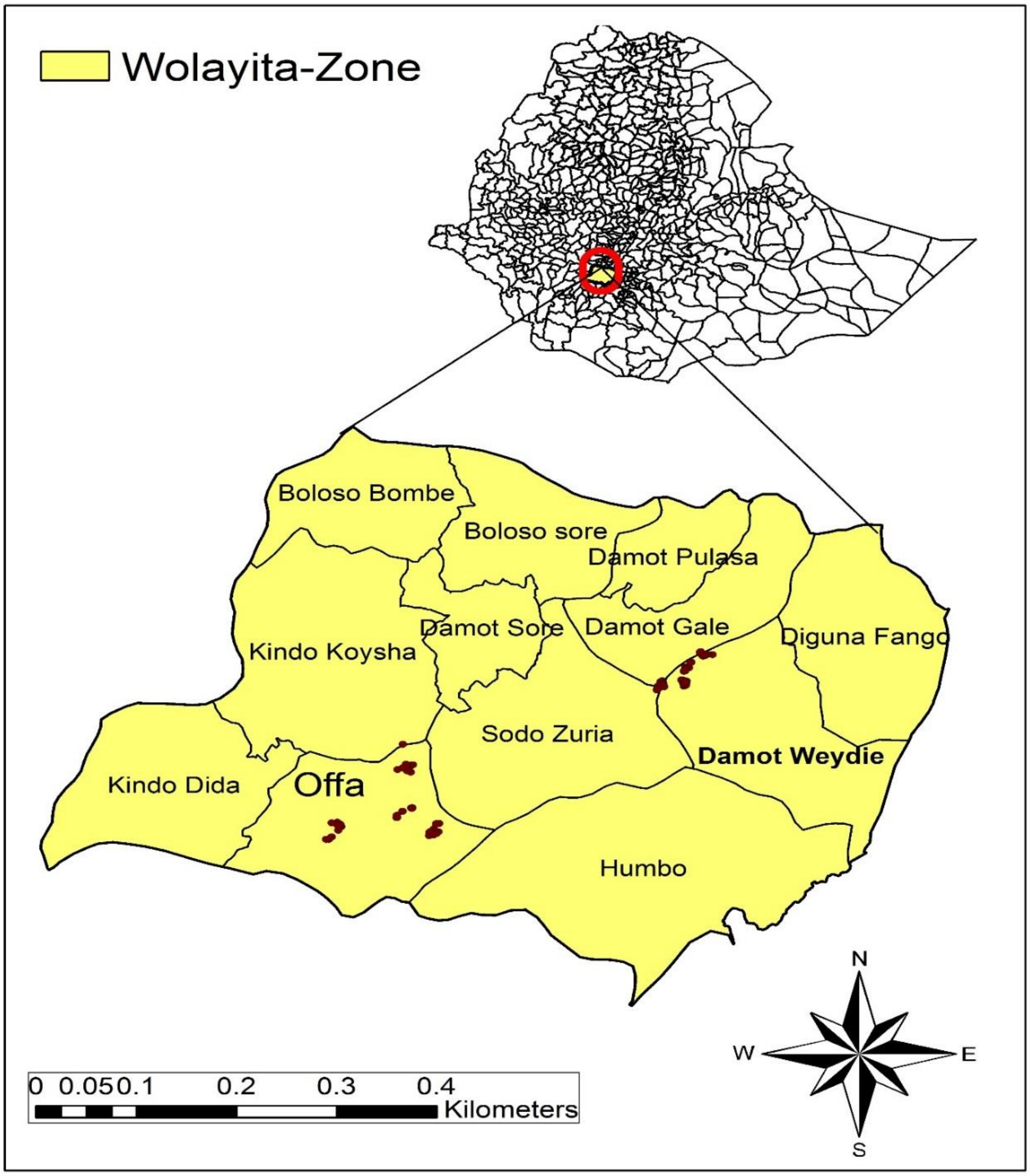

Figure 1. Administrative map of Wolayita zone

Damot weyide woreda is located 17 km north of the center of Wolayita Sodo and pre-selected by international potato center (IPC) as a potential orange-fleshed sweet potato cultivation area. According to the woreda health office, the woreda has 27 kebeles with the total population of 116,566 (58,050 male and 58,516 female). The total number of children between 36- 59 aged was 8,509. Offa is located 29 km South of the center of Wolayita Sodo and selected the same geographical and cultural woreda. According to the woreda health office, the woreda has 23 kebeles with the total population of 132,043 (65,758 male and 66,285 female).The total number of children between 36- 59 aged was 9,639.

Agriculture is the major economic activity of the two study area. Potato (*Solanum tuberosum L*.), sweet potato (*Ipomoea batatas*), cassava (*Manihot esculenta*), , enset (*Enset ventricosum*), maize (*Zea mays L*.), haricot bean (*Phaseolus vulgaris*), sorghum (*Sorghum bicolor* L. Moench), , broad bean (*Vicia faba* L., major), peas (*Pisum sativum*), kidney bean (*Vicia faba*) and chick-pea (*Cicer arietinum*) are main food crops grown in the area (Zema et al., 2015).

3.3. Data source, study population, inclusion and exclusion criteria

All children aged 36 to 59 months in the eight clusters (kebeles) were considered as the study population. Households in the study area were eligible for inclusion if they met the following criteria: Mothers who were the usual residents in the study area with a healthy child aged 36 to 59 months, and who have given consent to participate in the study. Children with severe anemia, severe acute malnutrition, obesity or severe illness such as dehydration, severe diarrhea or severe respiratory illness were excluded. Children’s age was confirmed by birthday and immunization card. The health centers’ data was completed through house-to-house visits. Whenever more than one child per household is found, one child was selected by the lottery method.

3.4. Sample size

This is part of a larger study that aimed to validate the serum retinol cut-offs against values obtained from isotope dilution method. For this component of the study, two district, 4 kebeles from each, were chosen. The sample size was calculated to detect a difference of 0.5 SD in means between two independent groups (consumption of OFSP and control). The sample size calculation assumed a minimum effect size (σ) is 0.5, 80% power, α= 0.05, which resulted in 64 children/group. Assuming 10% non-response, a total of n=69/group were required in each of the districts (total N=138) children conducted.

$$N= \frac{2\,(Z_{\alpha/2} + Z_{1-\beta})^2}{d^2}$$

$Z\alpha = 1.96$ 2- tailed hypothesis test

$Z\beta = 0.842$ power = 80%

Effect size (σ) = 0.5

$$N= \frac{2\,(1.96 + 0.842)^2}{(0.5)^2}$$

Need approximately 69 subjects in each group

3.5. Sampling techniques

First a total of 8 kebeles, 4 kebeles from each woreda (Damot Weydie and Offa) were selected, and one cluster or village from each kebele was selected by simple random techniques. In the selected cluster, all households who had eligible children were listed and 17 household/study participants were selected from each cluster by systematic random sampling techniques. The summary of sampling technique shown in Figure 2.

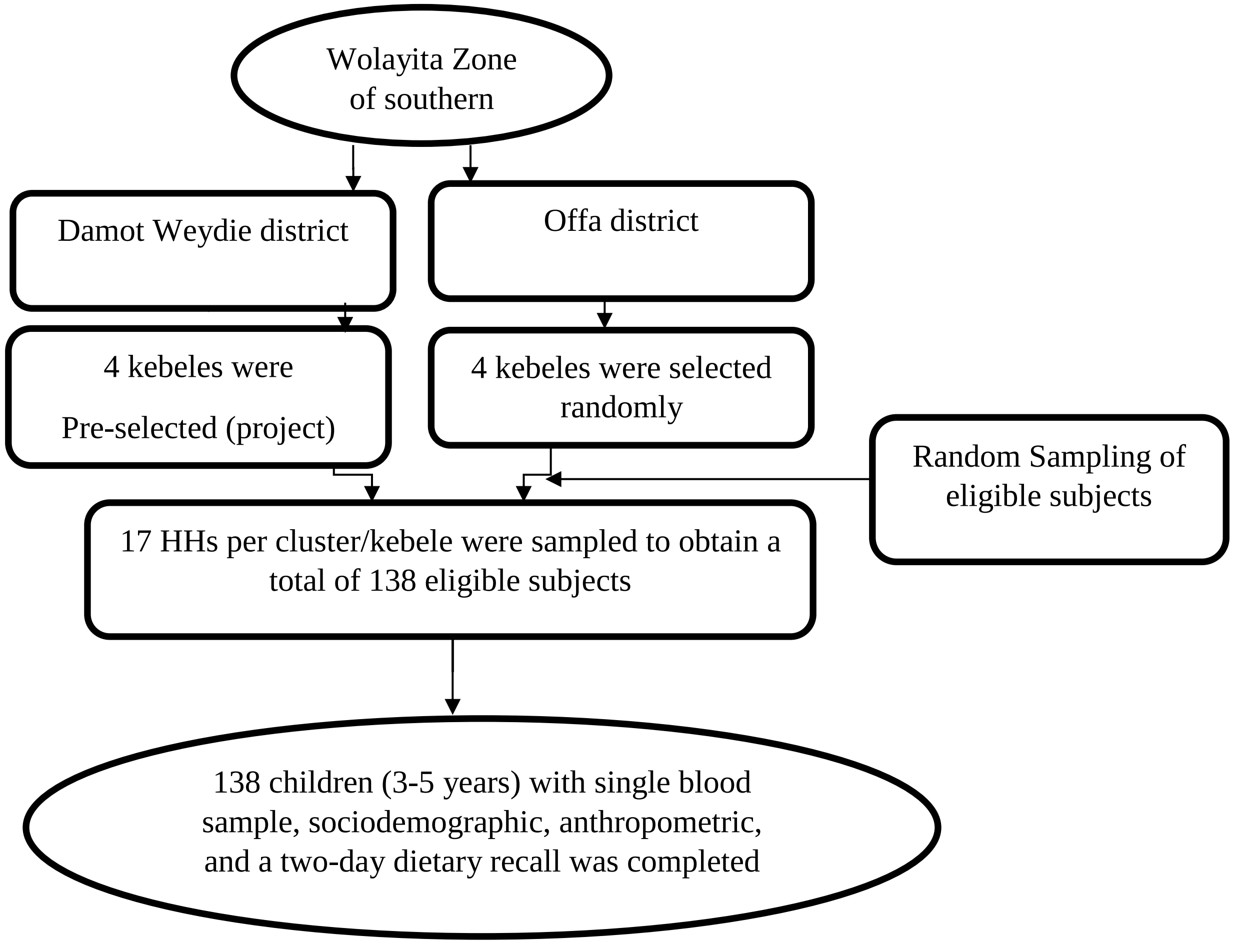

Figure 2. Schematic presentation of the sampling procedure.

3.6. Study variables

- Serum retinol (Vitamin A) Status
- Dietary factors (i.e. dietary diversity score, median energy and nutrient intake, nutrient density and desired density).
- Socio-economic factors (agricultural land size, occupation, marital status, family size, types of latrine and source of drinking water).
- Demographic factors (age and sex)

- Anthropometry (weight, height), and
- Anemia, and inflammation (CRP and AGP) status

3.7. Data collection tools and procedure

Data was collected by a pretested questionnaire adopted from Ethiopian demographic health survey (EDHS) and the Ethiopian National food consumption survey (EDHS, 2012; EPHI, 2013) to assess potential co-variate such as demographic, dietary, socio-economic, medical, healthcare-related issues. Anthropometric measurement, biological sample (blood), and dietary information were also collected. The data collection tools were prepared in English and translated to Amharic. Intensive training for the data collectors was given and pretesting was done before the actual field work. Data were collected by trained health professional workers and immediate supervisor under the direct supervision of the Principal investigator. After an interview, blood was collected by an experienced phlebotomist and the serum sample was processed by an experienced laboratory technologist.

3.7.1. Anthropometry

Children's anthropometric measurements were taken during the two-round data collection period. Height, weight and Middle Upper Arm Circumference (MUAC) measurements were done on all enrolled study participants. Weight of children was measured to the nearest 0.1 kg or 100g using calibrated digital weighing scale (Seca 874 digital floor scale) while wearing a light cloth and without shoes. The height of children was measured without shoes to the nearest of 0.1cm using wooden height boards. MUAC was also measured using the MUAC tape and recorded in centimeters to the nearest 0.1 cm. The date of birth was determined from existing immunization or birth certificate, and whenever this was not possible, it was estimated using a local events calendar.

Figure 3. Anthropometric measurement of selected preschool children

3.7.2. Dietary data collection and management

Dietary data for target children were collected twice, within a two-week period. Experienced data collectors were locally recruited and trained in one week in a classroom setting. A digital kitchen-scale was used to measure the amount of food consumed and ingredients used in food preparation (3kg maximum weight, model Kinlee ACS-EK01; Indonesia). All food and drinks consumed by the child were measured and recorded in the household, starting from early morning until the next day morning. A 24-hour period was defined as from the time the child was awake to the previous day the child woke up.

The dietary data obtained by a standard 24-hour recall. The 24-hour recall had three steps, the first was used to set a quick-list of food and list all the food that the child consumed during the 24 hours, second the ingredients/cooking methods used was asked, and finally portion size was estimated by direct weighting of foods/playdough or using household measures (Lewin, 1973). For liquids, water was used to measure the volume (EPHI, 2013).

The dietary intake assessment was repeated 14 days later in the same subjects (n=138). All days of the week were equally represented in the final sample. Dietary data were entered in duplicate to limit data entry errors and individual food intake was transformed in nutrients using (Nutriservay for windows, 2007) software.

3.7.3. Assessment of energy and nutrient

The nutrient and energy content of foods consumed was calculated using the Ethiopian food composition table (ENI, 1981). The median daily intakes of energy and nutrients from diets, recipes or commercial food products were compared with the equivalent estimated needs for energy and selected nutrients based on FAO/WHO (Food and Agricutural Organization, 2001). The adequacy of the energy intakes was calculated in two ways, first by comparison with the total energy intakes as a percentage of estimated energy needs from foods, and secondly by calculating the energy requirements of the children based on age (in months) and per kilogram body weight (FAO/WHO/ UNU 2004) (Food and Agricutural Organization, 2001).

3.7.4. Preschool child feeding practices

The child's feeding practices were assessed by using the WHO young child feeding indicators (World Health Organization, 2007). This include questions on the consumption of seven food groups and intake in the form of solid or semisolid, raw or cooked, gross or net based on seven food groups. The DDS was categorized into subgroups as low (1–2), medium (3–4), and high (≥5) based on the classification described by Arimond and Rule (Arimond & Ruel, 2004).

3.7.5. Estimation of nutrient density

The nutrient density of the diet was measured by dividing the average daily nutrient intake by the total energy intake as stated in Dewey and Brown (Dewey & Brown, 2003). Nutrient densities were compared with the desired nutrient densities, which are values that would allow children to meet their daily nutrient requirements provided that they have adequate energy intake (for each age group) and multiplying by 100 (Kathryn et al., 2005).

3.7.6. Prevalence of inadequate nutrient intake

The prevalence of inadequate nutrient intake was estimated after adjusting for within-subject variation using the software Intake Monitoring Assessment and Planning Program (IMAPP). The values to determine the prevalence of inadequate vitamin A intake was calculated using estimated average requirement (EAR). The EAR values used were: 210µg/d for 36-47months old, and 275µg/d for 48-59 months old, (Moura et al., 2016). We simulated the impact of replacing white by orange-flesh sweet potato at 15-75% levels assuming a vitamin A composition of 832µgRAE/100g (Jaarsveld et al., 2005).

3.7.7. Blood collection and measurement

Blood was drawn by trained phlebotomists. An appointment was made with the caregivers of children and blood was drawn in the nearby health facilities (health post/health center). Approximately 2-6 ml blood was drawn into red-top vacutainers via venipuncture. Before puncturing, the subject's skin was wiped with 70% alcohol. Serum was separated by centrifugation at 3000 rpm for 10 minutes within 1hour of collection and was frozen at -18°C in a portable refrigerator (WAECO-CF35 portable compressor freezer). Before and after serum separation, the samples were kept away from the light, by putting them in black/opaque ziplock bags. The samples were transported to the nearest district (Wolayita Sodo hospital) laboratory for temporary storage at -35°C refrigerator. After completion of fieldwork, all samples were shipped to EPHI laboratory and were stored at -80°C until further analyses (Martin-Prevel et al., 2016).

3.7.8. Hemoglobin

Hemoglobin (Hb) level was measured immediately after blood was drawn using Hemocue Hb 301 (HemoCue, Ängelholm, Sweden) test systems (Sanchis-gomar et al., 2012). Hemoglobin values were adjusted for altitude (Sullivan et al., 2008). Subjects with anemia as defined by hemoglobin values < 11 g/dl for children was referred to the nearest health facility for treatment (McLean et al., 2009).

3.7.9. Extraction of serum retinol

The Serum retinol concentration was analyzed using High-Performance Liquid Chromatography method (Shimadzu HPLC system) at the laboratory of the Ethiopian Public Health Institute. The extraction of serum retinol was done following standard procedures:

Initially, 5,10, 20, 40, 60 and 75 µg/dl of retinol serials of standards was performed by adding 100µl of saline solution and retinol acetate were prepared, and the extraction of 100 µl serum sample was transferred to a 15 ml plastic test tube. An equal volume of ethanol and retinol acetate (internal standard) was added to denature and precipitate proteins. The samples were vortexed, and the sampls were extracted twice with 1000µL of hexanes, was mixed for 30 seconds with vortex and centrifuged at 4000 rpm for 10 minutes. Subsequently, the supernatant of the hexane layer solution was collected using a micropipette and was transferred into another test tube. The hexane was evaporated under a stream of nitrogen gas. The dried sample was reconstituted with 400µL of methanol and was vortexed for 15 seconds, and was injected into the HPLC system. The mobile phase was HPLC-grade methanol, elution system was isocratic, A column size C18, 5-µm 3.9X250 mm, flow rate was 1.5 ml per minute, 30 µl of injection volume, detector Shimadzu SPD-10A UV-

VIS, and data was processed by LC solution software. Absorbance was monitored at wavelength of 350 nm to maximize detection (Kim & Quadro, 2010; Tanumihardjo et al., 2016).

3.7.10. C- Reactive protein (CRP) and Alpha-1-Acid Glycoprotein (AGP) analysis

Serum CRP and AGP were quantified by the particle-enhanced turbidometric method with automated clinical chemistry analyzer (Cobas Integra 6000 Roche Kits Germany) instrument in which human CRP forms insoluble antigen-antibody complexes.The turbidity formed proportionally to the CRP concentration. The resulting change in turbidity of the solution, proportional to the CRP concentration, and AGP another protein indicative of inflammation was also assayed and measured with the immune-turbidimetry method using Roche immunoassay kits. The precipitate CRP and AGP were determined turbid metrical at 552 and 340 nm, wavelength respectively.

3.8. Data quality control

The following quality control measures were followed. The questionnaire was pretested, a five days training was provided to data collectors both in the collection of the dietary data, administration of the questionnaire, and collection of blood sample. The supervisor performed all the anthropometric measurements using calibrated equipment to minimize inter-examiner error. During the survey, strict daily supervision, checking of consistency as well as completeness of filled questionnaires was performed strict data collection supervision was instated by the supervisors. On daily basis, the PI reviewed every filled questionnaire and provided proper feedback to the data collectors. In addition, regular evening sessions were arranged for the sake of experience sharing purpose.The children anthropometric measurements were taken using calibrated and pretested scales. Birthweight measurement was done by properly trained data collectors. Blood sample collection and laboratory analyses followed standard procedures.

Biological samples were collected using red vacutainer tubes. For the sake of avoiding risk of hemolysis and contamination.

3.9. Data processing and analysis

All continuous variables were tested for normality using the histogram and QQ plot. The dietary intake (amount per day) and nutrient density (amount per 100 kcal) were presented as medians and interquartile range (first and third quartiles). The estimated usual intake of vitamin A was done using IMAPP. This method requires a two- non-consecutive days of dietary assessment to estimate the within- person variance. The prevalence of inadequate intake of vitamin A estimated using the EAR cutoff point method. The statistical analysis was carried out using a STATA statistical software version 14 and in all comparisons, differences were considered statistically significant for $P<0.05$.

3.10. Ethical considerations

Ethical clearance was obtained from the Ministry of Science and Technology Institutional Review Board. At the time of data collection, a written consent was taken from the participants (mothers and/or caregiver) to confirm whether they were willing to participate. Those not willing to participate did not participate in the study. Confidentiality of responses was also ensured throughout the research process. The formal letter also summited and the study design was also explained to officials of the region, zone, and woreda Health Department for their permission and support. Information was collected after securing written consent from the study participants. Data obtained from each study participant was kept confidential. All subjects who participated in the study were acknowledged, but did not receive any compensation.

3.11. Operational definitions

Bioavailability: - is defined as the proportion of a nutrient in food that is absorbed and utilized for normal metabolic and physiological functions or storage.

Dietary intake: - The amount of energy, nutrients or anti-nutrients available in the food consumed by a preschool children.

Dietary adequacy: - The amount of food taken daily by preschool children relates to the standard recommendations

Estimated average requirement (EAR): - is the daily intake estimated to meet the requirements, as defined by a specified function or biochemical measurement of 50% of the individuals in a particular life-stage and sex.

Individual diet diversity score: is the sum of food groups eaten in a specified reference period serves as a proxy of nutrient adequacy of an individual's diet.

Median value: - is that value of the variable, in an ordered list of values, that has an equal number of items on either side of it

Prevalence: - is a measure of the number of persons with inadequate intakes of a nutrient or with malnutrition or disease at a given time.

Portion size:-The amount of one food item consumed at a time.

4. RESULTS

4.1. Socio-demographic characteristics

A total of 142 children were recruited from Damot weyide and Offa woreda and enrolled in this study. All of them completed the study giving 100% response rate. The socio-demographic characteristics of the study participants including age, sex, agricultural land size, educational status, occupation, marital status, family size, types of toilet and source of drinking water are shown in Table 1.

The mean age (SD) of the mothers and children were 37.4(9.2) years and 46.4(7.0) months, respectively. The ratio of boys to girls was 1.2:1. The majority of the households were male-headed (95 %). Ninety-seven percent of the households have less than 1-hectare land size, and forty-one (29 %) of the household-head did not have any formal education. About three-fourth (79%) of the participants were farming households. Over 50% had a family size of 3-7, while ~40% of households had a family size of greater than or equal to seven persons. Most caregivers (95.1%) were married. Three-fourth (73 %) of the households had access to improved water (tap/well) as a main source of water, and about 97 % of households had pit latrine.

The prevalence of stunting, underweight and wasting were 32.4 %, 13.4 %, and 2.8 % respectively.

Table 1. Sociodemographic and anthropometric characteristics of preschool children (N=142) aged 36-59 months from selected two Woredas, Wolayita zone, Southern Ethiopia (2017)

Variables	**Frequency (%) /mean ±SD**
Age (years)	37.4 ± 9.2
Household head (male)	135 (95.1)
Agricultural land size (<1 hectares)	138 (97.2)
Education status	
No formal education	41 (29)
Primary (1-8) grade	82 (57)
Secondary (9-12) grade and above	20 (14)
Occupation	
Farmer	113 (79)
Merchant	15 (11)
Others	15 (11)
Marital status	
Single	2 (1.4)
Married	136 (95)
Widow	5 (3.5)
Family size	
3-7	82 (58)
>7	60 (42)
Types of latrine	
Pit latrine with slab	2 (1.4)
Pit latrine without slab	138 (97)
No facility	2 (1.4)
Source of drinking water	
Tap	103 (73)
Well	1 (0.7)
Spring	38 (27)
Children characteristics	
Age (month)	46.4 ± 7
male: female	1.2:1
Nutritional status	
HAZ	-1.35 ± 1.4
WAZ	-0.87 ± 1.1
WHZ	-0.11 ± 0.9
Stunted(HAZ<-2)	32.4 (46)
Underweight (WAZ<-2)	13.4 (19)
Wasted (WAZ<-2)	2.8 (4)

HAZ: height for age z-score; WAZ: weight for age z- score; WHZ: weight for height z-score.

Stunting: HAZ< -2; Underweight: WAZ< -2; Wasting: WAZ< -2

4.2. Dietary diversity score

The mean Dietary Diversity Score (DDS) was 2.5; and as shown in fig 4, diets were predominantly starchy and cereal based. Legumes and nuts were consumed by nearly 59 % of the children, nearly half of the children consumed Vitamin-A rich fruits and vegetables, and 1/3 consumed dairy. However, consumption of egg almost noon in both age groups and animal source foods (ASF) was very low. Maize, white sweet potato, taro, cassava and Ethiopian kale were the most frequently consumed foods.

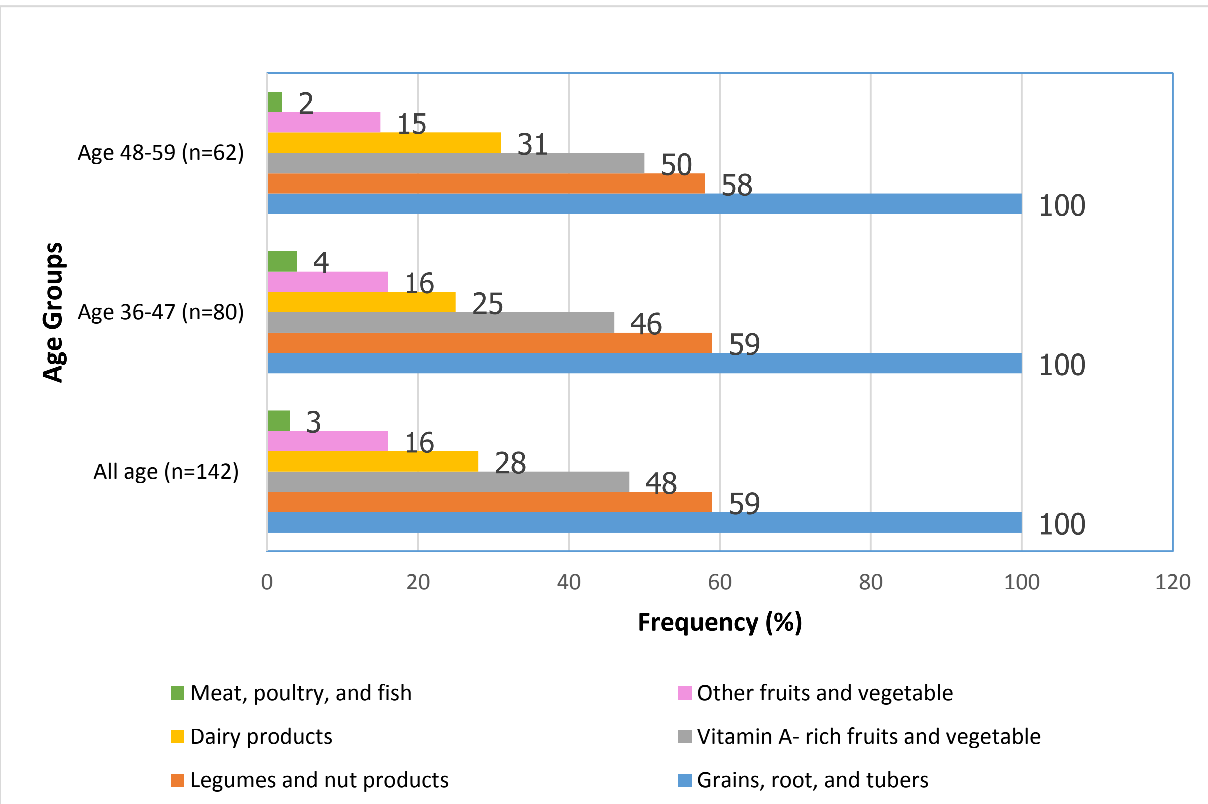

Figure 4. Food groups consumed (%) by preschool children in Wolayita Sodo,

The study also showed that out of seven food groups 1.4 % of preschool children had consumed ≥5 food groups, 47 % of preschool children consume 3-4 food groups and 51 % of preschool children consumed less than or equal to two food groups in the preceding day of the survey.

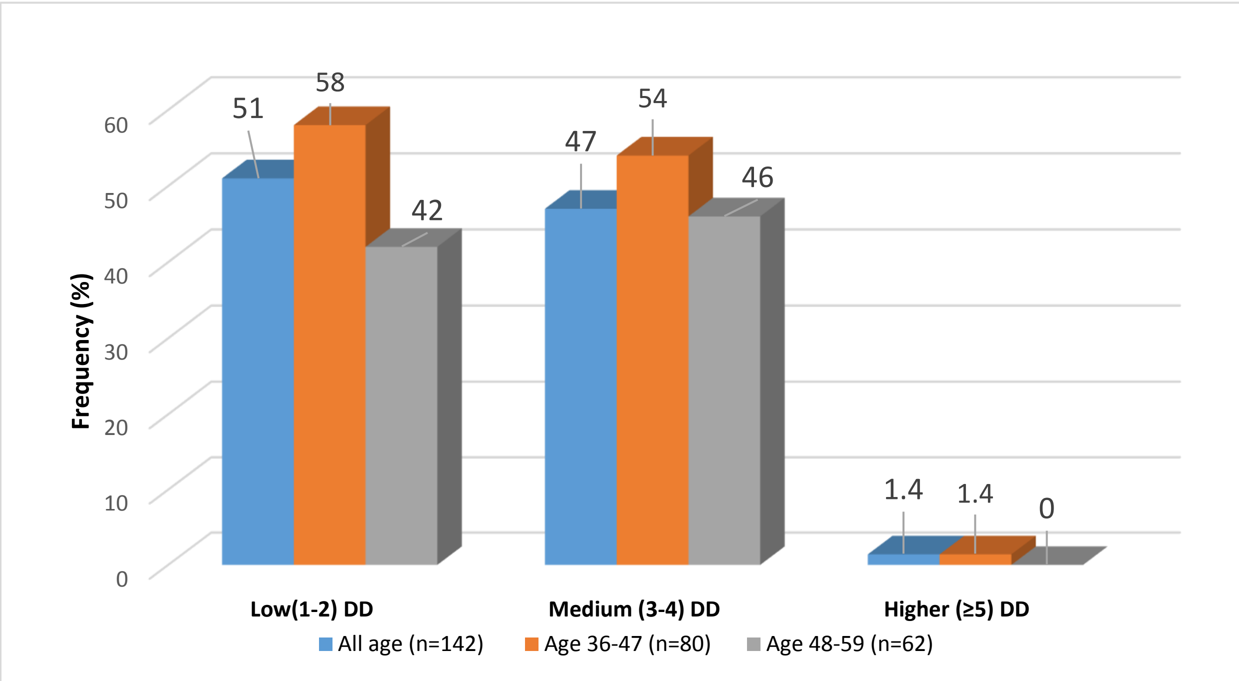

Figure 5. Dietary diversity of preschool children in the preceding 24h of the survey in Wolayita Sodo

4.3. Energy and nutrient intakes

Preschool Children in both age groups had an energy intake that was lower than the estimated need. In contrast, protein intakes were adequate for both age groups. Median vitamin A, calcium and vitamin C intakes did not meet the estimated needs of both age groups. Intake of Vitamin B of children 36-47month met both thiamin and riboflavin, but children 48-59 month met the estimated needs for thiamin, but did not meet their riboflavin requirements. Assuming low bioavailability, iron but not zinc intake requirements were met.

Table 2. Median (Q1, Q3) energy and nutrient intake of preschool children (36-59 month) in comparison with estimated needs, Wolayita Zone selected two district, SNNPR, Ethiopia (2017)

Energy and nutrients (/day)	All age (n=142)	Age 36- 47month (n-80)	Age 48-59 month (n=62)
Energy (kcal)	1141.2 (930.3, 1498.3)	1151.3 (907.14, 1519.4)	1129.8 (943.1, 1425.8)
Estimated need		1046	1742
Vitamin A (µg RAE)	77.6 (10.74, 166.67)	68.7 (9.8, 158.8)	82.4 (18.4, 185.8)
Estimated need		400	450
Protein (g)	26.455 (18.93, 38.76)	26.5 (20.76, 44.53)	27.2 (17.1, 37.5)
Estimated need		13	19
Calcium (mg/day)	293.24 (202.64, 514.45)	306.67 (200.3, 520.5)	291.3 (203.5, 475.8)
Estimated need		500	600
Iron (mg/day)	24.09 (14.79, 42.83)	25 (15.4, 41)	23.7 (15.72)
Estimated need		11.6 (L), 5.8 (M)	12.6 (L), 6.3 (M)
Zinc (mg/day)	6.11 (4.19, 8.48)	5.3 (4.0, 7.2)	5.6 (4.0, 7.9)
Estimated need		8.3 (L). 4.1 (M)	9.6 (L), 4.8 (M)
Vitamin C (mg/day)	12.85 (7.71, 23.76)	13.5 (8, 23.6)	11.5 (7.5, 23.6)
Estimated need		30	30
Thiamin (mg/day)	0.645 (0.47, 0.9)	0.67 (0.47, 0.94)	0.62 (0.5, 0.9)
Estimated need		0.5	0.6
Riboflavin (mg/day)	0.53 (0.35, 0.92)	0.58 (0.38, 0.98)	0.5 (0.3, 0.9)
Estimated need		0.5	0.6

L= low bioavailability; M= medium bioavailability; Q1= first quartile; Q3= third quartile
Estimated need determined by the Recommended Nutrient intake value: Energy, (Food and Agricutural Organization, 2001) protein, (Intakes, 2011) and mineral and vitamin, (FAO & World Health Organization, 1998) respectively.

4.4. Nutrient density

Calcium, vitamin A, and vitamin C nutrient densities were less than the desired density. Protein densities met desired value. Iron met desired values when both low and moderate bioavailability was assumed. However, zinc was only met when moderate bioavailability was assumed (**Table 3).**

Table 3. Median (Q1, Q3) nutrient densities of in preschool children (36- 59 months) age in comparison with desired densities of nutrient intake for (n=142) two district, Wolayita Sodo, Southern, Ethiopia (2017)

Nutrients	Nutrient Density (n=142) Median (Q1, Q3)	Desire density (/100 kcal) Age (month)	
		36-47 (n=80)	**48-59 (n=62)**
Protein (g)	2.3 (2.1-2.6)	1.22	1.65
Calcium (mg)	25.8 (22.4-34.5)	46.76	43.50
Iron (mg)	2.12(1.6-2.8)	1.08 (L), 0.54 (M)	1.1 (L), 0.55 (M)
Zinc (mg)	0.54 (0.5-0.6)	0.78 (L), 0.38 (M)	0.84 (L), 0.42 (M)
Vitamin A (RE)	6.83 (1.2-11.2)	37.41	39.15
Vitamin C (mg)	1.13 (0.9-1.6)	2.81	2.61
Thiamin (mg)	0.06 (0.1-0.1)	0.05	0.05
Riboflavin (mg)	0.05 (-0-0.1)	0.05	0.05

L=low bioavailability; M= medium bioavailability; Q1=first quartile; Q3=third quartile

4.5. Inadequate energy and nutrient intake

The prevalence of inadequate intake of vitamin A and calcium was very high 94 % and 71 % when it is compare with EAR value. One-third (37%) of energy intake was inadequate and 95 % of protein intake in the study area was adequate for all age children, even though the diets were cereal and tuber based, whereas the prevalence of inadequate intakes of zinc and iron was 39% and 8 % respectively.

Table 4. Prevalence of inadequate Energy and nutrient intake in preschool children (36- 59 months) age in selected two district,Wolayita Zone, SNNPR, Ethiopia, 2017

Nutrient	Prevalence of dietary intake inadequacy, n (%)		
	All age (n=142)	36-47 (n=80)	48-59 (n=62)
Energy	53 (37)	31 (39)	22 (35)
Protein	7 (5)	4 (5)	3 (5)
Vitamin A	133 (94)	77 (96)	56 (90)
Calcium	99 (71)	44 (56)	55 (90)
Iron	11 (8)	4 (5)	7 (11)
Zinc	55 (39)	32 (40)	23 (37)

Energy and nutrient inadequacy calculated based on Recommended Nutrient intake value: Energy,(Food and Agricutural Organization, 2001) protein, (Intakes, 2011) and mineral, (FAO & World Health Organization, 1998) respectively

4.6. Vitamin A, animea and ferritin status of preschool children

The value of ferritin, CRP and AGP were not normally distributed due to this reason median values were used. But for serum retinol and hemoglobin values (mean ± SD) are reported. Overall, the mean ± SD retinol concentration was 0.99 µmol/L ± 0.4. The mean hemoglobin concentration was 12.8 ± 0.9 (µg/dl), and median (Q1, Q3) concentration of serum ferritin was 44.5 µg/L (34.3, 65.7). Both median (Q1, Q3) CRP and AGP were 0.31 mg/L (0.1-1.2) and 0.9 g/L (0.7-1.2) respectively as shown in **Table 5**.

Table 5. The micronutrient status indices among preschool children (36-59 month) age in selected two district, Wolayita Sodo Zone, SNNPR, Ethiopia (2017)

Biomarker status	Mean ± SD/Median(Q1-Q3)		
	All age (n=142)	36-47 (n=80)	48-59(n=62)
Serum retinol (µmol/L)	0.99 ± 0.4	0.99 ± 0.4	0.98 ± 0.32
Hemoglobin (g/dL)	12.8 ± 0.9	12.7 ± 0.9	13.0 ± 0.8
Ferritin (µg/L)	44.5 (34.3, 65.7)	41.8 (34.4, 65.3)	45.6 (32.6, 66.5)
AGP (1 g/L)	0.9 (0.7, 1.2)	1 (0.7, 1.2)	0.8 (0.7, 1.1)
CRP (mg/L)	0.31 (0.1, 1.2)	0.33 (0.03, 1.39)	0.3 (0.08, 1)

AGP, α1-acid glycoprotein; CRP, C-reactive protein

The prevalence of vitamin A deficiency (serum retinol <0.70μmol/L) after adjusting for inflammation (AGP≥ 1g/L and CRP ≥ 5mg/L) was 22% (Table 5); whereas, only 2.1 % had low serum ferritin (< 12 μg/L). The percentage of children with raised inflammatory biomarkers were 9% (CRP) and 39% (AGP).

Table 6. Prevalence of Vitamin A, anemia, inflammation and iron deficiency among preschool children (36-59 month) after adjustment for inflammation at the selected two district, Wolayita Zone, SNNPR, Ethiopia, 2017

Biomarkers (n=142)	**Frequency (%)**
Serum retinol > 0.7μmol/L [a]	(111) 78
Serum retinol < 0.7μmol/L [a]	(31) 22
Infection Marker [b]	
CRP > 5 mg/L	(12) 9
AGP > 1 g/L	(56) 39
Anemia Hb (mg/dl) [c]	
Normal [d]	(137) 98
Moderate [e]	(3) 2.1
Iron deficiency [f] (ferritin < 12 μg/L)	(3) 2.1

[a] Adjusting for raised CRP and AGP concentrations, using regression approach (Larson et al., 2017; Suchdev et al., 2016); Adjusted serum retinol = unadjusted retinol μmol/L+ [(0.0090021* AGP g/L) + (0.0083189* CRP mg/L)]
[b] AGP, α1-acid glycoprotein; CRP, C-reactive protein
Individual Hemoglobin vales were adjusted for Altitude greater than 1000 meter above sea level (Sullivan et al., 2008).
[c] Anemia is defined as Hb<11.0 g/dL for children 36 to 59 months, Classification:
[d] Moderate Hb 7-11 g/dL and
[e] Normal Hb>11g/d
[f] Adjusted ferritin= unadjusted ferritin g/L – [(0.2432745* AGP g/L) + (1.73085* CRP mg/L)]

4.7. Simulation of the impact of replacing white by orange-fleshed sweet potato on vitamin A intake

The baseline prevalence of inadequate vitamin A intake was 96.5 %, but replacing 75% of the current level of white fleshed sweet potato by orange-fleshed bioforitifed varieties reduced the prevalence of inadequate vitamin A intake to 6.7 % (**Table 7)**.

Table 7. Simulation of impact of replacing white by orange-fleshed sweet potato on vitamin A intakes of preschool children (36-59 months old) in selected two district,Wolayita Sodo, SNNPR region, Ethiopia, November 2016

Substitution level RAE[2]	**Age 3-4 (n=80)**		**Age 4-5 (n=62)**		**All Age (n=142)**	
	Inadequate[3] %	Usual intake [4] µgRAE/d	Inadequate[3] %	Usual intake [4] µgRAE/d	Inadequate[3] %	Usual intake [4] µgRAE/d
0%	93.7	93.6 (16.2,177)	100	55.3 (9.4, 164.8)	96.5	79.6 (11.2, 171.9)
15%	23.3	312.4 (144.8, 492)	50.7	276.7 (84, 457.8)	35.4	293.7 (108.7,477.8)
25%	13.2	470.3 (144.8, 664.7)	30.5	356.2 (84, 655.4)	21	405.4 (110.6, 658.8)
50%	6.7	666 (157.6, 1217)	15.6	502.4 (84,1107.3)	10.6	576.3 (112.5, 1165.3)
75%	4.4	950.6 (157.6, 1748)	10.3	635.6 (84, 1552.4)	6.9	810.2 (112.5, 1726.6)

[1] Simulated white sweet potato intake with orange fleshed sweet potato; children were aged 36-59 month. EAR, estimated average requirement, RAE, retinol activity equivalent.
[2] Vitamin A intakes were calculated by using RAE.
[3] Prevalence of Inadequacy was based on the EAR of 210µg vitamin A/d for 36-47 age old and 275µg vitamin A/d for 48-59 age old (G. E. T. T., & Titles, 2001).
[4] Usual vitamin A intakes were estimated by using the Iowa state University method (De Moura et al., 2016) with the IMAPP program.

5. DISCUSSION

The present study evaluated the energy and nutrient intakes of preschool children in Wolayita Sodo, SNNPR. Diets were predominantly starchy root and cereal-based, with little consumption of fruits, vegetables and animal source foods. Consequently, deficits in energy, vitamin A and zinc were observed, while intakes of iron and protein met requirements. This was confirmed by low serum retinol levels and relatively low proportion of low serum ferritin in this study subjects. Simulating replacement of the consumption of white by orange-fleshed sweet potato led to significant reduction of the prevalence of inadequate vitamin A intake.

The predominantly starchy and cereal-based diet in this sample of preschool children was not surprising (Gashu et al., 2016; Abebe et al., 2017). Previous national and pocket-level studies have shown that diets are low in diversity and are particularly dominated by staples (Arimond & Ruel, 2004). The low consumption of fruits, vegetables, and animal source foods is likely to result in the deficits of several essential micronutrients (Gebremedhin et al., 2017). Indeed, such dietary pattern in Ethiopia and elsewhere has been consistently associated with suboptimal intake of multiple micronutrients (EPHI, 2013; Herrador et al., 2015). Similarly, the present study revealed deficits in the intakes of energy, vitamin A, and zinc. Nevertheless, iron and protein intakes were found to meet daily requirements. This is in line with previous findings from Sidama (Gibson et al., 2008) and North Wollo (Baye et al., 2013)

The nutrient intake data was supported by the serum micronutrients results. Iron deficiency (low serum ferritin) was relatively low and was in support of the high iron intake in this study (EPHI, 2013; Gashu et al., 2016). However, mean serum retinol (vitamin A) values were relatively low (0.99 µmol/L ± 0.35) and was in the order reported for 4-15 years old children in Fogera districts, Amhara region (0.92 µmol/L ± 0.31) (Herrador et al., 2014), but also in line with recent values obtained for SNNPR from the national micronutrient survey (0.98 µmol/L ± 0.29; EPHI, 2016). About 22% of children in this study had low serum retinol levels, which is a much lower figure than the estimated prevalence of deficiency based on vitamin A intakes.

Although improving energy intakes will also improve the intakes of nutrients like zinc and Vitamin A, which were found to be in deficient; as shown by the low nutrient densities relative to the desired needs, this will not suffice to fill the nutrient gap. A shift in dietary patterns towards more nutrient-dense foods will be required. Much of the vitamin A intake came from dark-green leafy vegetables, particularly kale. While frequent consumption of kale need to be maintained, other vitamin A rich foods will also need to be frequently consumed to fill the nutrient gap.

A distinct feature of the dietary pattern in SNNPR compared to other regions like Amhara is the wide consumption of roots like cassava and sweet potato. The wide consumption of sweet potato presents an opportunity as biofortified varieties like the OFSP are rich in vitamin A. Unfortunately, much of the sweet potato consumed was the white variety. This is despite the promotion of OFSP production in the region. Various None Governmental Organization (NGO) and universities in the region have also been promoting the production and consumption of OFSP through recipe development and behavioral change interventions (Busse et al., 2017). Perhaps a detailed understanding of the enablers and barriers to OFSP consumption will be needed for more effective promotion of its consumption. A key limitation is also the lack of information of the extent to which this intervention could reduce vitamin A deficiency by being easily integrated into current dietary patterns.

Without a significant change in the current dietary pattern, just replacing white by orange-fleshed sweet potato led to significant reductions in the risk of inadequate vitamin A intake. Replacing up to 75% of the white sweet potato by OFSP, led to a reduction of the prevalence of inadequate vitamin A intake from 96.5% to 7%. The replacement had a more profound effect on the younger group (36-47 months) which reduced the inadequate vitamin A intake to 4.4%, perhaps because of higher consumption of sweet potato relative to the older group (48-59 months). This clearly highlights that the promotion of OFSP in this and similar settings in Ethiopia could be an effective strategy to address vitamin A deficiency. This has the added advantage of presenting little or no side effects compared to more common strategies like food fortification and supplementation (Kurabachew, 2015). However, the present study also highlights that in settings where OFSP consumption is high, the effect of concurrent interventions (e.g. supplementation and fortification) need to monitored closely to ensure that intakes do not surpass upper limits (Hathcock et al., 1990).

Several limitations needs to be considered when interpreting our results. First, the cross-sectional nature of our study does not allow inferences to be made on causality and rather indicate associations. Second, the choice of the study site was governed by the bigger study and was not selected randomly. However, the intake values and the prevalence of deficiencies were found to be in line with values obtained in national survey for the region, and thus suggest that it might have been representative. Third, the bioavailability and retention of beta carotene in the OFSPs grown in the area is not known, and thus our intake simulation had to rely on average values from literature.

6. CONCLUSION AND RECOMMENDATION

Notwithstanding the above mentioned limitations, the present study highlighted that the diets of the preschool children were predominantly starchy root and cereal-based, with little consumption of fruits, vegetables and animal source foods. Consequently, deficits in energy, vitamin A and zinc were observed, while intakes of iron and protein met requirements. This was confirmed by low serum retinol levels and relatively low proportion of low serum ferritin in this study subjects. While improving energy intakes will improve intakes of vitamin A, consumption of more nutrient-dense foods will be needed to fill the nutrient gap.

Replacement of the consumption of white by orange-fleshed sweet potato by up to 75% led to significant reduction in the prevalence of inadequate vitamin A intake. Although this seems to be a feasible strategy given the wide consumption of the white variety sweet potato, it will need a more systematic evaluation. Behavioral change communication (BCC) interventions that promote consumption of OFSP are clearly needed, but these will benefit from detailed understanding of consumer preference, enablers and barriers towards the consumption of OFSP.

Given that OFSP has the potential of effectively mitigate vitamin A deficiencies, a closer monitoring of the risk of hypervitaminosis with concurrent interventions that include supplementation and fortification is warranted, particularly in areas where consumption of vitamin A-rich foods is high. Perhaps, studies on the right mix of interventions (OFSP, fortification, and supplementation) to effectively prevent and treat deficiencies are needed. Future studies on the retention and bioavailability of vitamin A in OFSP varieties grown in Ethiopia, taking into account host-factors, are warranted.

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8. ANNEXES

Annex 8. 1. Consent form (English)

This module will be asked for only the study children who are between 36 – 59 months

Informed Consent

We are from the Ethiopian Public health institute. We are working on a project concerning child nutrition. Among all the preschool children 36-59 months old in the study areas your child has been chosen to participate in this study. This information will help the government to plan health and nutrition services. The survey usually takes between 30 and 45 minutes to complete.

Among children 36-59 months, we would like to find out more about how well they are by collecting a sample of your child's blood and stool. We will also measure your child's height and weight and ask questions related to what they are eating and their health habits.

If your child is 36-59 months old, the benefit to you for taking part in this survey is that you will get results for your child's weight, height, and anemia. The other information you give us will not benefit you in a direct way. However, we will add the information you give us to that of other houses in the study area, and will create a report. The report will contribute to the good of your community. What you say is important and valuable, and will help the community to improve their health and nutrition programs.

You do not have to take part in this study. You may refuse to answer any question. If I ask you any question you don't want to answer, just let me know and I will go on to the next question. You may choose to stop the interview at any time. Refusing to answer will not affect your family's access to health services.

All of the answers you give will be confidential and will not be shared with anyone other than members of our study team. This form with your answers will be kept under lock and key. You don't have to be in the study, but we hope you will agree to answer the questions because your views are important.
If you have a question about this study please call survey coordinator (Mr. Meseret W/yohannes) at the mobile (0911964937). If you think you may have gotten sick or have been harmed by the study, please contact your local health clinic and the survey coordinator.

Do you have any questions for me?
May I begin the interview now?

RESPONDENT AGREES TO BE INTERVIEWED……………………………………….1
RESPONDENT DOES NOT AGREE TO BE INTERVIEWED…………………………..2 END

Annex 8.2. Questionnaire (English Version)

IDENTIFICATION	**HH**	
HH1. CLUSTER NUMBER: ☐☐☐	**HH4**. CLUSTER NAME ____________________	
HH2. HH NUMBER: ☐☐	**HH5**: RESPONDENT NAME: ____________________	
HH3. PRESCHOOL CHILD NAME: ____________________	**HH6**: Date/Month/Year of interview:____ ____ / ____ ____ / ____ ____ ____ ___	
HH7. Date of birth of the child (name) : (dd/mm/yyyy) ____ ____ / ____ ____ / ____ ____ ____ ___		
HH8. Total number of HH members: ☐☐	**HH9.** No. of children under age of 5: ☐☐	
HH10. What is the sex of the head of the household?	Male ………………………………………. Female ……………………………………	01 02
HH11. What is the age (in years) of the head of the household?	Full years ☐☐	
HH12. What is the marital status of the head of the household?	Single Married widowed Divorced	01 02 03 04
HH13. What is the highest level of school the head of household completed?	None………………………………………. Primary…………………………………… Secondary ………………………………… Technical / vocational certificate ……… Higher / university/ college ……………… Others (Specify) ____________________ Don't know ……………………..................	00 01 02 03 04 77 88

HH14a. What is Occupation the head of Household?	No occupation farmer Student Fisher Merchant Mining Gov't work Pastoralist House work Laborer Other (specify)	01 02 03 04 05 06 07 08 09 10 77
HH14b. What is monthly income of the head of household?	Below 2000 birr 2000- 5000 birr Above 5000 birr	01 02 03
HH15. How many rooms in this household are used for sleeping?	Rooms ☐☐	
HH16. What is the main source of drinking water for members of your household? (CIRCLE ONE ONLY)	PIPED WATER Piped Into Dwelling………………. Piped To Compound/Plot……........ Public Tap/Standpipe…………….. Tube Well Or Borehole…………. Dug Well Protected Well…................... Unprotected Well……………. Water From Spring Protected Spring…………… Unprotected Spring…………	 01 02 03 04 05 06 07 08

	Rainwater…………………………	09
	Tanker Truck………	10
	Cart With Small Tank………..	11
	<u>SURFACEWATER</u>	
	RIVER/DAM/LAKE/POND/STREAM/CANAL/IRRIGATION CHANNEL……………	12
	BOTTLED WATER……………………...	13
	OTHER *(SPECIFY)*________________	77
	Don't know………………………………	88
HH17. What do you do to make the water safer to drink? Anything else? (RECORD ALL MENTIONED)	Boil………………………………………	01
	Water purifying product…………………	02
	Strain through a cloth………………….	03
	Ceramic filter………………………………	04
	Let it stand and settle …………………...	05
	Do noting	06
	Other *(specify)*______________ ____	77
	Don't know ……………………………..	88
HH18. What kind of latrine/toilet facility do members of your household usually use? (Observation**)**	Flush to piped sewer system………….….....	01
	Flush to septic tank……………...................	02
	Flush to pit latrine ……………………...	03
	Flush to somewhere else ……..	04
	Flush, don't know where……	05
	Ventilated improved pit latrine (vip)….............	06
	Pit latrine with slab…………………………	07
	Pit latrine without slab/open pit ….…………	08
	Bucket toilet …………………………….......	09
	No facility/bush/field ………………………	10
	Other *(specify)*__________________________	77

HH19a. Do you wash your hands after using the toilet/latrine? **(**Check presence of hand wash facility in the household) (OBSERVATION ONLY)	No …………………………………… Yes ……………………………………….	00 01
HH19b. Do you wash your hands before you eat?	No………………………………. Yes………………………………	00 01
HH20. Check presence of water at the specific place for hand washing.(OBSERVATION ONLY)	No ………………………………………. Yes …………………………………………..	00 01
HH21. Does any member of this household own any agricultural land? **If the answer is NO skip go to HH23**	No …………………………………………. Yes ………………………………………	00 01
HH22. How many hectares of land (altogether) are owned by the members of this family?	Number (in local Unit of Measurement) ☐☐☐ . ☐ Specify the name of measurement ______________________ Number of hectares ☐☐☐.☐☐ (Calculate hectares if answer given is in local unit of measurement) If ≥1000 record 999.9 Unknown…………………………………888.8	
HH23. Does this household own any livestock, herds?	No …………………………………… Yes …………………………………	00 01
HH24. If yes, how many animals? (If None, Write 000, If More Than 1,000 Write 999)	Number of animals 1 Milk cows or ox ☐☐☐ 2 Horse/donkey/mule ☐☐☐ 3 Goats ☐☐☐	

	4 Sheep 5 Poultry 6 Camels 7 Pigs 8 Other________________________	
HH25. Does your household have a separate room outside the house for the livestock (any of the animals listed above)? (observation)	No ………………………………………… Yes…………………………………………	00 01
VITAMIN A MODULE		**VA**
VA1. Has ever received a vitamin A capsule like this one? ***Show the vitamin A capsule 200,000 IU for children 12-59 months old.***	Yes ……………………………………… No………………………………………….. DK……………………………………….	01 00 88
VA2. How many months ago did (name) take the last dose?	Months ago ………………… ____ __ DK………………………..	 88
VA3. Where did (name) get this last dose?	On routine visit to health facility ……….. Sick child visit to health facility ……….. National immunization day campaign …… DK………………………………… Other (specify)________________________	01 02 03 88 77
VA4. We would like to know if some food products (fortified oil/sugar/baby food) are used in your household. Do you have fortified oil/sugar/baby food in the house?	Yes …..………………………………. No………………………………… DK………………………………………	01 00 88

CARE OF ILLNESS MODULE		CA
CA1. Has (name) had diarrhea in the last two weeks, that's since (day of the week) of the week before last? **Diarrhea is determined as perceived by mother or caretaker, or as three or more loose or watery stools per day, or blood in stool. If the answer is NO skip go to CA6**	Yes …………………………………… No…………………………………….. DK………………………………………	01 00 88
CA2. During this last episode of diarrhoea, did (name) drink any of the following: Read each item aloud and record response before proceeding to the next item.	A. Fluid from ORS packet………….... B. Recommended homemade fluid…...	**Y N DK** 01 00 88 01 00 88
CA3. During (*name's*) illness, did he/she drink much less, about the same or more than usual?	Much less or none............................ About the same (or somewhat less)... More... DK..	01 02 03 88
CA4. How many times did you feed (*name*) /day when he /she had diarrhea?	_________________ No. of times DK …………………………….….	 88
CA5. During (*name's*) illness, did he/she eat less, about the same, or more food than usual? If "less", probe: much less or a little less?	None... Much less.. More……………………………... About the same................................ More.. DK...	01 02 03 04 05 88
CA6. Has (name) had an illness with a cough with short, difficult, faster breathing than usual at any time in the last two weeks, that is, since (day of the week) of the week before last? **If the answer is NO skip go to CA10**	Yes …………………………….…… No…………………………………….. DK……………………………….….	01 00 88

CA7. Did you seek advice or treatment for the illness outside the home?	Yes.. No.. DK...	01 00 88
CA8. From where did you seek care? Anywhere else? Circle all providers mentioned, but do NOT prompt with any suggestions. If source is hospital, health center, or clinic, write the name of the place below. Probe to identify the type of source and circle the appropriate code. __________________________ (Name of place)	Govt. hospital................................. Govt. health center.......................... Govt. health post............................. Village health worker....................... Mobile/outreach clinic..................... Private hospital/clinic...................... Private physician............................. Private pharmacy............................ Shop.. Traditional practitioner.................... Other (*specify*)__________________	01 02 03 04 05 06 07 08 09 10 77
CA9. Was (*name*) given medicine to treat this illness?	Yes... No... DK..	01 00 88
CA10. Did the child have measles in the last one year?	Yes…………………………………… No……………………………….…..	01 00
CA 11. The last time *(name)* passed stools, what was done to dispose of the stools?	Child used toilet/latrine..................... Put/rinsed into toilet or latrine............ Put/rinsed into drain or ditch.............. Thrown into garbage (solid waste)..... Buried.. Left in the open.................................. Other (*specify*).................................... DK...	01 02 03 04 05 06 77 88
CA 12. In the last six month, has this child been given a drug for intestinal worms?	Yes ……………………………….… No…………………………………… DK…………………………………	01 00 88
CA 13. Has (child's name) been ill with a fever in the past 2 weeks?	No……………………….. Yes ………..………………. Don't know……….……..	00 01 88

CA 14. Has (child's name) been ill with malaria in the past 2 weeks?	No……………………....... Yes ………..……………. Don't know……….……..	00 01 88
CA 15. Was the child treated with any modern drugs or medications for malaria?	Yes …………………….. No ……………………….. Don't know …………………..	01 00 88
CA 16. Has (child's name) been ill with rashes in the past 2 weeks?	No…………………...... Yes ………..……………. Don't know……….……..	00 01 88
CA 17. Has (child's name) been ill with measles in the past 2 weeks?	No…………………...... Yes ………..…………… Don't know……….…….	00 01 88

BREAST FEEDING MODULE		**BF**
BF1. Has (name) ever been breastfed?	Yes …………………………………… No………………………………………. DK………………………………………	01 00 88
BF2. Is He/she still being breastfed?	Yes ………………………………………. No………………………………………….. DK……………………………………….	01 00 88

Annex 8.3. Consent for anthropometry and biochemical

CONSENT STATEMENT FOR ANTHROPOMETRY AND BIOCHEMICAL SAMPLE COLLECTION

As part of this survey, we would also like to assess the vitamin A in your 36-59 month old child's body. Vitamin A deficiency is a serious health problem that usually results from poor nutrition, infection, or chronic disease

We would like to take a sample of his/her blood and stool. We need also to check your eyes for spots. The tests are safe. Some tests may cause your child slight discomfort, such as taking a blood sample. For the blood sample, your child will have blood drawn from a vein in the arm with a needle. The equipment used in taking the blood is clean and completely safe. It has never been used before and will be thrown away after each test. We would also like you to collect a sample of stool from the same child in a cup. By giving us his/her stool to test, you will help the Ministry of Health learn more about parasites that make people sick in your community.

Your child's blood will be tested for anemia immediately, and the result told to you right away. The benefit to you for taking part in this study is that your child will get results for weight, height, and anemia, and referral to the nearby health facility if needed. The other information you give us will not benefit you in a direct way. However, we will add the information you give us to that of other houses, and will create a report. The report will contribute to the good of your community. What you say is important and valuable, and will help the community to improve their health and nutrition programs.

The result will be kept strictly confidential and will not be shared with anyone other than members of our survey team.

We will refer your child to the clinic if s/he has severe anemia.

You can say yes to any of these tests, or you can say no. It is up to you to decide. Do you have any questions? Will you provide a small amount of blood and stool?

Consent given for: (Y OR N) **PL01** Blood ☐	**PL02** Stool ☐
PL03 Code for Laboratory Technician: ☐☐	Lab. Tech Name ________________________
PL04 Bitot's Spot	No…..……………..…………………00 Yes……………………………..…… 01
PL05 Blood collected using TUBE Not collected =00.0 Refused = 77.7	ML. ☐☐ ● ☐
PL06 Date blood sample taken	Date: ______/_______/__________ Day / Month / Year
PL07 TIMEBLOOD DRAW	Blood draw ___ ___ : ___ ___ Hour Minute
PL08 When did you eat your most recent meal (food)?	___ ___ : ___ ___ Hour Minute
PL09 MALARIA RESULTS (RDT)	NEGATIVE……………...........................00 POSITIVE P FALCIPARUM ……..……... 01 POSITIVE PFACIPARUM and VIVAX……………………..…02 INVALID……………………… 03
PL10 HEMOGLOBIN RESULTS	g/dL ☐☐ ● ☐
We would like to collect a stool sample from your child. If you can provide this now, we appreciate it. If not now, we can come back to pick up the sample at a later time. *INSTRUCTIONS IF UNABLE TO PRODUCE AT WILL*: **For stool**: We will return tomorrow to pick up child's (NAME) stool. We would like the freshest stool child can give us. Please use this cup to collect the first stool the child passes.	
Pl11stool collected?	NO…………………….....00 YES ………...…………....01
pl12 date stool sample taken	Date: ______/_______/__________ Day / Month / Year
pl13 time: stool passed	___ ___ : ___ ___ Hour Minute
pl14 time: stool collected(as recorded on cup)	___ ___ : ___ ___ Hour Minute
PL15 Time blood centrifuged	___ ___ : ___ ___ Hour Minute
PL16 Referral given	No……………………….. 00 Yes ………..……………. 01
PL17: final interview result:	Result Codes: 1 Completed 2 Not At Home

	3 Parent Refused 4 Child Refused 5 Partly Completed 6 Incapacitated 7 Other (Specify) ________________

Annex 8.4. 24-hour Dietary Recall and Anthropometry Form

1. Child's code: ☐☐☐☐	**2.** Date of interview ☐☐ Day ☐☐ Months ☐☐ Year	**3.** Location (Gote code) ☐☐☐☐	4.Data collectors code: ☐☐
Child's name: ____________ First name ____________ Middle name ____________ Last name			
Caregiver name: ____________ First name ____________ Middle name ____________ Last name			
5. Child sex (1= M, 2 = F) ☐	**6.** Date of birth ☐☐ Day ☐☐ Months ☐☐ Year	**7.** Age (months) ☐☐	**NOTE:** if the child is younger than 36 months or 60 months old or older, do not apply the survey
8. Was (child) breastfed yesterday? (0 = No, 1 = Yes) ☐		**9.** Yesterday, was it a holiday in the community? (0 = No, 1 = Yes)	
10. Yesterday, was there a celebration in the family? (0 = No, 1 = Yes) ☐		**11.** Yesterday, was the child sick with fever, cough or diarrhea? (0 = No, 1 = Yes) ☐	
12. Child weight in kilograms ☐☐ ☐☐		**13.** Child length in centimeters ☐☐ ☐☐	
14. Child mid-upper arm circumference (MUAC) in centimeters ☐☐ • ☐☐			

Explain the questionnaire to the caregiver before beginning.

Help her recall (remember) the previous day, based on the times when the child woke up, the activities the child had, etc. Go slowly.

*Child's Code*________________

Ask the caregiver the following: Please tell me everything that the child ate and drank yesterday. After the child woke up, what was the first thing you gave him/her to eat or drink? After that, what other food or drink did you offer the child? Write all the foods or dishes consumed the day before that the caregiver mentions. Be sure to ask this: What is the name of that mealtime (e.g., breakfast, lunch, or dinner, or morning, afternoon, or evening snack)?

Quick List

Breakfast	Snack	Lunch	Snack	Dinner	Snack

SECOND PASS (Detailed list) for Child

*Child's Code*________________

Measurements taken in the home			office	Measurements taken in the home						Net grams (office)			Is the meal has ingredient (0=no,1= yes) If the answer is 1= go to next page or table
15. Meal-time	Name of food or dish	Ingredients and charac-teristics	16. Code of food or dish	Served (gm/ml)	Not Consumed	Consumed	Weighed (1=gross 2=net)	How consumed (1=cooked 2=raw)	17. Days consumed in past week	Conversion to grams	18. Served	19. Consumed	

Mealtime:
Meals code: 10 mornings (breakfast); 20 mid-day (lunch); 30 evening (dinner)
Snacks: 11, 12, 13 ... 19 Morning (after breakfast); 21, 22, 23 … 29 Afternoon (After lunch); 31, 32, 33 … 39 Evening (after dinner)

3rd steps: if the food has ingredients

*Child's Code*________________

Measurements taken in the home				Office		Measurements taken in the home				Office	
Dish:				**Total weight of cooked ingredients:**		**Dish:**				**Total weight of cooked ingredients used for**	
Ingredients	**Quantity used (gm/ml)**	**Weighed (1=gross 2=net)**	**Used (1=cooked 2=raw)**	**Conversion to cooked**	**Cooked grams**	**Ingredients**	**Quantity used (gm/ml)**	**Weighed (1=gross 2=net)**	**Used (1=cooked 2=raw)**	**Conversion to cooked**	**Cooked grams**

Annex 8.5. Questionnaire (Amharic)

የመጣነዉ ከኢትዮጵያ የህብረተሰብ ጤና ኢንስቲትዩት ነዉ፡፡ የልጆችን ስርአተ-ምግብ የሚመለከት ፕሮጄክት እየሰራን ነዉ፡፡ እድሜያቸዉ ለትምህርት ካልደረሱት ህጻናት መካከል ማለትም ከ36-59 ወራት ከሆኑት ዉስጥ የርስዎ ልጅ የዚህ ጥናት ተሳታፊ እንዲሆን ተመርጦኣል፡፡ ይህ መረጃ መንግስት ስለ ጤና እና ስርአተ-ምግብ አገልግሎት ለማቀድ ይረዳዋል፡፡ መጠይቁ ከ30-45 ደቂቃ ይወሰዳል፡፡

እድሜያቸዉ ከ36-59 ወራት ከሆኑት ልጆች ዉስጥ ምን ያህል ጤነኛ መሆናቸዉን መረዳት ያስችለን ዘንድ ከልጅዎ ላይ የደም እና የሰገራ ናሙና እንወሰዳለን፡፡ እንዲሁም ደግሞ የልጆትን ቁመት እና ክብደትም እንለካለን በመጨረሻም የልጆትን አመጋገብ እና ጤና ሁኔታ የሚመለከት መጠይቅ እንጠይቆታለን፡፡

የልጅዎ እድሜ ከ36-59 ወራት ከሆነ እና የዚህ ጥናት ተሳታፊ ከሆኑ ከዚህ ጥናት በቀጥታ እና በተዘዋዋሪ ተጠቃሚ ይሆናሉ፡፡በቀጥታ የሚጠቀሙት የልጆትን ቁመት ፣ ክብደት እንድሁም ደግሞ የወባ እና የደም ማነስ በሽታ መኖር አለመኖሩን ለማወቅ ሲሆን በተዘዋዋሪ የርስዎ መረጃ ከሌሎቹ የጥናቱ ተሳታፊዎች ጋር በመደመር የአካባቢዎን የጤና ሁኔታ ለማሻሻል ይረዳል፡፡ እርስዎ ጠቃሚ ነዉ ብለዉ የሰጡን መረጃ ለጤና ጥበቃ ሚኒስቴር የጤና እና ስርአተ-ምግብ ፕሮግራሞችን ለማሻሽል ይረዳል፡፡

በዚህ ጥናት ላይ አለመሳተፍ ይችላሉ፡፡ጥያቄዎችንም ያለመመለስም እንዲሁ፡፡ ጥያቄ ስጠይቅዎ መመለስ የማይፈልጉ ከሆነ እባክዎትን ያሳዉቁኝ፡፡መጠይቁን በማንኛዉም ሰአት ማቆም ይችላሉ፡፡ በዚህ ጥናት ላይ ባለመሳተፍዎ ምክንያት የሚያጡት ምንም አይነት የጤና አገልግሎት አይኖርም፡፡

ሁሉም ምላሾችዎ ሚስጥራዊነቱ የተጠበቀ ይሆናል፤ይህም ማለት ከእኛ የጥናቱ ተሳታፊ አባላቶቻችን ዉጭ ለማንም አናካፍለዉም፡፡እርስዎ ለመጠይቆቻችን የሰጡን ምላሾች በካዝና ዉስጥ ተቆልፈዉ ይቀመጣሉ፡፡ በጥናቱ ላይ ተሳታፊ ባይሆኑም የእርስዎ እይታ በጣም ጠቃሚ ስለሆነ ለመጠይቆቹ ምላሽ ይሰጡናል ብለን ተስፋ እናደርገለን፡፡

ምንም አይነት ጥያቄ ካለዎት እባክዎን ሐላፊያችንን (አቶ ተስፋዬ ሀይሉ) በ ሞባይል ስልካቸዉ (0944123108) ይደዉሉ፡፡በዚህ ጥናት ሳቢያ የታመሙ ወይም ያጋጠሞት ማንኛውም አደጋ ካለ ባቅራቢያዎ ያለዉን የጤና ተቋም ወይም የጥናቱን ሐላፊ ያግኙ፡፡

ጥያቄ አለዎት?

ቃለ-መጠየቁን መጀመር እችላለዉ?

ተሳታፊዉ ለቃለ-መጠይቁ ተስማምተዋል--1

ተሳታፊዉ ለቃለ-መጠይቁ አልተስማሙም--------------------------------------,-----------------------2 መጨረሻ

መለያ	HH
HH 1. የቆጠራ ቦታ መለያ ቁጥር ☐☐☐	**HH4**. የጥናቱ ቦታ ስም ______________________
HH2. የቤተሰብ መለያ ቁጥር ☐☐☐	**HH5**. የተጠያቂዉ ስም: ______________________
HH3. የህጻኑ ስም ______________	**HH6**. የተጠየቀበት: ቀን/ወር/ዓ.ም ___ ___ / ___ ___ / ___ ___ ___ ___
HH7. የህጻኑ (ስም) የልደት ቀን/ወር/ዓ.ም ___ ___ / ___ ___ / ___ ___ ___ ___	
HH8. የቤተሰቡ አባላት ብዛት ☐☐	**HH9**. ከአምስት ዓመት በታች ያሉ ህጻናት ብዛት: ☐☐

HH10. የቤተሰቡ ኃላፊ ፆታ	ወንድ .... ሴት	01 02
HH11. የቤተሰቡ ኃላፊ እድሜ(በአመት)	ሙሉ አመታት ☐☐	
HH12. የቤተሰቡ ሐላፊ የጋብቻ ሁኔታ?	ያላገባ ያገባ በሞት የተለያዩ በፍቺ የተለየ	01 02 03 04
HH13. የቤተሰቡ ሐላፊ ከፍተኛ የትምህርት ደረጃ?	አልተማሩም.. የመጀመሪያ ደረጃ.. ሁለተኛ ደረጃ .... ቴክኒክ እና ሙያ......... ከፍተኛ/ዩኒቨርስት/ኮሌጅ .... ሌላ (እባክዎን ይግለፁ) _____________ አላዉቅም	00 01 02 03 04 77 88
HH14A. የቤተሰቡ ሐላፊ ዋነኛ ስራ ?	ስራ አጥ/ስራ የሌለዉ ገበሬ ተማሪ ዓሳ አጥማጅ ነጋዴ ማዕድን አዉጪ የመንግስት ስራ አርብቶ አደር የቤት ስራ የቀን/የጉልበት ሰራተኛ ሌላ (እባክዎን ይግለፁ)	01 02 03 04 05 06 07 08 09 10 77
HH14B. የቤተሰቡ ሐላፊ ወርሃዊ ገቢ?	ከ 2000 ብር በታች ከ 2000- 5000 ብር ከ5000 ብር በላይ	01 02 03
HH15. ለመኝታ ብቻ የሚያገለግሉ ምን ያህል ክፍሎች አላችሁ?	የክፍሎች ብዛት ☐☐	

HH16. የቤተሰቡ ዋና የመጠጥ ዉሃ ምንጭ ምንድነዉ? (እንድ ብቻ አከብብ/ቢ)	<u>የቧንቧ ዉሃ</u> አስከ መኖሪያ ቤቱ ድረስ በቧንቧ የመጣ------------ አስከ መኖሪያ ግቢዉ ድረስ በቧንቧ የመጣ--------- የህዝብ ቧንቧ--------------------------------------- የከርሰ ምድር በቧንቧ የመጣ----------------------- <u>የጉድጓድ ዉሃ</u> የተከለለ የዉሃ ጉድጓድ------------------------- ያልተከለለ የዉሃ ጉድጓድ----------------------- <u>የምንጭ ዉሃ</u> የተከለለ የምንጭ ዉሃ--------------------------- ያልተከለለ የምንጭ ዉሃ------------------------ የዝናብ ዉሃ-------------------------------------- በመኪና ላይ የተጫነ የታንከር ዉሃ ------------- ጋሪ ላይ የተጫነ ታንከር ዉሃ------------------- <u>የከርሰ ምድር ዉሃ</u> ወንዝ /ግድብ/ሀይቅ/ብርካ/ጅረት/ቦይ/መስኖ------- የታሸገ ዉሃ----------------------------------- ሌላ (እባክዎን ይግለፁ) ______________ አላዉቅም------------------------------------	 01 02 03 04 05 06 07 08 09 10 11 12 13 77 88
HH17. ዉሃዉ ንፁህ እንዲሆን የሚያደርጉት ነገር አለ? ሌላስ? (ከአንድ በላይ መልስ ይቻላል)	ማፍላት--- ዉሃ ማጽጃ ምርት መጠቀም/ምሳሌ ዉሃ አጋር---------- በልብስ ማጥለል------------------------------------- በሴራሚክ ማጥለል--------------------------------- ቆሻሻዉ እስኪዘቅጥ ድረስ መተዉ ----------------- ሌላ (እባክዎን ይግለፁ) ___________________________ አላዉቅም---	01 02 03 04 05 77 88
HH18. የቤተሰቡ አባላት በአብዛኛዉ ጊዜ የሚጠቀሙበት መፀዳጃ ቤት ምን አይነት ነዉ? (ምልከታ)	ዉሃ ያለዉ ከፍሳሽ ማስወገጃ ጋር የተያያዘ----------------- ዉሃ ያለዉ ወደ ታንክ የሚገባ------------------------------ ዉሃ ያለዉ ወደ ጓሮ ጉድጓድ የሚፈስ -------------------- ዉሃ ያለዉ ወደ ሌላ ቦታ የሚፈስ------------------------- ዉሃ ያለዉ ወዴት ቦታ እንደሚፈስ የማይታወቅ------------ የአየር ማስተንፈሻ ያለዉ ሽንት ቤት------------------------- በስሚንቶ/ሊሾ የተሰራ ሽንት ቤት-------------------------- በስሚንቶ/ሊሾ ያልተሰራ ሽንት ቤት/ክፍት ሽንት ቤት------ ፖፖ --- መፀዳጃ የለም/ሜዳ ላይ-------------------------------- ሌላ (እባክዎን ይግለፁ)_____________________	01 02 03 04 05 06 07 08 09 10 77

HH19a መፀዳጃ ቤት ከተጠቀሙ በኋላ እጅዎን ይታጠባሉ? (የእጅ መታጠቢያ መኖሩን ያረጋግጡ) *(ምልከታ ብቻ)*	አይደለም .... አዎ..	00 01
HH19b. ምግብ ከመመገብዎ በፊት እጅዎን ይታጠባሉ?	አይደለም አዎ	00 01
HH20. ለእጅ መታጠቢያ ተብሎ የተቀመጠ ዉሃ መኖሩን ያረጋግጡ. (ምልከታ ብቻ)	አይደለም .... አዎ..	00 01
HH21 ከቤተሰቡ አባላት መካከል የእርሻ መሬት ያለዉ ሰዉ አለ? (መልሱ አይደለም ከሆነ ወደ ጥያቄ **HH23** ይሂዱ)	አይደለም .... አዎ	00 01
HH22 አጠቃላይ የቤተሰቡ አባል ምን ያህል ሄክታር መሬት አለዉ?	በቁጥር(በአከባቢዉ መለኪያ) [ ][ ][ ] . [ ] የመለኪያዉን ስያሜ ይግለፁ ________________ ብዛት በሄክታር .... [ ][ ][ ] [ ] (ምላሹ በአከባቢዉ መለኪያ ከተሰጠ ወደ ሄክታር ለዉጣችሁ አስሉ) ከ1000 በላይ ከሆነ ....999.9 ካልታወቀ 888.8	
HH23. የቤት እንስሳት /ከብቶች አላችሁ?	አይደለም .... አዎ...	00 01
HH24. አዎ ካላችሁ ምን ያህል? (መልስዎ ምንም ከሆነ,000 ይጻፉ, ከ 1,OOO በላይ ከሆነ, 999 ይጻፉ)	**እንስሳት ብዛት** 1 የወተት ከብት ወይም በሬ [ ][ ][ ] 2 ፈረስ/አህያ/በቅሎ [ ][ ][ ] 3 ፍየል [ ][ ][ ] 4 በግ [ ][ ][ ] 5 ዶሮ [ ][ ][ ] 6 ግመል [ ][ ][ ] 7 አሳማ [ ][ ][ ] 77 ሌላ(ይገለጽ)________________	
HH25 ቤተሰብዎ ለእንስሳቱ ማደሪያ የሚሆን የተለየ ክፍል አለዉ (ከላይ ለተጠቀሱት ማንኛዉም እንስሳት)? (ምልከታ)	አይደለም.. አዎ...	00 01

የቫይታሚን ኤ ክፍል		**VA**
VA1. የዚህ ዓይነት የ ቫይታሚን ኤ ጠብታ ወስዶ/ዳ ያዉ.ቃል/ለች? (ዕድሜያቸዉ ከ12-59 ለሆኑት ህጻናት 200.000 IU ቫይታሚን ኤ ጠብታ ያሳዩ)	አዎ .... አይደለም.. አላዉ.ቅም..	01 00 88
VA2. ከስንት ወር በፊት (ስም) የመጨረሻዉን የቫይታሚን ኤ ጠብታ ወሰደ/ች?	ከወራት በፊት .... ___ ___ አላዉ.ቅም..	 88
VA3. ልጅዎ (ስም) የመጨረሻዉን ጠብታ የወሰደዉ/ችው የት ነዉ?	ሁሌ በምንሄድበት ጤና ተቋም .... በታማሚ ህጻናት ጤና ተቋም .... በሀገር አቀፍ የክትባት ዘመቻ ላይ .... አላዉ.ቅም.. ሌላ (እባክዎን ይግለፁ) _______________	01 02 03 88 77
VA4. አሁን ደግሞ በቤትዎ ዉስጥ በንጥረ ምግበ የተቀየጠ ዘይት/ስኳር ወይም የህፃን ምግብ መኖሩን ለማወቅ እንወዳለን፡፡በቤትዎ ዉስጥ በንጥረ ምግበ የተቀየጠ ዘይት/ስኳር ወይም የህፃን ምግብ አለ? (ምልከታ)	አዎ .... አይደለም.. አላዉ.ቅም..	01 00 88
VA5. በአይን ላይ ለሚወጣዉ እና አይብ መሰል ነጭ ነጥብ (Bitot's Spot)	የለም .... አዎ	00 01
ጡት ከመጥባት ጋር የተያያዙ መጠይቆች **BF**		
BF1. ልጅዎ (ስም) ጡት ጠብቶ/ታ ያዉ.ቃል/ለች?	አዎ .... አይደለም.. አላዉ.ቅም..	01 00 88
BF2. ልጅዎ እስካሁን ጡት በመጥባት ላይ ነዉ/ናት?	አዎ .... አይደለም.. አላዉ.ቅም..	01 00 88
ለታመሙት ህጻናት የሚደረግ ክብካቤ ክፍል **CA**		
CA1. ልጅዎ (ስም) ባለፉት ሁለት ሳምንታት ዉስጥ የተቅማጥ በሽታ ይዞት/ዟት ያዉ.ቃል? ተቅማጥ በወላጅ ወይም በአሳዳጊ የሚገለፅ ሲሆን በቀን 3 እና ከዚያ በላይ ቀጭን/ወሃማ/ደም የቀላቀለ ሰገራ (መልሱ አይደለም ከሆነ ወደ ጥያቄ CA6. ይሂዱ)	አዎ .... አይደለም.. አላዉ.ቅም..	01 00-----CA6 88
CA2. ልጅዎ (ስም) ባለፈዉ ተቅማጥ የያዘዉ ግዜ ከሚከተለዉ አንዱን ወስዶ ያዉ.ቃል? (ወደ ሚቀጥለዉ ጥያቄ ከመሄዳችሁ በፊት ዝርዝሮቹን ድምጻችሁን ከፍ አድርጋችሁ አንቡቡላቸዉ)	A. የኦ.ር.ኤስ ፈሳሽ/ለምለም/ሕይወት አድን ንጥረ-መድሀኒት B. በቤት ዉስጥ እንድዘጋጅ የሚመከረዉ?	አዎ አይ አላ 01 00 88 01 00 88

CA3. ልጅዎ (ስም) በህመሙ/ሟ ግዜ ከተለመደዉ ያነሰ፣ ተመሳሳይ ወይንስ ከተለመደዉ የበለጠ ፈሳሽ ይወስዳል?	ያነሰ ወይም ምንም .... እንደተለመደዉ (ወይም ትንሽ ያነሰ).... የበለጠ.. አላዉቅም..	01 02 03 88
CA4. ልጅዎ (ስም) ተቅማጥ ሲይዘዉ በቀን ምን ያህል ግዜ ይመግቡታል?	_____________ ግዜ አላዉቅም	 88
CA5. ልጅዎ (ስም) በህመሙ ግዜ የምግብ ፍላጎቱ ምን ይመስላል? እንደተለመደዉ፣ከተለመደዉ ያነሰ ወይንስ ከተለመደዉ የበለጠ? ከተለመደዉ "ያነሰ", ከሆነ" በጣም ያነሰ" ወይንም "ትንሽ አነስ" ያለ መሆኑን ለማወቅ ያዉጣጡ?	ምንም... በጣም ያነሰ... የበለጠ..................................... እንደበፊቱ... አላዉቅም...	01 02 03 04 88
CA6. ህፃኑ (ስም) ባለፉ ሁለት ሳምንት ከወትሮዉ በተለየ መልኩ የሳል በሽታ፣ቶሎ ቶሎ የመተንፈስ ወይንም ለመተንፈስ መቸገር አጋጥሞት ያዉቃል? (መልሱ አይደለም ከሆነ ወደ ጥያቄ CA10. ይሂዱ)	አዎ .... አይደለም................................... አላዉቅም..................................	01 00 88
CA7. ከቤትዎ ዉጪ ለህመም ምክር ወይንም ህክምና ጠይቀዉ ያዉቃሉ? (መልሱ አይደለም ከሆነ ወደ ጥያቄ CA10. ይሂዱ)	አዎ.. አይደለም.. አላዉቅም...	01 00 88
CA8. እርዳታዉን ያገኙት ከየት ነዉ? ማንኛዉም ቦታ? ሁሉን መልሶች አክብቡ, ቢሆንም ምንም አስተያየት አይስጡ እርዳታዉን ያገኙት ከሆስፒታል ከ ጤና ጣቢያ ወይንም ከ ክልኒክ ከ ሆነ በታዉን ከታች ባለዉ ክፍት ቦታ ይጻፉ፤. እርዳታዉን ያገኙበትን ቦታ በማወጣጣት ትክክለኛዉን ኮድ ያክቡ፡፡ _______________________________ (የቦታዉ ስም)	የመንግስት ሆስፒታል.................................. የመንግስት ጤና ጣቢያ .... የመንግስት ጤና ኬላ.............................. የመንደር ጤና ሰራተኛ........................ ተንቀሳቃሽ ክልኒክ...................... የግል ሆስፒታል/ክልኒክ........................ የግል ሀኪም............................... የግል መድሀኒት ቤት .... ሱቅ .... ከባህል ሀኪሞች .... ሌላ (እባክዎን ይግለፁ)_____________	01 02 03 04 05 06 07 08 09 10 77
CA9. ልጅዎ (ስም) ለህመሙ መድሀኒት ተስጥቶታል?	አዎ.. አይደለም.. አላዉቅም...	01 00 88
CA10. ልጅዎ (ስም) በዚህ ዓመት በኩፍኝ በሽታ ታሞ ያዉቃል?	አዎ.. አይደለም...	01 00
CA11. ልጅዎ (ስም) ለመጨረሻ ግዜ የተፀዳዳዉ ሰገራ ለማስወግ ምን አደረጉ?	ልጁ የተፀዳዳዉ ሽንት ቤት ዉስጥ ነዉ...................... ሽንት ቤት ዉስጥ ደፋነዉ............ ቦይ ዉስጥ ደፋነዉ............... ቆሻሻ መጣያ ዉስጥ ተጣለ (ደረቅ ቆሻሻ)...... ተቃጠለ... ክፍቱን ተዉነዉ.................................. ሌላ (እባክዎን ይግለፁ)........................ አላዉቅም..	01 02 03 04 05 06 77 88
CA 12. ባለፈዉ ስድስት ወራት ዉሥጥ ልጅዎ ለሆድ ዉስጥ ትላትል መድሀኒት ወስዶ ያዉቃል?	አዎ .... አይደለም... አላዉቅም...	01 00 88

CA 13. ልጅዎ (ስም)ባለፈዉ ሁለት ሳምንታት ግዜ ዉስጥ በትኩሳት ታሞ ያዉቃል?	አይደለም............................. አዎ............................ አላዉቅም..................	00 01 88
CA 14. ልጅዎ(ስም)ባለፈዉ ሁለት ሳምንታት ግዜ ዉስጥ በወባ በሽታ ታሞ ያዉቃል?	አይደለም............................ አዎ .... አላዉቅም.................	00 01 88
CA 15. ልጅዎ በዘመናዊ መድሀኒቶች ለወባ በሽታ ታክሞ ያዉቃል?	አዎ .... አይደለም .... አላዉቅም..	01 00 88
CA 16. ልጅዎ (ስም)ባለፈዉ ሁለት ሳምንታት ግዜ ዉስጥ የቆዳ በሽታ (በጣም የማሳከክ ስሜት ያለው) ታሞ ያዉቃል?	አይደለም........................... አዎ .... አላዉቅም.................	00 01 88
CA 17. ልጅዎ (ስም) ባለፈዉ ሁለት ሳምንታት ግዜ ዉስጥ በኩፍኝ በሽታ ታሞ ያዉቃል?	አይደለም........................... አዎ .... አላዉቅም.................	00 01 88

የሰዉነት ልኬት (ANTHROPOMETRY) እና የደም እና ሰገራ ናሙና ፈቃደኝነት መጠየቂያ ቅፅ

እንደ ጥናቱ አንድ አካል ከ36-59 ወራት እድሜ ባለዉ ልጅዎ ሰዉነት ዉስጥ ያለዉን የ ቫይታሚን ኤ መጠን እንመረምራለን፡፡የ ቫይታሚን ኤ እጥረት በጣም አስከፊ የጤና ችግር ሲሆን የሚከሰተዉም ባልተመጣጠነ የምግብ ስርዓት፣በበሽታ አምጪ ተዋስያን በመጠቃት እና ሊድኑ በማይችሉ የእድሜ ልክ በሽታዎች በመጠቃት ነዉ፡፡ይህ ጥናት መንግስት የቫይታሚን ኤን እጥረት ለመከላከል እና ለማከም የሚያስችል ፕሮግራም ለመቅረፅ ይረዳዋል፡፡

ከልጅዎ ላይ የደም እና ሰገራ ናሙና እንወስዳለን፡፡የልጅዎን ዓይን በአይን ላይ ለሚወጣዉ እና አይብ መሰል ነጭ ነጥብ (Bitot's Spot) መመርመር እንወዳለን፡፡ሁሉም ምርመራዎች ሰላማዊ እና ምንም አይነት የጎንዮሽ ጉዳት የማያስከትሉ ናቸዉ፡፡አንዳንድ ምርመራዎች ልጅዎ ላይ ትንሽ ህመም ሊፈጥሩ ይችላሉ ለምሳሌ ደም መዉሰድ፡፡ይሁን እንጅ ከልጅዎ ከንድ ስር ካለዉ የደም ስር ደም ስወሰድ ደም ለመቅዳት የምንጠቀምበት መርፌ ንፁህ እና በፍፁም ሰላማዊ ነዉ ይህም ማለት ከዚህ በፊት ጥቅም ላይ ያልዋለ እና አሁንም ከእያንዳንዱ ምርመራ በኋላ የሚወገድ ነዉ፡፡ከዚሁ ልጅዎ የሰገራ ናሙናም በዚህች ኩባያ ዉስጥ እንወሰዳለን፡፡የልጅዎን የሰገራ ናሙና ለምርመራ በመስጠትዎ ጤና ጥበቃ በመንደርዎ ዉስጥ ለህመም መንስኤ የሆነዉን የሆድ ትላትል ይበልጥ ለይቶ ለማወቅ ይጠቅመዋል፡፡

ከወሰድነዉ የደም ናሙና ላይ የልጅዎን የወባ እና የደም ማነስ በሽታ መኖር አለመኖሩን፤ ቁመት ና ክብደት ወዲያዉ የሚደርሱ ዉጤቶች ሲሆኑ ሪፌራል ካስፈለገም ባቅራቢያዎ ወዳለዉ ጤና ተቋም ይላካል ፡፡ ሌላዎቹ መረጃዎች ከሌሎቹ የጥናቱ ተሳታፊዎች ጋር በመደመር የአካባቢዎን የጤና ሁኔታ ለማሻሻል ይረዳል፡፡እርስዎ ጠቃሚ ነዉ ብለዉ የሰጡን መረጃ ለጤና ጥበቃ ሚኒስቴር የጤና እና ስርአተ-ምግብ ፕሮግራሞችን ለማሻሽል ግብዓት ሆኖ ያገለግላል፡፡

ሁሉም ምላሾችዎ ሚስጥራዊነቱ የተጠበቀ ይሆናል፤ይህም ማለት ከእኛ የጥናቱ ተሳታፊ አባላቶቻችን ዉጭ ለማንም አናካፍለዉም፡፡

ልጅዎ የደም ማነስ፣የወባ እና እግሮቹ ላይ እብጠት ካለበት ሪፌራል ይላካል፡፡

ለማንኛዉም ምርመራ እሺም እንቢም ማለት ይችላሉ፡፡ የእርስዎ ዉሳኔ ነዉ፡፡ ጥያቄ አለዎት?

ጥቂት የደም እና ሰገራ ናሙና ሊሰጡን ይችላሉ?

ፈቃደኝነታቸዉን የገለፁት: **PL01** ደም ☐ **PL02** ሰገራ ☐ (አዎ......01 ወይም የለም.....00)	
PL03 የላብራቶሪ ቴክኒሻኑ ኮድ: ☐☐	የላብራቶሪ ቴክኒሻኑ ስም__________________
PL04 በአይን ላይ ለሚወጣዉ እና አይብ መሰል ነጭ ነጥብ (Bitot's Spot)	የለም ....00 አዎ 01
PL05 የተሰበሰበ የደም ናሙና ካልተሰበሰበ = 00.0 ከተቃወሙ = 77.7	ሚሊ. ☐☐ ● ☐
PL06 የደም ናሙናዉ የተሰበሰበበት ቀን	ቀን: _____/______/_________ ቀን / ወር / ዓ.ም
PL07 ደም የተቀዳበት ሰዓት	ደም የተቀዳበት __ __ : __ __ ሰዓት ደቂቃ
PL08 በቅርቡ የተመገበዉ/ችዉ መቼ ነበር?	__ __ : __ __ ሰዓት ደቂቃ
PL09 የወባ ምርመራ ዉጤት (RDT)	ኔጋቲቭ..00 ፖዘቲቭ ፋሊሲፋረም ....01 ፖዘቲቭ ቫይቫክስ..02 አልሰራም/ዉድቅ ሆኗል.................................03
PL10 የሄሞግሎቢን ምርመራ ዉጤት	ግ/ዴ.ሊ ☐☐ ● ☐
ከልጅዎ የሰገራ ናሙና ልንወስድ ነዉ.ናሙናዉን አሁን ማግኘት ብንችል በጣም ደስ ይለናል፡፡ካልተቻለም ግድየለም ወደ በኋላ ተመልሰን እንወስዳለን፡፡ ***መመሪያ ሰገራዉን ማግኘት ካልቻልን*** ለሰገራ የልጅዎን(ስም) ሰገራ ለመዉሰድ ነገ ተመልሰን እንመጣለን፤ ይህችን ኩባያ በመጠቀም የልጅዎን በቅርብ ጊዜ የተፀዳዳዉን የመጀመሪያ ሰገራ ያኑሩበት	
PL11 ሰገራ ተሰብስቧል?	የለም..............................00 አዎ............................01
PL12 የሰገራ ናሙና የተፀዳዱበት ቀን	ቀን: _____/______/_________ ቀን / ወር / ዓ.ም
PL13 ሰገራ የተፀዳዱበት ሰዓት	__ __ : __ __ ሰዓት ደቂቃ
PL14 የሰገራ ናሙና የተሰበሰበበት ቀን እና ሰዓት	ቀን: _____/______/_________ ቀን / ወር / ዓ.ም __ __ : __ __ ሰዓት ደቂቃ

PL15 ደሙ ሴንቲሪፊዉጅ የተደረገበት ሰዓት	__ __ : __ __ ሰዓት ደቂቃ
PL16 ሪፈራል/ ሪፈር ተደርጓል	የለም............................ 00 አዎ 01
PL17: የቃለመጠይቁ የመጨረሻ ዉጤት:	የዉጤት ኮዶች: 1 መጠይቁ ተጠናቋል ....01 2 ቤት አልነበሩም ....02 3 ወላጅ/አሳዳጊ ፈቃደኛ አልሆኑም ....03 4 ህፃኑ ፈቃደኛ አልሆኑም..................................04 5 በከፊል ተጠናቋል...05 6 መጠይቁን ማድረግ አይችሉም........................06 7 ሌላ (እባክዎን ይግለፁ) ____________ 77

በ24 ሰዓት ውስጥ የህፃኑ አመጋገብ እና የሰውነት አቋም ልኬት (Anthropometry) መጠይቅ

4. የህፃኑ ኮድ: ☐☐☐☐	**5.** መጠይቁ የተካሄደበት ☐☐ ቀን ☐☐ ወር ☐☐ ዓ.ም	**6.** አድራሻ : (ወረዳ እና ቀበሌ)	**7.** የመረጃ ሰብሳቢዉ ኮድ: ☐☐

የህፃኑ ስም : ____________ ____________ ____________

የህፃኑ ስም　　　የአባት ስም　　　የአያት ስም

የወላጅ/አሳዳጊ ስም : ____________ ____________ ____________

የወላጅ/አሳዳጊ ስም　　　የአባት ስም　　　የአያት ስም

8. የህፃኑ ፆታ (1= ወ, 2 = ሴ)	**9.** የህጻኑ የትውልድ ቀን ☐☐ ቀን ☐☐ ወር ☐☐ ዓ.ም	**7**. እድሜ (በወራት) ☐☐	**ማስታወሻ:** የህፃኑ እድሜ ከ36 ወር በታች ወይም 60 ወር እና ከዛ በላይ ከሆነ መጠይቁን አትጠይቁ

8. ህፃኑ ትላንትና ጡት ጠብቷል? (0 = የለም, 1 = አዎ) ☐	**9.** ትላንት በአከባቢዉ ማህብረሰብ ዘንድ የበዓል ቀን ነበር? (0 = የለም, 1 = አዎ) ☐
10. ትላትና በቤታችዉ ዉስጥ በዓል /ድግስ ነበር? (0 = የለም, 1 = አዎ) ☐	**11.** ትላንትና ልጅዎ በትኩሳት፣በሳል ወይንም በተቅማጥ በሽታ ታሞ ነበር? (0 = የለም, 1 = አዎ) ☐
12. የህፃኑ ክብደት በ ኪ.ግ ☐☐ . ☐☐	**13.** የህፃኑ ቁመት በ ሴ.ሜ. ☐☐☐ . ☐☐
14. የህፃኑ የላይኛዉ ክንድ መጠነ ዙሪያ (MUAC) በሴ.ሜ. ☐☐ . ☐☐	

መጠይቁን ከመጀመራችሁ በፊት ለወላጅ/አሳዳጊ ገለፃ ያድርጉ

ህፃኑ ከእንቅልፉ ሲነሳ እና ያደረጋቸዉን እንቅስቃሴ ላይ በመመርኮዝ የህፃኑ ወላጅ/አሳዳጊ የትላንትናዉን እለት እንዲያሥታዉሱ እርዷቸዉ፤ በቀስታ ይጠይቁ

የህፃኑ ኮድ:___________________

ወላጅ/አሳዳጊን ይጠይቁ : እባክዎን ልጅዎ በትላትናዉ እለት የበላዉን እና የጠጣዉን ይግለፁ ልጅዎ ከእንቅልፉ ከተነሳ በኋላ በመጀመሪያ እንዲበላ ወይም እንዲጠጣ የሰጡት ምን ነበር? ከዛ በኋላስ ለልጅዎ የሰጡት ምግብ ወይንም መጠጥ ምን ነበር? (ወላጅ/አሳዳጊ የነገራችሁን ምግብ በሙሉ ፃፉት) የምግብ ሰዓቱን ስም መጠየቃችሁን እርግጠኛ ይሁኑ (ለምሳሌ ቁርስ፣ምሳ፣ እራት ወይንም የቁርስ፣ምሳ፣ እራት መክሰስ)?

ፈጣን ምላሽ ለልጆች

ቁርስ	መቆያ	ምሳ	መቆያ	እራት	መቆያ

ሰፊ ዝርዝር ለ ልጆች

የህፃኑ ኮድ:_______________

ቤት ዉስጥ የተወሰደ ልኬት			ቢሮ	ቤት ዉስጥ የተወሰደ ልኬት						የተጣራ ግራም (ቢሮ)			በምግቡ ውስጥ ያሉት ግብዓቶች መዘርዝር ይፈልጋል (0 = የለም፣ 1 = አዎ) መልሱ 1 ከዎነ ወደ ሚቀው ገጽ ወይም ሰንጠረዝ ይሂዱ
15. የምግብ ሰዓት	የምግቡ ስም	የተሰራበት ንጥረ ምግብ እና ባህሪያቶቹ	16. የምግቡ ኮድ	የቀረበው ምግብ መጠን	ያልተመገበዉ ምግብ መጠን(የቀረ)	የተመገበዉ ምግብ መጠን	ክብደት 1= አጠቃላይ 2=የተጣራ	የአመጋገብ ሁኔታ 1=የበሰለ 2=ጥሬ	17.ባለፈዉ ሳምንት የተመገባቸዉ ቀናት	ወደ ግራም ሲለወጥ	18. የቀረበው ምግብ መጠን	19. የተመገበዉ ምግብ መጠን	

የምግብ ሰዓት: ዋና ዋና ምግቦች: 10 ጧት (ቁርስ); 20 እኩለ ቀን (ምሳ); 30 ማታ (እራት)
መክሰሶች: 11, 12, 13 ... 19 ጧት (ከቁርስ በኋላ); 21, 22, 23 … 29 ከሰዓት (ከምሳ በኋላ); 31, 32, 33 … 39 ምሽት (ከእራት በኋላ)

3 ኛ ምግቡ ግብዓቶች ካሉት

ቤት ዉስጥ የተወሰደ ልኬት				ቢሮ		ቤት ዉስጥ የተወሰደ ልኬት				ቢሮ/ መስክ	
የምግቡ ስም				አጠቃላይ የበሰለዉ ግብዓቶች ብዛት:		የምግቡ ስም				አጠቃላይ ሕጻኑ የተጠቀመው	
ግብዓቶች	የተጠቀ መዉ መጠን	ክብደት (1=አጠቃላይ 2=የተጣራ)	የተመገበ ው (1=የበሰለ 2=ጥሬ)	ወደ በሰለዉ ሲለወጥ	የበሰለዉ በግራም	ግብዓቶች	የተጠቀመ ዉ ብዛት	ክብደት (1= አጠቃላይ 2=የተጣራ)	የተጠቀመ ዉ (1=የበሰለ 2=ጥሬ)	ወደ በሰለዉ ሲለወጥ	የበሰለዉ በግራም

Annex 8.6. Consent letter from Ministry of Science and Technology

በኢትዮጵያ ፌዴራላዊ ዴሞክራሲያዊ ሪፐብሊክ
የሳይንስና ቴክኖሎጂ ሚኒስቴር
The Federal Democratic Republic of Ethiopia
Ministry of Science and Technology

ቁጥር Ref. No. 3.10/116/2016
ቀን Date May 12, 2016

To: Ethiopian Public Health Institute

Addis Ababa

Re: Using Stable Isotope Techniques to Monitor and Assess the Vitamin A Status of Children Susceptible to infection in Ethiopia

Dear Sir/Madam//Mr./Mrs./Dr,

The National Research Ethics Review Committee (NRERC) has reviewed the aforementioned project protocol in an expedited manner. We are writing to advise you that NRERC has granted

Full Approval

To the above named project, for a period of **one year (May 12, 2016- May 11, 2017).** All your most recently submitted documents have been approved for use in this study. The study should comply with the standard international and national scientific and ethical guidelines. Any change to the approved protocol or consent material must be reviewed and approved through the amendment process prior to its implementation. In addition, any adverse or unanticipated events should be reported within 24-48 hours to the NRERC. Please ensure that you submit biannual progress report once in six months and annual renewal application 30 days prior to the expiry date.

We, therefore, request you as PI and your esteemed organization to ensure the commencement and conduct of the study accordingly and wish for the successful completion of the project.

With regards,

Yohannes Sitotaw
Secretary of NRERC

CC: _ Mr. Tesfaye Hailu (PI)

_ NRERC Chairperson

ማነጋገር ቢያስፈልግዎ
You may Contact

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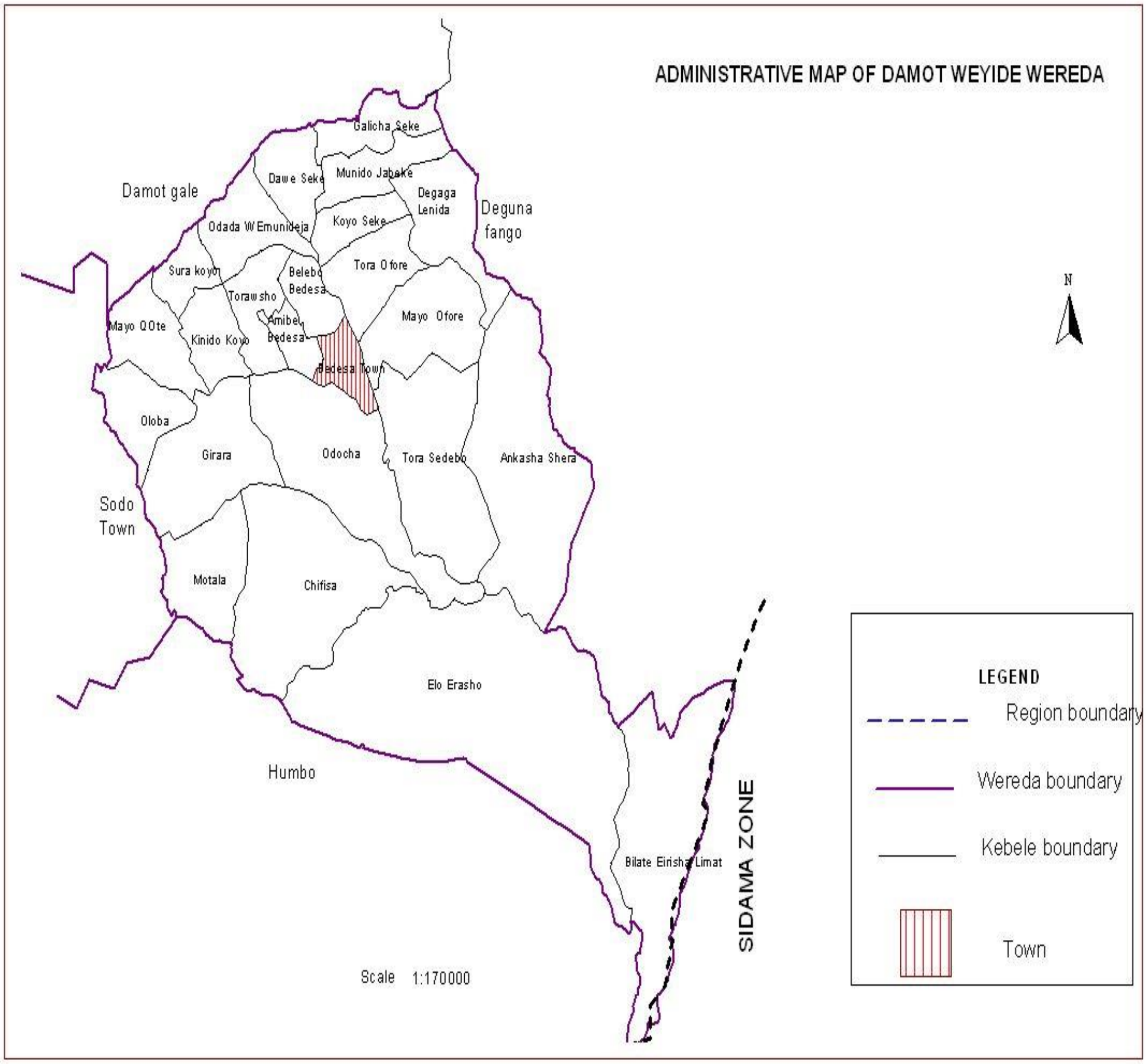
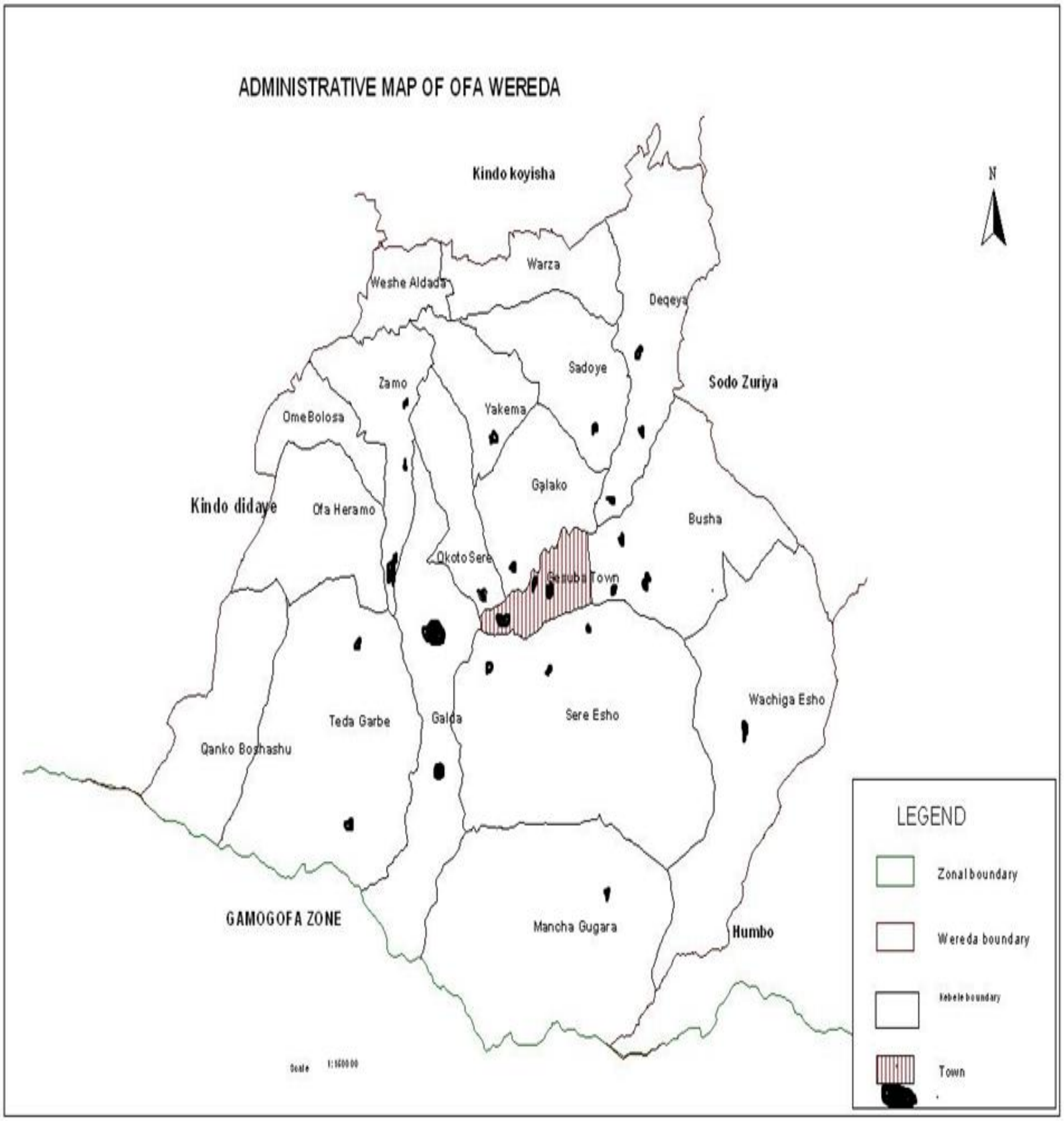
E-mail most@ethionet.et
ስልክ Tel. 251-011-4-674353
Web site:-http://www.most.gov.et
ፋክስ Fax +251-011-4-66 02 41

Annex 8.7. Administrative map of Damot Weyide woreda



Annex 8.8. Administrative Map of Offa Wereda



Annex 8. 9. Calibration Curve of Retinol