PREVALENCE AND DETERMINANTS OF UNDERNUTRITION AMONG 6-59 MONTHS CHILDREN IN LOWLAND AND HIGHLAND AREAS IN KILOSA DISTRICT, TANZANIA

JACKLINE DEOGRATIUS MREMA

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ABSTRACT

Undernutrition is the most dominant form of malnutrition among children in developing countries including Tanzania. Despite several studies on prevalence of undernutrition among children of 6-59 months old in Tanzania there is limited information on the differences in prevalence between the highland and lowland areas. This study aimed to assess nutritional status and its determinants, dietary intake as well as nutrients content in food consumed by children aged 6-59 months in the lowland and highland areas in Kilosa district. A Cross sectional study was conducted among 341 randomly selected mother-child pairs households whereby 200 and 141 mothers were from the lowland and highland areas respectively. Socio-demographic, feeding practice, as well as dietary intake information were collected using a pretested questionnaire. Nutrition status of the children was determined using anthropometric indicators. Weight and height for children were measured using standard procedure while age was calculated from birth date which was obtained from child growth monitoring card. Cooked food samples were sampled from 14 households based on frequently consumed foods. Anthropometric data were analysed by ENA for SMART software. Dietary intake data were analysed using Nutrisurvey 2007. Standard laboratory procedures were used to determine protein, fat, carbohydrate, iron, zinc, vitamin A and fibre contents on the collected cooked food samples. Data were coded and entered in Statistical Package and Service Solution where descriptive, chi-square and binary logistic regression statistical analysis were done. Underweight, stunting, and wasting was 11.5, 41 and 2.5% in the lowland area and 22, 64.5 and 1.4% in the highland area respectively. Prevalence of underweight and stunting was higher in the highland area compared to lowland area ($p<0.001$). Determinants for underweight were areas of residence, ages of the children and birth weight while determinants for stunting were area of residence, maternal marital status, sex of household head, maternal age, sex of child and child birth weight ($p<0.05$). Majority of infants did not meet RDA for almost all nutrients. Grains were most consumed food group (99.1%) while eggs were the least consumed (1.2%). Food from highland area had high protein, fat, iron, zinc and vitamin A while food from lowland had high fat iron and vitamin A. Living in the highland area of Kilosa is a predisposing factor for undernutrition in children of 6-59 months of age; therefore more intervention and effort to combat undernutrition should focus on children living in highland areas.

DECLARATION

I **Jackline Deogratius Mrema** do hereby declare to Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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Jackline Deogratius Mrema Date

(MSc. Human Nutrition Candidate)

The above declaration confirmed;

__________________________ ___________________

Prof. C.N.M. Nyaruhucha Date

(Supervisor)

________________________ ___________________

Dr. A. W. Mwanri Date

(Supervisor)

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LIST OF ABBREVIATIONS AND ACRONYMS

^{0}C	Degrees Centigrade
AOR	Adjusted Odd Ratio
BMI	Body Mass Index
Ca	Calcium
CF	Crude Fat
CHO	Carbohydrate
CI	Confidence Interval
Cm	Centimetre
CP	Crude Protein
EE	Ether Extract
ENA for	Emergency Nutrition Assessment for Standardized Monitoring
SMART	Assessment of Relief and Transition
FAO	Food and Agriculture Organization
Fe	Iron
g	Gram
HAZ	Height-for-Age Z-score
HIV	Human Immunodeficiency Virus
IDD	Iodine Deficiency Disorder
IRB	Institutional Review Board
Kg	Kilogram
Km	Kilometre
m	Meter
MC	Moisture Content

mg	Milligram
MUHAS	Muhimbili University of Health and Allied Science
NBS	National Bureau of Statistic
OD	Optical Density
OR	Odd Ratio
RDA	Recommended Daily Allowance
SD	Standard Deviation
SPSS	Statistical Package and Service Solution
SUA	Sokoine University of Agriculture
TDHS	Tanzania Demographic and Health Survey
TFNC	Tanzania Food and Nutrition Centre
UNICEF	United Nations Children's Fund
UNU	United Nations University
URT	United Republic of Tanzania
USAID	United States Agency for International Development
VAD	Vitamin A Deficiency
WAZ	Weight-for-Age Z-score
WB	World Bank
WHO	World Health Organization
WHZ	Weight-for-Height Z-score
Zn	Zinc
β–carotene	Beta-carotene

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Malnutrition is a state of poor nutritional status, which is the result of inadequate or excess intake of nutrients by the body. Malnutrition is one of the most serious problem affecting infants, children and women of reproductive age in Tanzania (TFNC, 2012).

Globally, the prevalence of stunting is 25.7, wasting is 8% and prevalence of underweight is 15.7% (UNICEF/ WHO/WB, 2012). Malnutrition, as the main cause of morbidity and mortality in infants and children under five years of age, accounts for at least half of all childhood death worldwide and child malnutrition was associated with 54% of deaths in children in developing countries in 2001 (Meshram *et al*., 2012; Demissie and Worku., 2013). In addition it is recognized as the underlying cause of related deaths of childhood disease such as measles, diarrhoea and acute respiratory infectious diseases.

Malnutrition remains a significant cause of morbidity and mortality in under-five children in Tanzania. Studies conducted in different parts of Tanzania have shown high levels of malnutrition among children below five years of age (Mamiro *et al.*, 2005; Safari *et al*., 2015; TDHS-MIS, 2015-16). About one third of children aged 6-59 months are iron deficient and vitamin A deficient and 69% are anaemic (TFNC. 2012). Consequences of childhood undernutrition have been explained as growth failure, impaired intellectual and physical development, low resistances to infection and high incidence rate of some chronic disease (Demessie and Worku, 2013).

Nutritional status of children can be evaluated by their growth. Undernutrition, as one form of malnutrition, has been measured by anthropometric indicators including stunting, wasting, and underweight. Stunting (low height-for-age) and wasting (low weight-for-height) are associated with chronic malnutrition and current nutritional status. Underweight (low weight-for-age) represents both chronic and acute malnutrition (Janevica *et al*., 2010).

There are several studies undertaken inside and outside the country which showed different factors that contribute to childhood undernutrition. These factors are household income, sex of child, maternal education, family size and unsafe water supply (Kavosi *et al*., 2014). Other factors are maternal working status, age of mother, maternal BMI, exclusive breastfeeding, size of baby and geographic zone (Chirande *et al*., 2015). In another study factors observed were birth order, child spacing, early recommended complementary foods, complete immunization and time care seeking (Bhandari and Chhetri, 2013). Others are low birth weight, low nutritional knowledge, insufficient energy and micronutrient intake, food availability and infectious disease (Masibo, 2012).

The survey conducted by TFNC (2012) showed that there were significant geographical variations in the proportion of stunted children in Tanzania. This difference was presented in terms of regions. Despite big number of studies carried on nutritional status of children in different parts of the country, there is limited information on nutritional status of children residing in lowland and highland of Tanzania. Some studies which compared the nutritional status of children on geographical location in terms of lowland and highland areas were carried in other countries and different results were obtained. Most studies showed that children residing in highland areas had increased risk of underweight compared to those residing in lowland. For example a study carried by Katuli *et al.* (2012)

in Ecuador and UNICEF (2012) in Yemen showed that children in highlands were more malnourished than lowlands while other authors reported that children in lowlands were more malnourished compared to their peers in highlands (Frisancho *et al.,* 1975; Katuli *et al.,* 2012; UNICEF, 2012).

Inadequate dietary intake is one of the immediate causes of malnutrition. Adequate nutrition during infancy and early childhood is essential to ensure growth, health, and development of children to their full potential (WHO, 2009). Poor nutrition increases the risk of illness, and is responsible, directly or indirectly, for one third of the estimated 9.5 million deaths that occurred in 2006 in children less than 5 years of age globally (Black *et al.,* 2008). Due to this reason the dietary intake of the studied children were assessed to find out if they met recommended dietary intake and if there was any relationship between dietary intake and nutritional status. Most time children fail to meet their RDA not because of quantity they consume rather quality (nutrient content). Nutrients content of the food can be affected by many factors such as cooking method, soil where grown and storage. Cooked food from lowland and highland were taken for laboratory analysis to determine if there significant difference in nutrient content.

1.2 Problem Statement and Justification

The rate of malnutrition increases very rapidly between birth and two years of age. Beyond two years, much of the damage caused by poor nutrition cannot be corrected (TFNC, 2012). Despite striking improvement in many health indicators over the last decade, there is little progress in improving the nutritional status of children in Tanzania. Stunting currently affects 34% of under five children, and is 8% points lower than it was in 2010 which was 42%. Prevalence of children underweight is 14% and for wasting is 5% (TDHS-MIS, 2015-16).

The prevalence of malnutrition in children under five years in Morogoro Region is still high. According to survey conducted by Tanzania Demographic and Health Survey prevalence of stunting was 33.4% and underweight 11.5% in Morogoro Region, and they are slightly lower compared to National levels 34% and 14% respectively. Prevalence of wasting 6% is slightly higher in Morogoro region compared to national level 5% (TDHS-MIS, 2015-16). According to WHO (1995) classification of severity of malnutrition Morogoro has high rate of stunting and underweight and medium rate of wasting.

Despite all interventions implemented by the Government for the purpose of combating malnutrition like promotion of exclusive breastfeeding, promotion of complementary feeding, hygiene and sanitation and food fortification, the rate of malnutrition is still unacceptable. This indicates that still there are some other minor factors that are not taken into consideration but they have high influence on children nutrition status. If these factors are addressed it will help to reduce or eradicate the problem of undernutrition that face most of under five children in Kilosa District.

Due to change in lifestyle and occurrence of nutrition transition, disease patterns and nutritional status of community have changed. However, malnutrition remains a serious nutritional problem in Tanzania. So the rate of undernutrition and its determinants may have changed in recent years. Therefore, measuring the risk factors can be helpful in the control of malnutrition and also improve health development. Due to limited information on nutritional status of children residing in lowland and highland areas and its determinants, the aim of this study was to fill the gap by finding out if differences in nutritional status between lowland and highland areas exist. Secondly, the study aimed to determine if determinants of undernutrition differ in these two areas.

Results from this study will form a basis for policy makers to develop strategies that can address those factors. The results also will be useful to the Ministry of Health, Community Development, Gender, Elderly and Children to develop and implement interventions or programs based on specific causes and improve nutritional status of children below five years in Kilosa District.

1.3 Objectives

1.3.1 Overall objective

To assess the prevalence and determinants of undernutrition of children aged 6-59 months in lowland and highland areas of Kilosa District Morogoro, Tanzania.

1.3.2 Specific objectives

i. To assess dietary intake among children aged 6-59 months in the study areas
ii. To assess nutrient composition in different cooked foods given to children aged 6-59 months.
iii. To determine factors influencing nutritional status of children aged 6-59 months in lowland and highland.
iv. To determine nutritional status (stunting, wasting and underweight) of children aged 6-59 months.

1.4 Research Questions

1. Do the children 6-59 months of age have adequate nutrient intake?
2. Does dietary intake of the children differ among those residing in highland and lowland?
3. Do nutrient contents of the same foods differ significantly between lowland and highland areas of Kilosa District?

4. What are the determinants of undernutrition in children 6-59 months of age in lowland and highland areas of Kilosa District? Do these determinants differ across the District?
5. Are there differences in nutritional status among children 6-59 months of age who reside in lowland and highland areas of Kilosa District?

CHAPTER TWO

2.0 LITERATURE REVIEW

This section presents a synthesis of the reviewed literature on the determinants of malnutrition and dietary intake among children below five years in different settings particularly in developing countries. It also includes factors affecting nutrient content of the food.

2.1 Dietary Intakes

High prevalence rate of macro and micro-nutrient deficiencies observed in developing countries is mainly due to inadequate intake of dietary energy and protein, the low content of micronutrients in the diet and poor bioavailability (Rivera *et al.,* 2003). Inadequate dietary intakes and poor feeding practices directly affect the nutritional status of children in the country (Kulwa *et al*., 2015).

A study conducted in Lagos State in Nigeria showed that children from rural and urban communities consumed more cereals, legumes, and animal proteins than any other food group. For the cereal group, most popular food item consumed was rice, bread, spaghetti, and biscuit in both rural and urban communities. Among the plant and animal protein, the food items commonly consumed were beans, milk, and fish. Consumption of beans and fish was higher in rural community while consumption of milk was higher in urban community; also it observed that the consumption of roots and tubers, fruits, and vegetable was generally low in both rural and urban communities (Senbanjo *et al*., 2016).

A study conducted in rural central Tanzania reported that porridge was the main complementary meal. Common types of flour were maize, sorghum, pearl millet and finger millet. Food diversity observed to be a problem. Very few 6–11 months-old infants met the minimum dietary diversity criterion of 4 or more food groups (Kulwa *et al*., 2015).

Results from a study conducted in Mbeere South District in Kenya reported that majority of the children (41.9%) had low diversity (<4 food groups), and about 35.7% had medium diversity (4-5 food groups). Only 22.5% accessed high dietary diversity score (6- 8 food groups (Badake *et al*., 2014).

A study conducted in Kweneng District, Botswana reported that in food frequency questionnaire records intake, only five food items met the core/main foods criteria. Some of the core/main foods items that had the highest frequency of consumption included, sorghum porridge (5.5), tea (5), sugar (5.8), milk (5) and yoghurt (3.6). The grains had the highest total average serving count at 16.2, indicating that on average 16.2 servings of grain were consumed during the week of the study. The food groups/subgroups that followed were sweets with 2.73 serving counts, and meat fish and poultry1.94, vegetables, 1.17 and fats 1.24 serving counts (Jorosi-Tshiamo, 2012).

2.2 Factors Affecting Dietary Intake of Under Five

There are some factors which affect dietary intake of under five children in different areas.

2.2.1 Culture

According to a study carried by Chege *et al.* (2015) in Kajiado, Kenya, it was noted that culture affects dietary intake. In Maasai culture men normally move with the livestock in search for pasture leaving women and children behind. This takes two weeks to three months limiting the children adequate access to the immediate animal products like milk and blood. With the change in climatic conditions, it was reported that the duration of men staying away from homes in search for pasture had prolonged. This leaves women to struggle while providing food for the family on their own. Also Maasai culture prohibits the consumption of wild animals, chicken and fish which limits the food scope. This leads to food insecurity especially when there is none or minimal animal products.

Some cultures and even religions emphasize a vegetarian or even vegan diet. A vegan diet refers to a diet that excludes meat and animal products, such as milk and eggs. For instance, vegetarians need to seek out protein sources other than meat in order to stay healthy. This can include eggs, milk, tofu, beans, and so forth (Cheprason, 2003).

2.2.2 Health factors

In Botswana some foods were not permissible for cultural or health reasons. Few children were not allowed to consume the following selected food items. For instance, mopani worms were restricted for five children , pork for four children, donkey meat for three children, eggs for two children while melon porridge, spicy (hot) foods, pumpkin, game meat, fish, beans and cabbage were each restrict acceptable for one participant. Overall, 21.2% of the participants had some food restrictions (Jorosi-Tshiamo, 2012).

2.3 Recommended Dietary Allowance (RDA) for Children

2.3.1 Recommended dietary energy for children

The energy needs from complementary foods for infants with “average” breast milk intake in developing countries are approximately 200 kcal per day at 6-8 months of age, 300 kcal per day at 9-11 months of age and 550 kcal per day at 12-23 months of age. For those who were not being breastfed 600 kcal per day at 6-8 months of age, 700 kcal per day at 9-11 months of age, and 900 kcal per day at 12-23 months of age (TFNC, 2013). Recommended energy intake for older children is 1000 kcal per day at 2 years and 1200 kcal per day at 3 -5 years of age (Otten *et al.*, 2006).

2.3.2 The recommended daily allowance (RDA) of some macronutrients and micronutrients for children below five years

Recommendation of dietary intake of macronutrients and micronutrients differs with ages and it depends on body requirements. It is the recommended daily macronutrients, vitamins and mineral intake considered adequate for healthy people (WHO/FAO, 2004). Fats, carbohydrates and proteins are macronutrients, meaning that the body requires them in relatively large quantities and consumed in gram amounts. Micronutrients are nutrients that the body requires in relatively small quantities, which are vitamins and minerals, and good health requires them in milligram and microgram amounts (Weisenberger, 2014). Table 1 show the RDA for carbohydrate, protein, fat, iron, zinc, calcium and vitamin A for children below five years.

Table 1: Recommended daily allowances for macro and micronutrients for children at various age groups

	6-12 months	13-36 months	37-59 months
Nutrients			
Carbohydrate (g)	95	130	130
Protein (g)	11	13	19
Fats (g)	30	30	30
Iron (mg)	11	7	10
Calcium (mg)	260	700	1000
Zinc (mg)	3	3	3
Vitamin A (µg)	500	300	400

Source: Otten *et al*. (2006)

2.4 Nutrient Contents of Food

Nutrients are chemical compounds in food that are used by the body to function properly and maintain health. Nutrients are digested and then broken down into basic parts to be used by the body. There are two main types of nutrients, macronutrients and micronutrients.

2.4.1 Macronutrients

Macronutrients are carbohydrates, fats and proteins, and make up the majority of the food eaten. They are abundant in most foods and requirements for these are measured in grams. In some circumstances body can convert some macronutrients from others, which reduce the emphasis the need of specific quantities (Francis *et al*., 2012).

2.4.1.1 Dietary carbohydrate

Carbohydrates are the primary source of fuel for the bodies and can be classed as either simple or complex. Carbohydrate food such as bread, potatoes, rice, fortified breakfast cereals, cassava, chapatti and pasta should be given at each meal and at least one snack during the day for children aged 1 to 5 years (Taylor *et al*., 2013). Carbohydrates providing easily available energy for oxidative metabolism, carbohydrate-containing foods are vehicles for important micronutrients and phytochemicals. Dietary carbohydrate is important to maintain glycemic homeostasis and for gastrointestinal integrity and function. Unlike fat and protein, high levels of dietary carbohydrate, provided it is obtained from a variety of sources, is not associated with adverse health effects. Finally, diets high in carbohydrate as compared to those high in fat, reduce the likelihood of developing obesity and its co-morbid conditions. An optimum diet should consist of at least 55% of total energy coming from carbohydrate obtained from a variety of food sources (FAO/WHO/UNU, 2001).

2.4.1.2 Dietary protein

Proteins are macronutrients made of amino acids. They are essential nutrients found in both animal and plant foods. The name protein originates from the Greek *proteios,* which means “first quality” (Elia and Cummings, 2007). Foods naturally rich in protein include meat, fish, chicken, eggs, beans, pulses and nuts. A source of protein is an essential element of a healthy diet, allowing both growth and maintenance of the 25 000 proteins encoded within the human genome, as well as other nitrogenous compounds, which together form the body’s dynamic system of structural and functional elements that exchange nitrogen with the environment (WHO/FAO/UNU, 2002).

2.4.1.3 Dietary fat

Fat is an essential part of diet and is important for good health. Dietary fats provide the medium for the absorption of fat-soluble vitamins. Also, are primary contributors to the palatability of food and are crucial to proper development and survival during the early stages of life-embryonic development and early growth after birth on through infancy and childhood (FAO, 2010). Fat is an essential contributor to overall energy intake in the under- five as it can provide a lot of calories in a small amount, without making the diet of a small child bulky. Dietary sources of fat are dairy foods such as butter, cream, full fat milk and cheese, meat such as fatty cuts of beef, pork and lamb and chicken (especially chicken skin), processed meats like salami, some plant-derived products such as palm oil coconut, coconut milk and cream and cooking margarine (Bradford Dietetians, 2013). Fat can be categorized in three types saturated, unsaturated and trans fat in which unsaturated fat is considered to be good compared to saturated fat. Unsaturated fat is an important part of healthy diet because it helps to reduce risk of heart diseases (FAO, 2010).

2.4.2 Micronutrients

Micronutrients also known as vitamins and minerals are essential components of a high quality diet and have a profound impact on health. While they are only required in tiny quantities, micronutrients are the essential building blocks of healthy brains, bones and bodies (UNICEF, 2015). Vitamins are carbon-containing molecules and are classified as either water-soluble or fat-soluble. Vitamin can be changed and inactivated by heat, oxygen, light and chemical processes. The amount of vitamins in a food depends on the growing conditions, processing, storage and cooking methods. Minerals do not contain carbon, and are not destroyed by heat or light and most of them are not generated in the body but are derived from food intake (Weisenberger, 2014). These micronutrients include vitamin A, calcium, iron, folic acid, iodine, and zinc.

2.4.2.1 Important micronutrients in children

2.4.2.1.1 Iron

Iron is an essential component of haemoglobin, found in red blood cells and requirements are high in the under- five children. This is reflective of the rapid growth and development seen in this age group. Iron is found in red meat, oily fish, eggs, nuts, beans and pulses, fortified breakfast cereals, dried fruit and dark green leafy vegetables. Too little iron in the diet causes anaemia, which can affect the child’s development (Otten *et al*., 2006).

2.4.2.1.2 Calcium

Calcium is essential for healthy functioning of bones and teeth. Infants less than 12 months of age have a very high requirement for calcium due to their rapid growth. Older children over 11 years, also have a high calcium requirement due to the growth spurt that occurs at that age. For children aged 1 to 3 years, as growth slows down, calcium requirements decrease significantly (UNICEF/WHO, 2003). Dietary sources of calcium for children under 5 years include milk, cheese, yoghurt, custard, milk based puddings (semolina, rice pudding and tapioca), breakfast cereals fortified with calcium, tinned fish where the bones are eaten (sardines, pilchards, salmon), calcium enriched soya milk and desserts and foods made with white or cheese sauces.

2.4.2.1.3 Zinc

Zinc is needed for healthy growth and development, and normal neurological and immune function (Shenkin, 2006). Zinc is a mineral which is needed for a number of cellular functions such as cell division, protein synthesis and facilitates the action of over 100 enzymes. It is fundamentally essential for all cell activity and as the cells of children are so active they have a high demand for zinc (WHO/FAO, 2004). Lean red meat, whole-grain cereals, pulses, and legumes provide the highest concentrations of zinc.

2.4.2.1.4 Vitamin A

Vitamin A is a fat soluble vitamin that is also a powerful antioxidant. Vitamin A (retinol) is an essential nutrient needed in small amounts by humans for the normal functioning of the visual system; growth and development; and maintenance of epithelial cellular integrity, immune function, and reproduction (WHO/FAO, 2004). Preformed vitamin A is found almost exclusively in animal products, such as human milk, glandular meats, liver and fish liver oils (especially), egg yolk, whole milk, and other dairy products (Rodriguez-Amaya, 2004). Provitamin A carotenoids are found in green leafy vegetables (e.g. spinach and amaranth) yellow vegetables (e.g. pumpkins, squash, and carrots), and yellow and orange non-citrus fruits (e.g. mangoes, apricots, and papayas) (Booth *et al.*, 1992).

2.5 Factors Affecting Nutrient Content of Food

There are factors which affect nutrient content of food. These factors occur at different stages. Quality of the food in local grocery store is subject to a variety of factors ranging from how the food was grown, to how long it has been sitting on the grocer's shelves (Rehman, 2006).

2.5.1 Preparation and cooking methods

Foods preparation method such as cut of fresh fruits and vegetable which is common in supermarket, markets and at home to make it convincible to consumers has negative effect in nutrition content of food. Fresh cut produce deteriorates more quickly than intact produce which leads to decreased nutritional value (Francis *et al*., 2012). Different cooking methods can affect nutrients content of food. Most vegetables are commonly cooked before being consumed. In general, vegetables are prepared at home on the basis of convenience and taste preference rather than retention of nutrient and health-promoting compounds (Masrizal *et al*., 1997). A study conducted by Yuan *et al.* (2009) to investigate nutrient retention on broccoli involved five domestic cooking methods (steaming, microwaving, boiling, stir-frying, and stir-frying followed by boiling). The results showed that all cooking treatments, except steaming, caused significant losses of chlorophyll and vitamin C and significant decreases of total soluble proteins and soluble sugars while microwaving, steaming, and stir-frying did not cause any significant loss of total carotenoids when compared with raw sample.

2.5.2 Farming practices

Currently most crops especially fruits and vegetables are highly treated with pesticides due to increase in pests and diseases. Food treated with pesticides or antibiotics, as is the case with a lot of conventionally grown produce and animal products, affect the quality of food and isn't as good as organically grown food (Braverman, 2015). The nutritive value of any food crop depends entirely on the soil on which crop was grown and on how the soil is cultivated, fertilized and irrigated. Climatic condition such as light, temperature, atmospheric humidity and wind movement and genetic factors plays vital part in determining the nutritive value of any crop (DaMatta *et al*., 2010).

2.5.3 Storage

There are different food storage methods and depends on types of food stored. A study conducted by Tefera *et al*. (2007) showed that reducing the temperature was good method of storage. The high temperature to the point of enzyme inactivation, or to the point of microbial sterilization, “stabilizes” the food so that it does not “spoil” but at the same time causes a greater initial reduction in certain nutrients, and a more gradual reduction with extended storage. Depending on the commodity, freezing and canning processes may preserve nutrient value. The initial thermal treatment of processed products can cause loss of water-soluble and oxygen-labile nutrients such as vitamin C and the B vitamins. However, these nutrients are relatively stable during subsequent canned storage owing to the lack of oxygen. Frozen products lose fewer nutrients initially because of the short heating time in blanching, but they lose more nutrients during storage owing to oxidation (Rickman, 2007). Another study carried by Rehman involved freshly harvested wheat, maize and rice grains. Grains were stored at temperature of 10, 25 and 45°C for six months. Significance decrease on nutrient during six months was observed in grains stored at 25 and 45°C. No significant change in nutritional quality was observed during storage of cereal grains at 10°C (Rehman, 2006).

2.6 Factors Contributing to Undernutrition

2.6.1 Diseases

Children become malnourished if they suffer from diseases that cause undernutrition or if they are unable to eat sufficient nutritious food (WHO, 2006). Diseases and inadequate dietary intake often occur together and are caused by multiple underlying factors including inadequate physical or economic access to food, poor health services, an unhealthy environment and inadequate caring practices for children and women (WHO, 2010). A study conducted in Haramaya District, Eastern Ethiopia showed that children who had fever in the past two weeks, prior to the study, were 3 times more wasted (OR=2.9, 95 % CI (1.16-7.2) (Yisak, 2015).

2.6.2 Child feeding practices

The risk of mortality due to diarrhea and other infections can increase in infants who are either partially breastfed or not breastfed at all (Edmond *et al.*, 2006)**.** According to TFNC (2014) 98.4% of children 0-23 months have been ever breastfed. Early initiation of breastfeeding, within one hour of birth, protects the newborn from acquiring infections and reduces newborn mortality. Early initiation of breastfeeding has the potential to prevent 22% of new born deaths. In Tanzania 50.8% of children 0-23 months were initiated breastfeeding within one hour (TFNC, 2014).

UNICEF and WHO recommend that children be exclusively breastfed (i.e. feed only on breast milk with no other liquids including water or food) on demand for the first 6 months of life (WHO, 2009). Exclusive breastfeeding for 6 months help in protection against gastrointestinal infections which is observed not only in developing but also industrialized countries. Breast milk is also an important source of energy and nutrients in children aged 6 to 23 months. Breast milk is also a critical source of energy and nutrients during illness, and reduces mortality among children who are malnourished (UNICEF/WHO, 2003). A study by TDHS-MIS (2015-16) reported that 59% of children were exclusively breastfed. However, the figure may not be true because most of the mothers do not consider water or tea as a food hence exclusive breast feeding in Tanzania could be overestimated.

A study conducted in Nzega District in Tanzania showed that almost all children (98.5%) were breastfed. Although the prevalence of breastfeeding is high, appropriate breastfeeding was not always practiced. In some families, colostrum (first milk) was discarded and the onset of breastfeeding by newborns was delayed for up to more than 24 hours. Only a quarter of the children (25.6%) were fed immediately after birth (Safari *et al*., 2015). Delayed initiation, however, deprives infants of the nutritional benefits of colostrum and is likely to increase risks of neonatal mortality or impede optimal nutritional status (Edmond *et al*., 2006; Umam, 2012).

From six months a child should be introduced to complementary food and continue breastfeeding up to two years and above to meet increase in nutrient requirement for proper growth and development. The early introduction of complementary foods before the age of six months can lead to displacement of breast milk and increased risk of infections, besides the babies being physiologically immature (Aggarwal *et al*., 2008). Ninety percent of children 6-8 months and 97 percent of children 9-11 months, receive timely complementary foods, and almost one half (47 percent) of children aged 18-23 months had completely stop to depend on breast milk (TDHS-MIS, 2015-16). Inadequate and inappropriate complementary feeding, portion size, frequency and unhygienic practices leads to recurrent and persistent infections and malnutrition which is followed by growth retardation, immunodeficiency, and eventually fatal outcomes (Patel *et al.*, 2015).

2.6.3 Maternal education

Undernutrition seems to have relationship with education level especially of mothers. Several studies conducted within and outside the country reported that undernutrition decrease with increase of maternal education level. A study conducted in Belgium showed that stunting was more among children of mothers who had secondary and below level of education (Nayak *et al*., 2014). Another study conducted in Fars province, Iran, reported that the mothers with diploma and lower were determined as stunting risk factors as compared to universal education (Kavosi *et al*., 2014). Maternal education is very important in nutritional status of children (Bhandari and Chhetri, 2013). To achieve optimal growth and development of children, there is a need to educate mothers on provision of food variety (Senbanjo *et al*., 2016).

2.6.4 Child birth weight

Birth weight can have positive or negative impact on nutritional status of children. Different studies have been conducted to determine relationship between birth weight and nutritional status of children. Nayak *et al*. (2014) reported that low birth weight was associated with stunting; showing that nutritional makeup of child is reflected right from birth. The prevalence of malnutrition was markedly higher in children with low birth weight than those with normal birth weights (Rahman *et al*., 2016).

2.6.5 Sex of children

Sex of the child has been observed to be a significant determinant for child nutritional status. Prevalence and severity differ in these two groups. The studies conducted in different areas in the country and in the world came up with different answers. Some studies reported that females were more malnourished compared to males. For example, a study conducted by Patel *et al*. (2013) in Western Maharashtra, India, reported that a higher proportion (80.3%) of females of birth order 3rd and subsequent were malnourished compared to the males of the same birth order. It might be viewed that the first child, whether a son or a daughter, is always cared for and discrimination starts when there is already a son in the family or when the expectation of having a son is not met. In Bangladesh, 54% of malnourished children are females and have a likelihood of 1.44 times greater to be malnourished than males (Bain e*t al*., 2013).

Other studies reported that males were more malnourished compared to female children. According to a study done in Kwara State, Nigeria, there was a significant relationship between sex of a child and malnutrition; male children were more likely to be malnourished than their female counterparts (Babatunde, 2011). A study conducted in Haramaya District, Eastern Ethiopia by Yisak *et al.* (2015) reported that wasting among male children was 2 times higher than that of female children. According to these studies, there is variation in undernutrition depending on the areas where the study was conducted.

2.6.6 Children age

It is important to note that specific ages, children's nutritional status is sensitive to feeding, weaning practices, care, and exposure to infection. A cumulative indicator of growth retardation (height-for-age) in children is positively associated with age. Majority of the studies conducted in different parts of the world confirmed that child's age was a significant determinant of child malnutrition. A study conducted in Ethiopia showed that the prevalence of stunting was the lowest in children at age zero. It rose at age of 1 year and consistently declined for the subsequent ages (Gurmu and Etana, 2013). Tanzania Demographic and Health Survey (TDHS-MIS, 2015-16) reported that stunting increases with age, peaking at 44% among children age 24-35 months.

Another study conducted in East Belesa District, northwest Ethiopia reported that children aged 36–47 months were less likely to be stunted compared to infants aged 6–11 months. This could be due to the fact that the latter have poorer nutritional reserve capacity compared to the former. Poor nutritional reserve capacity with chronic exposure to poor quality complementary food increases the child’s risk of developing stunting (Fentahun *et al*., 2016).

2.6.7 Sex of head of household

Sex of head of household has association with nutritional status of children below five years; it can have positive or negative impacts. Children living in households headed by women are more likely to be undernourished as female household heads lack key livelihood assets (Fentaw *et al*., 2013). Hence, they are forced to be engaged in informal sector activities for survival that demands much of their time which creates barrier on their ability to produce more to supplement household earnings (Kimmel, 2006). A woman heading a household in developing countries often earns little income due to less favourable labour market conditions being affected by her triple roles of production, reproduction, and care. Poor mothers not only resume their daily activities as early as four days after giving birth but also work for at least twelve hours a day and are responsible for all domestic chores. Such over stretched engagement of females in productive activities tends to reduce the care they shall give to their children (Wareen 2010; Zenebe, 2011).

2.6.8 Marital status

A study conducted in Ethiopia found that child's malnutrition is significantly associated with marital status. It was found out that malnutrition in children below five years were higher among unmarried rural and divorced/separated women compared to married ones (Teller, 2000). Similarly, being a married mother was positively associated with good nutritional status among children below five years in the Volta Region of Ghana (Appoh and Krekling, 2005). Contrary to the above studies, a study conducted in Tanzania found that mothers who were married were more likely to have undernourished children unlike those who were unmarried perhaps because of the cost of maintaining families hence sometimes these families fail to produce nutritious supplements to their children below five years (Nyaruhucha *et al.,* 2006).

2.6.9 Maternal age at birth

Mother's age at birth has been associated with malnutrition among children below five years. A number of studies have reported that mother's age at birth is one of the most important determinants of malnutrition among under-five children. Myrskyla and Fenelon (2014) reported that offspring born to mothers younger than age of 25 or older than 35 have worse outcome with respect to mortality, self-related health, height, obesity and the number of diagnosed conditions than those born to mothers aged 25-34. Risk is greater in younger mothers particularly those below 24 years because they are not ready to take care of the child including providing all the necessary attention required by the baby and is higher also among children whose mothers give birth when they are older especially after 35 years. This is attributed to the fact that giving birth at an older age is associated with a higher likelihood of giving birth to babies with a low birth weight (Jeyaseelan, 1997; Shrimpton *et al*., 2001).

A study carried in Bangladesh reported that children whose mothers were less than 20 years at the time of birth were 1.22 times more likely to be stunted, wasted and underweight compared to children whose mothers were 20 years and above at birth (Nure *et al*., 2011).

2.6.10 Occupation of mother

Studies conducted in different places showed that mother's occupation was a significant determinant of nutritional status of children below five years. Some studies showed that malnutrition decreases with increase in mother's occupation but others showed a decrease with decrease of maternal status. A study conducted by Uganda Demographic and Healthy Survey in 2006 showed malnutrition decreased with mother's occupation. Children whose mothers were housewives showed a lesser prevalence of wasting and stunting as compared to mothers working out-doors (Nayak *et al*., 2014).

A study in Vietnam showed that children from mothers who were labourers or farmers and housewives had a greater prevalence of stunting, underweight and wasting than those from mothers who worked in office or were housewives (Nguyen and Kam, 2008). This is because working mothers rarely get time to take care of their children. They also leave their children at home with other siblings who may neglect feeding them following the right frequency and this sometimes worsens the problem of malnutrition. It is also common for mothers to fail to provide complementary feeds including protein foods since most of them cannot afford them (Olwedo *et al.,* 2008).

2.6.11 Geographical variation in nutritional status

Some studies have been carried in assessing nutritional status by comparing lowland and highland areas. For example, studies done to compare nutritional status in lowland and highland areas have come out with contradicting results. A study conducted in Yemen found that stunting rate in the Hijja mountainous zone was higher (61.3%) compared to lowland zone and (48.8%) (UNICEF, 2012).

Another study conducted by USAID (2014) in Guatemala shows that the most vulnerable are children living in the highlands communities, where stunting affects almost 70% of children under-five. Similarly, a study conducted in highland and lowland in Ecuado showed that children who lived in the highlands were four times more likely to be stunted (OR=3.92) and three times likely to be mildly underweight (OR=3.05) than children in the lowland areas (Katuli *et al*., 2012).

But a study conducted in lowland and highland areas of Peruvian Quechua showed that the growth of the lowland children is markedly delayed when compared to that of the highland children (Frisancho *et al*., 1975). This contradicts with studies above.

2.7 Overview for Malnutrition

About 10 million children worldwide are estimated to suffer from severe undernutrition (defined by the presence of severe wasting, stunting and underweight, which greatly increase the risk of mortality). Faltering in length extends through the first 40 months of life and pronounced during the first 18 months (Lutter and Dewey, 2003). Due to different efforts made the magnitude of undernutrition globally decreases though not at an acceptable rate. According to 2012 joint report on global state of malnutrition in children below five years the prevalence of stunting in 2011 was 164.8 million (25.7%) while in 1990 it was 253.1 million children (39.9%). The prevalence of wasting was 51.5 million (8%) 2011 while was 58 million (9.1%) in 1990. The problem of underweight decreased slightly between 1990 and 2011 from 159.1 million (25%) to 101.7 million

(15.7%) respectively, but the problem of overweight increased by 14.2 million between 1990 (28.4 million) and 2011 (42.6 million) (UNICEF/WHO/WB, 2012).

The prevalence of malnutrition in Sub-Saharan Africa is still high compared to global prevalence. Though there is slight decrease of undernutrition in Sub-Saharan between 1990 and 2011 the prevalence of overweigh is two times higher compared to that in 1990. Stunting in 2011 was 39.6% while in 1990 it was 47.2%. The prevalence of wasting was 9.4% in 2011 while was 10.3% in 1990. The problem of underweight decreased slightly between 1990 and 2011 from 29% to 21.4% respectively, but the problem of overweight increased by 3.8% between 1990 (3.2) and 2011 (7%) which is slightly higher compared to global prevalence (6.6%) (UNICEF/WHO/WB, 2012).

Malnutrition is a big problem in Tanzania. Despite progress made, millions of children and women in Tanzania continue to suffer from one or more forms of malnutrition including low birth weight, stunting, underweight, wasting, anaemia, and micronutrients deficiencies (TFNC, 2012). Currently, stunting, underweight and wasting affects 34%, 14% and 5% of children respectively. The trends of undernutrition in Tanzania declined sharply when compared to prevalence in the past twenty years. Stunting declined sharply between 1999 (44%) and 2010 (35%) which was a difference of 9% but only slightly (1%) between 2010 and 2015-16 surveys. A similar pattern is observed for underweight, which dropped by 8% between 1990 and 2010 and by 5% between 2010 and 2015-16 percentage points. The prevalence of wasting has remained basically the same in Tanzania for the past twenty years, where in 1999 it was 5% and slightly dropped to 4% in 2010 and slightly rose to 5% in 2015-16 (NBS, 1999; NBS, 2004-05; NBS, 2010; TDHS-MIS, 2015-16).

Micronutrient deficiencies are often referred to as ‘hidden hunger’ because they develop gradually over time, their devastating impact is not seen until irreversible damage has been observed. Millions of children suffer from stunted growth, cognitive delays, diseases and weakened immunity as a result of micronutrient deficiencies (UNICEF, 2015). In Tanzania more than two-thirds of children aged 6-59 months were anemic (hemoglobin concentration <11 g/dL) and about 4% were severely anemic (hemoglobin concentration <7 g/dL), Iodine deficiency disorder (IDD) 13% and vitamin A deficiency (VAD) 30% (NBS, 2005).

2.8 Summary of Literature Review

Literature reviewed indicates that malnutrition among children below five years is determined by several factors, however a need to find out if similar are responsible for malnutrition in lowland and highland in Kilosa District in Tanzania is quite important. There are a lot of studies which were conducted in Morogoro Region on prevalence and determinants for undernutrition but are irrespective of ecological distribution. There is a possibility of variation across districts and across ecological zones or livelihoods. This was part of the research gap that this study sought to examine. Fig. 1 shows the conceptual framework with some of the determinants of undernutrition.

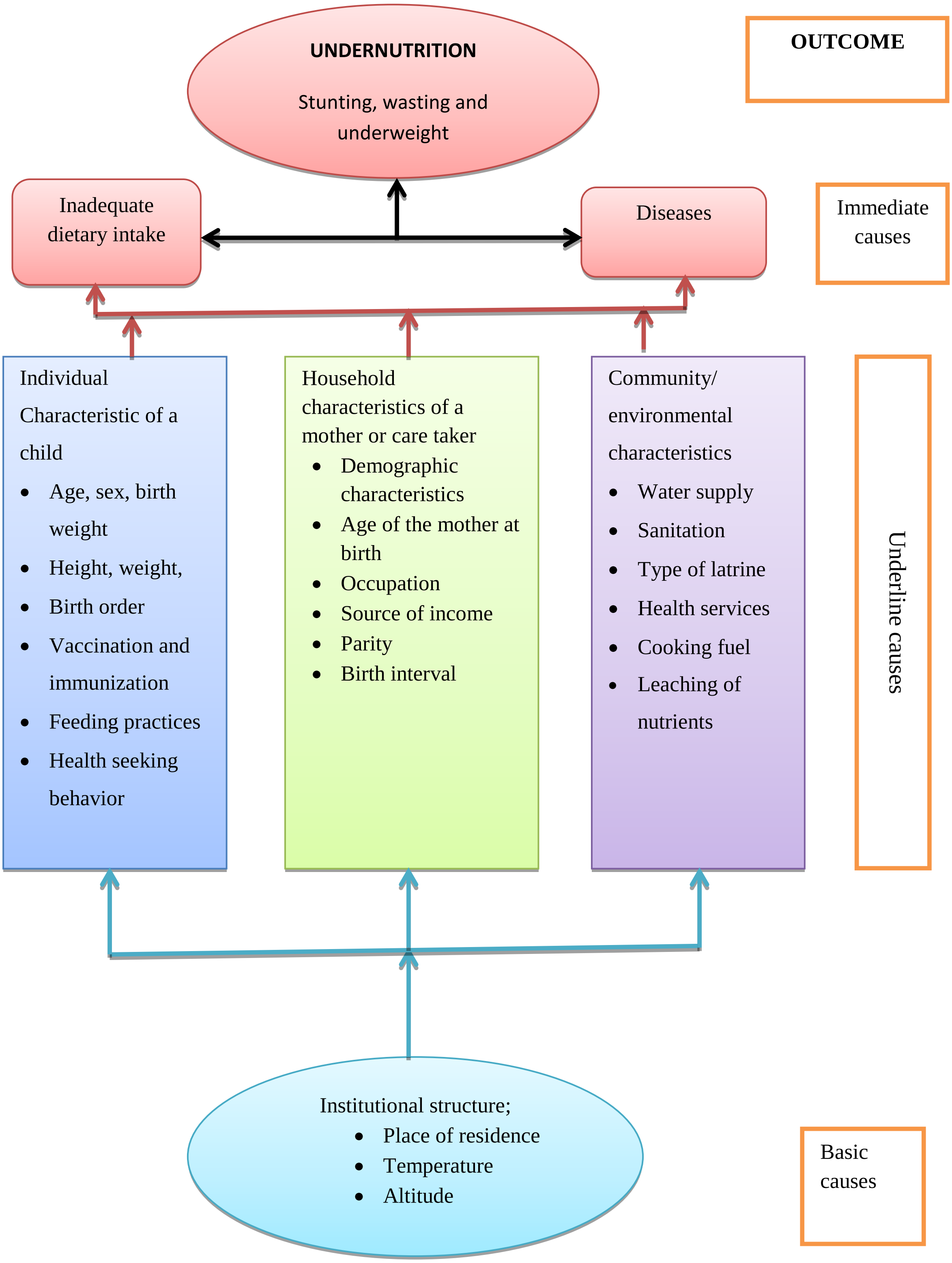

Figure 1: Conceptual Framework showing some determinants of undernutrition among children below five years of age

Source: Adopted from UNICEF (1998)

CHAPTER THREE

3.0 METHODOLOGY

This chapter presents the methodology used in the study. The chapter has been divided into different section such as description of study area, study population, study design, sampling technique and sample size, data collection and data analysis.

3.1 Description of Study Area

Kilosa District is located in East Central Tanzania, about 148 km from Morogoro town. Kilosa extends between latitude 5°55’ and 7°53’ South and longitudes 36°30’ and 37°30’ East. The District covers 12 394 square kilometres; is divided into 35 wards, in which 11 of them are in highland area and 24 are in lowland area and 118 registered villages with 752 hamlets; has two parliamentary constituencies and two township authorities (Kilosa and Mikumi) (Ishengoma *et al*., 2016). Kilosa District has a population of 438,175 people according to 2012 National Census (URT, 2013). It is bordered to the North by Manyara Region to the Northeast by Tanga Region, to the East by Mvomero District, to the Southeast by Morogoro rural district and to the South by Kilombero District. The District is bordered with Iringa to the Southwest and West with Dodoma Region. Its administrative seat is Kilosa town.

This study involved two wards, namely Chanzuru and Rudewa. In each ward data was collected from lowland and highland areas. In Chanzuru ward three villages studied were Peapea and Chanzuru from lowland and Mfuluni in highland. In Rudewa ward two villages studied were Batini located in lowland and Unone in highland. Lowlands had altitude of 437m while highlands had 598 and 865m Unone and Mfuluni respectively. Fig. 2 below is the map of Kilosa District which shows the areas where this study was conducted.

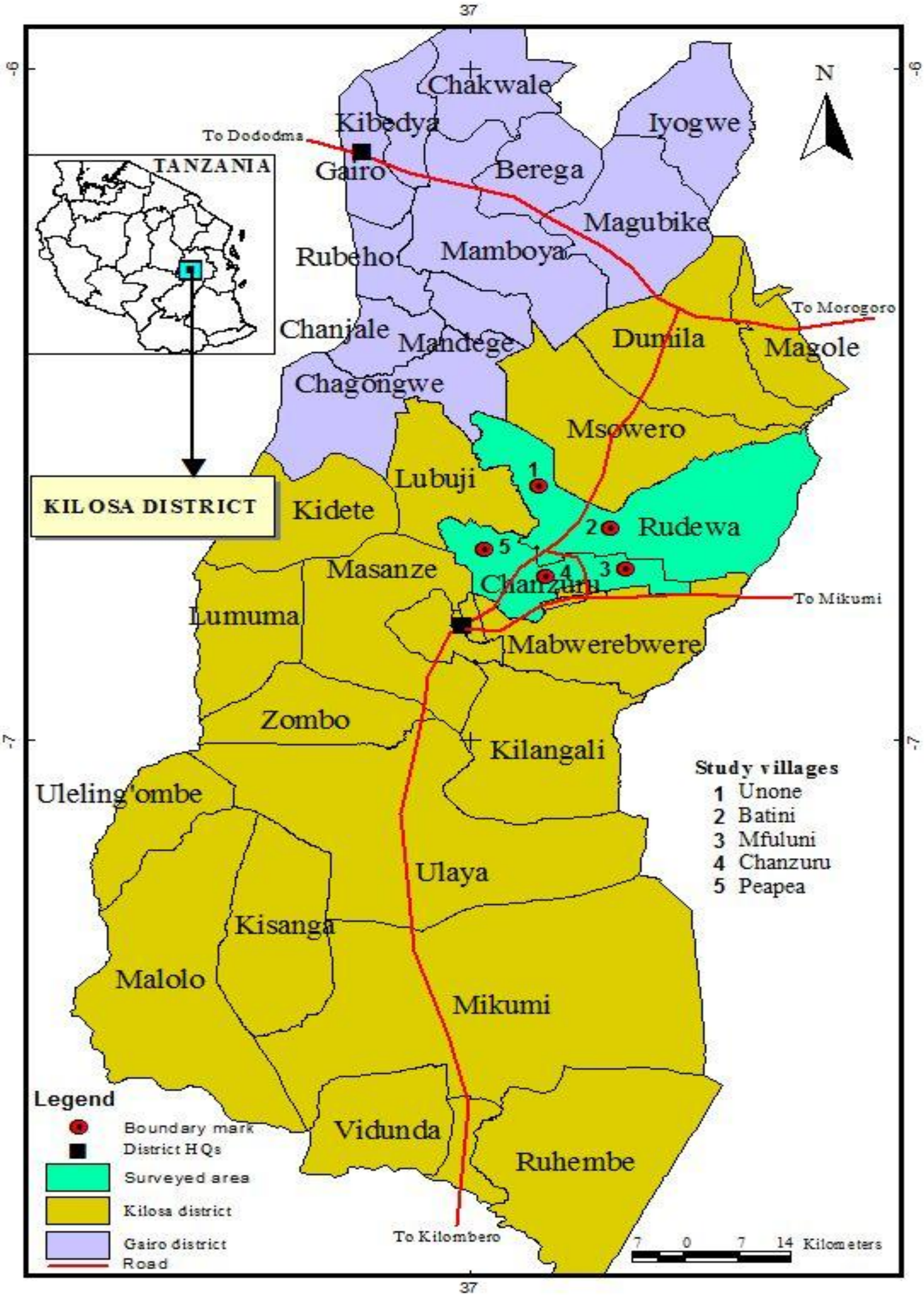

Figure 2: Map of Kilosa District showing the study areas.

3.2 Study Population

The study involved mother/care giver child pair for children of age 6-59 months living in Kilosa District.

3.3 Study Design

The study design was a cross sectional that allows data to be collected at a single point in time. Cross sectional studies are the best way to determine prevalence and are useful in identifying associations.

3.4 Sampling Technique and Sample Size

3.4.1 Sampling technique

Simple random sampling was used to select the 341 households with children aged 6 to 59 months for interview. For the households with more than one under five children the youngest one was selected. Children with malformation, those who were sick and those whose mothers refused to participate were excluded from the study.

3.4.2 Sample size

The sample size was determined by using a Fisher's formula (Fisher *et al*., 1991).

$n = z^2pq/d^2$

Whereby;

n= the desired sample

z = the standard normal deviate (which is 1.96 corresponding to 95% CI)

p = Proportion of prevalence of stunting in Morogoro region (0.334)

q = 1-p

d = degree of accuracy desired (0.05)

Calculating the value of n, $n= 1.96^2*0.334*0.666/0.05^2$

n= 341

About 341 respondents were recruited for the study to represent the highland and lowland population (141 and 200 respectively). More respondent recruited from lowland because there is high population compared to highland areas.

3.5 Data Collection

3.5.1 Construction of questionnaires

The study used primary data. Primary data were obtained from the anthropometric measurement and structured questionnaires. Questionnaire was prepared to solicit information to answer objectives two and three. The questionnaire had five sections. Section A was on mother's information which included demographic information, food security, women work load and reproductive health. Section B covered child information which included feeding practices (breastfeeding and complementary feeding), infections and diseases and immunization status. Section C covered aspects of environmental sanitation and personal hygiene, section D was composed of 24 dietary recall and dietary diversity and the last section E sought information on child anthropometric measurement which included weight and height (Appendix 1).

3.5.2 Training of enumerators

Three enumerators who assisted in data collection were trained for three days before they went to the field. Training was based on ethics of research, how to take some measurements such as height and weight properly and how to read and record the readings. The enumerators included Kilosa district nutrition officer and two community health workers in which one from Chanzuru village and another from Unone village.

3.5.3 Pretesting of the questionnaire

Before data collection questionnaire was tested. Pre- testing of the questionnaire was done in Ilonga village in Kilosa District where ten families who met criteria for inclusion in the study were involved. The necessary corrections were then made for the questions which were unclear to the respondent.

3.5.4 Administration of the questionnaire

The respondents were interviewed face to face at the household during day time by using pre-tested and translated (Swahili) questionnaires. Respondents were asked questions and their responses were filled in specific questions by interviewer. Answering of question was voluntary.

3.5.5 Dietary assessment

In assessing dietary intake, 24 dietary recalls were used where mothers or care givers were asked to recall foods and beverages they fed their children in the twenty-four hours prior to the interview. A mother was asked to show the local utensils such as bowl, cup or plate used and amount of food fed to the child in order to be estimated the food portion to the gram by comparing with the standard weight obtained by using food weighing scale (TANITA digital kitchen scale).

3.5.6 Anthropometric data

Anthropometric variables such as weight, height/length and age were collected. Weight and height/length of children were measured by using SECA weighing scale and stadiometer respectively while ages were recorded from growth monitoring card or mothers were asked if the information or card was unavailable.

3.5.6.1 Weight measurement

Weight was measured by using SECA-Germany electronic bathroom weighing scale (0-150 kg). The clothes of child were reduced as much as possible and shoes were removed. The scale placed on flat surface area and those children aged 2 years and above who were able to stand were weighed while standing on a scale and the reading recorded. For those children who were not able to stand alone (less than 2 years of age) his/her mother was stood on scale and the reading recorded; then the mother together with the child stood upright on the scale and the reading also recorded. Weight of child was obtained by deducting weight of the mother alone from weight of the mother with a child.

3.5.6.2 Height/length measurement

Height/length was measured by using stadiometer (Shorr Production, Perspective Enterprises Portage Missouri) at supine position or recumbent position of the child below two years, by using a measuring board which had a fixed head rest and a movable foot piece and placed on a flat surface. The child was placed face upwards, with the head towards the fixed end and the body parallel to the long axis of the board. The shoulder-blades rested against the surface of the board. The position of the child on the measuring board was; the child's feet, without shoes, toe pointing directly upward and the child's knees were kept straight. The movable footboard piece was placed firmly against the child's heels. The measurements were taken to the nearest 0.1 cm (Gibson, 2005). Children two years of age and above were measured by using a stadiometer and the measurement was recorded while the child stood without shoes on a horizontal flat with heels together, back straight and eyes looking straight ahead, and the board was pressed firmly horizontally against the board then the measurement was recorded to the nearest 0.1 cm.

Height-for-age, weight-for-height and height-for-age indices were employed to assess the nutritional status of children. Information on birth date of the children was obtained from their clinic cards. Anthropometric data were processed and analysed using a computerized program ENA for SMART (Version: November 2008). Children were classified as having, severe and moderate malnutrition and normal (WHO, 2006). Z-scores/percentiles were calculated from the measurements of height and weight. Z-score or standard deviation unit (SD) is defined as the difference between the value for an individual and the median value of the reference population for the same age or height, divided by the standard deviation of the reference population. Thus, Z-core was calculated using the following equation:

$$\text{Z-score} = \frac{\text{(observed value) - (median reference value)}}{\text{SD of reference population}}$$

Using the above formula, Z-scores were computed and Z-scores of children were classified as follows: <-3 SD severe low weight for age, low height for age and low weight for height malnutrition, <-2 SD as moderate undernutrition and >-2 SD as normal weight for age, height for age and weight for height.

3.6 Ethical Considerations

The study was initiated only after obtaining an ethical written approval from Muhimbili University of Health and Allied Science (MUHAS) with Ref. No. 2016-10-19/AEC/Vol.XI/307, Sokoine University of Agriculture and permission letter from District Executive Director of Kilosa. Details of the study were well explained to the mothers, before commencement of data collection. Informed written consent was obtained from the mothers.

3.7 Data Analysis

Dietary intake data were analysed using Nutrisurvey to get actual amount of nutrients from macronutrients (carbohydrate protein and fats) and micronutrients (vitamin A, calcium, zinc and iron) consumed and be compared with recommended daily allowance (RDA) to determine if intake was adequate or inadequate. Binary and multivariate logistic regression analysis was done to identify independent variables associated with underweight and stunting (dependent variables). Child's birth date, sex, height and weight were entered in ENA for SMART and then weight-for-age, height-for-age and weight-for-height/length z-scores were generated. Z-scores were transferred into Microsoft excel and categorized as severe, moderate and normal weight -for -age, height- for- age and weight- for- height according to WHO (2006) classifications then were entered in IBM SPSS Statistics version 20 for more analysis. Also, demographic, health, environment and sanitation data from questionnaire were coded, entered, cleaned and analysed using IBM SPSS Statistics version 20. Descriptive statistics covered measurements of central tendency (means), frequency, percentages and measures of dispersion namely standard deviation. To determine if nutritional status was significantly different between lowland and highland areas independent *t* test was used (continuous data were used).

3.8 Laboratory Work

3.8.1 Sampling and sample size

Purposive sampling was applied to select foods for laboratory analysis. Based on a 24 dietary recall questionnaire, the foods which were mostly consumed by children were selected. The selected foods were maize porridge with sugar, maize porridge with salt, stiff porridge (ugali), rice, sweet potato leaves, pumpkin leaves and beans (Fig. 3 and 4). Since food preparation and cooking methods were similar nearly for all households in highland area which was the same case for households in lowland area, a total of fourteen food samples were randomly obtained; seven from lowland and seven from highland areas where at each household only one sample was taken.

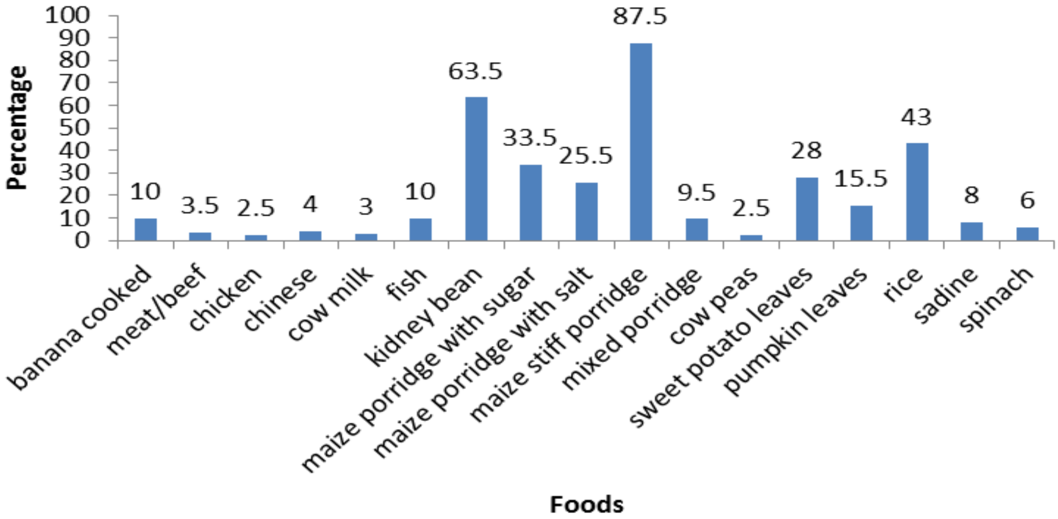

Figure 3: Percentage of children consuming specific food in lowland area

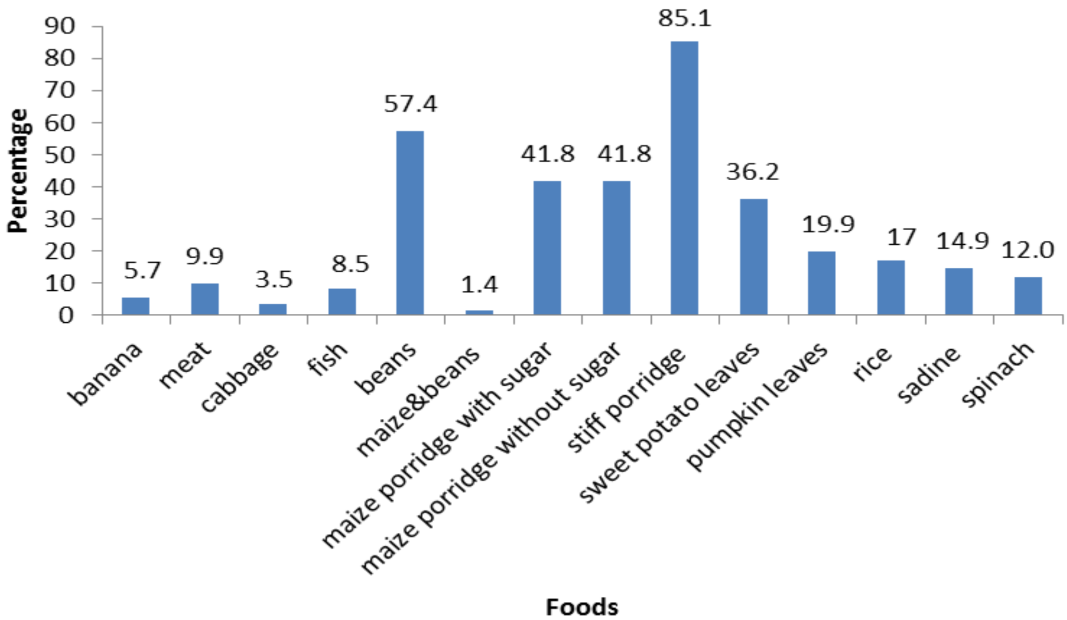

Figure 4: Percentage of children consuming specific food in highland area

3.8.2 Sample collection

Cooked food samples were collected from households with a child in lowland and highland areas. Food samples were packed in special packet, sealed and packed in a cooling box (4˚C) then were transported to Sokoine University of Agriculture, Department of Food Technology, Nutrition and Consumer Sciences laboratory where analysis was done. The cooked food samples were kept in the cooling box for one week until analysis was completed.

3.8.3 Laboratory analysis

A total of ten parameters were analysed: proximate analysis (carbohydrate, crude fat, crude fibre, crude protein, ash and moisture content), minerals (calcium, iron and zinc) and vitamin A in each food sample collected.

3.8.3.1 Proximate analysis of cooked food samples was determined as follows

3.8.3.1.1 Crude protein determination

Crude protein of food samples was determined using the semi micro Kjeldahl method as described in the AOAC (1995) method No.920.152. About 0.5 g of food samples were weighed in duplicate and digested.

Total Nitrogen (*N*) and crude protein in the food samples were worked out as follows:

$$\text{Percent } N = \frac{(14\times 0.1)\times A}{W}\times 100$$

Where:

A = the titre of acid used in millilitres

W = original weight of the digested sample

N = Total Nitrogen

Percent crude protein = Percent N x Factor (6.25)

3.8.3.1.2 Crude fat determination (Ether Extract)

Crude fat content of food samples was determined by the soxhlet method as described in AOAC (1995) methods No. 960.39. Food samples were homogenized in a motor and pestle in order to increase the surface area for the extraction. About 5 g of the sample was subjected to the soxhlet continuous ether extract for 5 hours.

The percentage of crude fat was calculated as follows:

$$\text{Crude fat percent} = \frac{(W_3 - W_1) \times 100}{W_2}$$

Where:

W_1= Weight of flask

W_2= Weight of sample

W_3= Weight of flask and fat

3.8.3.1.3 Ash content determination

Ash content of the tested food samples was determined by AOAC official method No. 940.26 (AOAC, 1995). About 5 g of the test sample was weighed SS in pre-weighed crucibles. The samples were then ignited in carbolite muffle furnace (530 2RR, England) at 550^{o}C for six hours. The ash content was calculated as bellow:

$$\text{Percent ash} = \frac{(W_3 - W_1) * 100}{W_2}$$

Where:

W_1= Weight of crucible

W_2= Weight of sample

W_3= Weight of sample in a crucible

3.8.3.1.4 Determination of moisture content

The moisture content of cooked food samples was determined in duplicate samples following the AOAC method No. 925.10 (AOAC, (1995). The food samples were then dried at 105ºCovernight, and then weighed. The average moisture content was calculated using the following formula:

$$\text{Percent moisture in g/100g} = \frac{(W_2 - W_1) - (W_3 - W_1) \text{ X } 100}{(W_2 - W_1)}$$

Where W_1 = Weight of crucible

W_2 = Weight of wet sample and crucible

W3 = Weight of dry sample in a crucible

i.e.MC = 100 - %Dry matter

3.8.3.1.5 Carbohydrate

The total carbohydrate content was obtained by difference, according to AOAC (1995) that is, 100% - other proximate chemical compositions, using the following formula;

Total carbohydrate = 100 – (% CP +% EE + % CF + % Ash content + % MC).

Where:

CP = Crude protein

EE = Ether extract

CF = Crude Fibre

MC = Moisture content

AC = Ash content

3.8.3.2 Mineral analysis

The mineral content of cooked food samples were carried out by AOAC (1995) method No. 968.08. Mineral contents (Ca, Fe and Zn) for samples were determined by using Atomic Absorption/Flame Emission Spectrophotometer (AA 630-12). Absorbencies of various cations were read at 422.7, 248.3 and 213.9 nm for calcium, iron and zinc respectively. Absorbencies of the diluted standards read and standard calibration plot constructed (Fig. 5, 6 and 7) the linear regression equation obtained was used to calculate the calcium, Iron and Zinc content of samples.

The linear regression equation obtained (Y= 0.0114x – 0.009) was used to calculate the calcium content of the sample

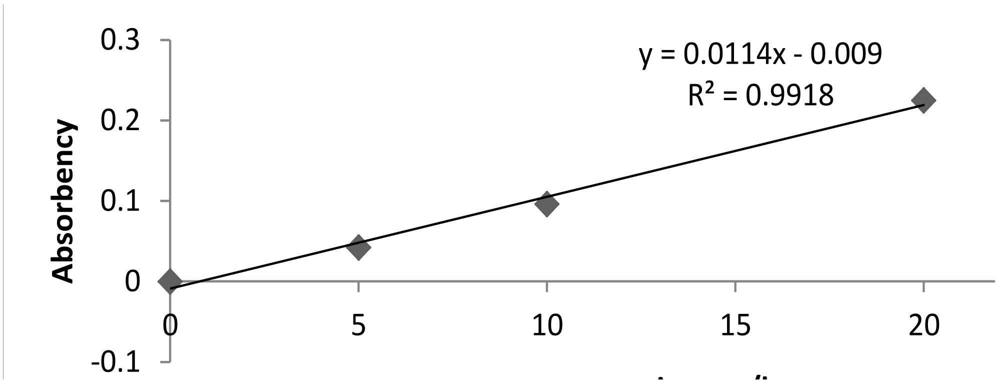

Figure 5: A standard plot for calcium

The linear regression equation obtained (Y= 0.0077x + 0.0043) was used to calculate the Iron content of the sample.

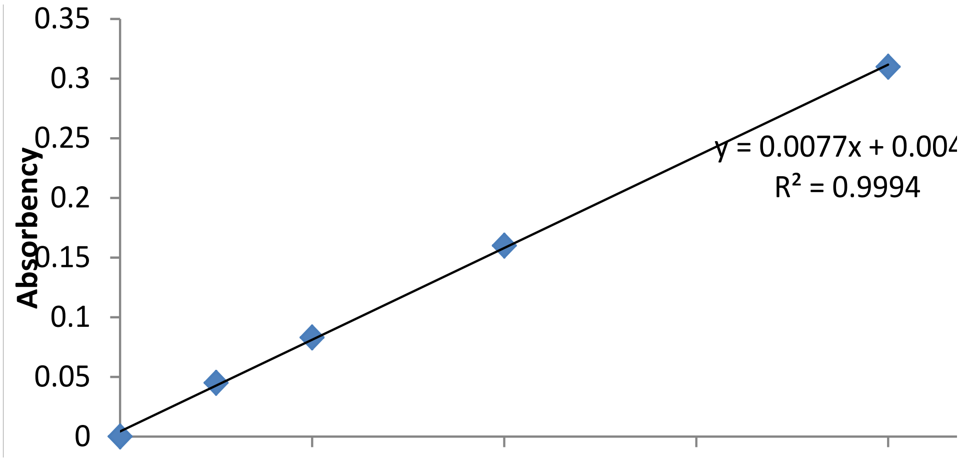

Figure 6: A standard plot for iron

The linear regression equation obtained ($Y= 0.0698x + 0.0006$) was used to calculate the zinc content of the sample.

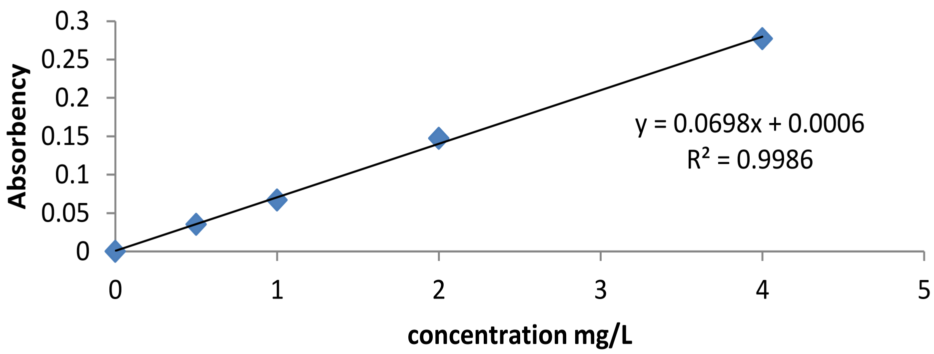

Figure 7: A standard plot for zinc

The minerals content (mg/100g) was calculated as below:

$$\text{Mineral content mg/100g} = \frac{R \times E \times D\,F}{S \times 10}$$

Where:

R = Reading in ppm (mg/L)

E = Volume of sample made (10 ml)

D.F = Dilution factor

10 = Conversion factor to mg/100g

S = Sample weight (g)

3.8.3.3 Beta-carotene determination by spectrophotometer

Beta-carotene content of cooked food sample was determined by extraction method using acetone (Rodriguez-Amaya and Kimura, 2004). Two grams homogenized sample taken in Polytron bottle was extracted 4 times using 50mls proportions of cold acetone. The 4 portions of extracts were transferred into the separating funnel containing petroleum ether (40-60^{o}C Bp), followed by a thorough washing with about 300 mls of distilled water until the extracts were acetone free. During the washing process, the distilled water was added by wall of the glass separating funnel to avoid formation of emulations (water stones) in the carotenoid extracts. The washed samples were then passed through anhydrous sodium sulphate to make it free from any trace of water. The dried carotene extracts were then collected into a clean and dry volumetric flask. The extract was then read under UV-Visible Spectrophotometer (Wagtech, CECIL 2021 at 450 nm to obtain its optical density (OD). Beta carotene standard solution with the concentration of a 10 µg/ml was prepared by taking 0.001 g of β-carotene standard powder obtained from Sigma-Adrich into 100 ml volumetric flask. 10ml petroleum ether added and swirled to dissolve and finely petroleum ether added until the volume made to 100ml mark of the volumetric flask. Serial dilutions of 0, 0.5, 1, 2, 4, 8 and 10 µg/ml were prepared. Absorbencies of the diluted standards read and standard calibration plot constructed (Fig. 8) the linear regression equation obtained (Y=0.0915x + 0.0542) was used to calculate the beta carotene content of the samples.

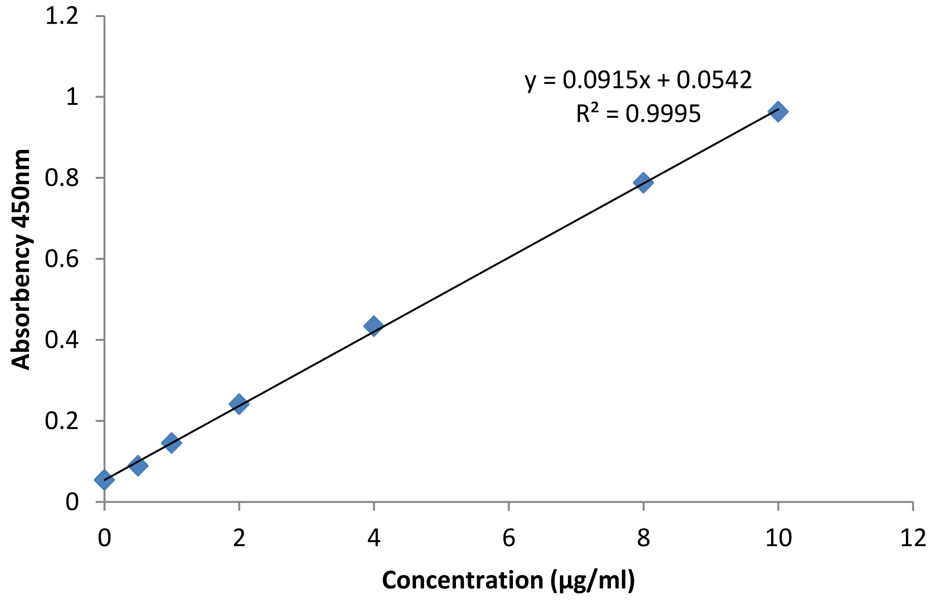

Figure 8: β-carotene standard calibration plot

Total carotenoids were calculated using the following formula;

$$\text{Beta carotene content } (\mu g/g) = \frac{A \times E}{\text{Sample weight } (g)}$$

Where:

A = Concentration in µg/ml calculated using linear regression equation of the standard plot

E= total volume of extract (50ml)

3.9 Data Analysis

Duplicate data obtained were entered in R software version 3.3.1 where means and standard deviations were computed and further analysis was done by ANOVA. Comparisons between samples were done by Tukey's Honestly Significant Difference.

CHAPTER FOUR

4.0 RESULTS

This chapter presents the findings of the study on: background information (socio demographic, use of health services, feeding practices and environmental hygiene and sanitation) and nutritional status of the under-five children in lowland and highland areas (prevalence of underweight, stunting and wasting). Also the determinants of undernutrition (underweight and stunting), dietary intake of children in lowland and highland areas and Nutrients content in the foods investigated.

4.1 Socio-demographic Characteristics

Socio-demographic characteristics of the mothers and their children are presented in Table 2. Most of the mothers (46.9%) their age were ranging from 25-34 years and 82.1% were married. Fifty one percent of children were boys and majority were range at the age of 36-59 months. In the lowland area 83.5% of mothers were married compared to 80.1% in the highland. In both lowland and highland areas majority of the mothers (73.5 and 75.9%) respectively had primary school education. More than half of the households (53.5%) in lowland were based on agriculture while in highland were based on both agriculture and casual labour (48.9 and 49.6%) respectively. Most of the households (84.5 and 81.6%) were male headed in lowland and highland respectively. Majority of the mothers (49 and 44%) in both lowland and highland areas respectively were at the age range from 25-34 years.

Table 2: Demographic characteristics of the studied population

Demographic information	Lowland (N = 200)		Highland (N = 141)		Total (N=341)	
	n	%	n	%	n	%
Marital status						
Single	33	16.5	28	19.9	61	17.9
Married	167	83.5	113	80.1	280	82.1
Total	**200**	**100**	**141**	**100**	**341**	**100**
Maternal education level						
Informal education	36	18	25	17.7	61	17.9
Primary	147	73.5	107	75.9	254	74.5
Secondary/university	17	8.5	9	6.4	26	7.6
Total	**200**	**100**	**141**	**100**	**341**	**100**
Occupation of mother						
Farmer	185	92.5	139	98.6	324	95
Employed	5	2.5	0	0	5	1.5
Business	10	5.0	2	1.4	12	3.5
Total	**200**	**100**	**141**	**100**	**341**	**100**
Household main source of income						
Salary / wage	9	4.5	0	0	9	2.6
Agriculture	107	53.5	69	48.9	176	51.6
Business	17	8.5	2	1.4	19	5.6
Casual labour	67	33.5	70	49.7	137	40.2
Total	**200**	**100**	**141**	**100**	**341**	**100**
Head of household						
Male	169	84.5	115	81.6	284	83.3
Female	31	15.5	26	18.4	57	16.7
Total	**200**	**100**	**141**	**100**	**341**	**100**
Age of mothers/caregiver						
14-24	56	28	57	40.4	113	33.2
25-34	98	49	62	44	160	46.9
≥35	46	23	22	15.6	68	19.9
Total	**200**	**100**	**141**	**100**	**341**	**100**
Sex of children						
Boys	106	53	68	48.2	174	51
Girls	94	47	73	51.8	167	49
Total	**200**	**100**	**141**	**100**	**341**	**100**
Children age						
6-23 months	63	31.5	51	36.2	114	33.4
24-35 months	58	29	44	31.2	102	29.9
36-59 months	79	39.5	46	32.6	125	36.7
Total	**200**	**100**	**141**	**100**	**341**	**100**

4.2 Use of Health Services

Health information for the studied population is shown in Table 3. All mothers reported to have attended at least one antennal visit during pregnancy. About 85.3% of pregnant women took folic acid and 62.2% reduced work during pregnant. Though high percentage of mothers (69.5) delivered at hospital/dispensary still some mothers (29.3%) delivered at home. Majority of the mothers (90.1%) in the highland area took folic acid throughout a pregnancy period compared to 82% in the lowland. Most of the mothers (74%) in lowland delivered in hospital/dispensary compared to 63.1% in the highland area and also high percentage delivered at home (36.8%). All children from lowland areas were immunized but only 2.1% were not immunized from highland.

Table 3: Health information from interviewed household in Kilosa district

Variable	Lowland (N=200)		Highland (N=141)		Total (N=341)	
	n	%	n	%	n	%
Attend antenatal clinic						
Yes	200	100	141	100	341	100
Total	**200**	**100**	**141**	**100**	**341**	**100**
No. of visit						
Once	0	0	3	2.1	3	0.8
Two times	9	4.5	11	7.8	20	5.9
Three times	76	38	79	56	155	45.5
Four times	66	33	38	27	104	30.5
More than four	49	24.5	10	7.1	59	17.3
Total	**200**	**100**	**141**	**100**	**341**	**100**
Iron and folic acid intake						
No	16	8	3	2.1	19	5.6
Yes throughout pregnancy	164	82	127	90.1	291	85.3
Yes for sometimes	20	10	11	7.8	31	9.1
Total	**200**	**100**	**141**	**100**	**341**	**100**
Reduce work during pregnancy						
No	62	31	67	47.5	129	37.8
Yes	138	69	74	52.5	212	62.2
Total	**200**	**100**	**141**	**100**	**341**	**100**
Place of giving birth						
Hospital/Dispensary	148	74	89	63.1	237	69.5
Home	48	24	52	36.9	100	29.3
On the way to hospital	4	2	0	0	4	1.2
Total	**200**	**100**	**141**	**100**	**341**	**100**
Child immunized						
No	0	0	3	2.1	3	0.9
Yes	200	100	138	97.9	338	99.1
Total	**200**	**100**	**141**	**100**	**341**	**100**

4.3 Infant and Young Child Feeding Practices

Table 4 below summarizes infant and young child feeding practices. Almost all children (99.4%) were breastfed where 57.2% were breastfed soon after birth (within one hour) and 97.7% were breastfed on demand. More than half of the children (70.4%) were exclusively breastfed for six months and majority stopped to be breastfed at 24 months of age. More than half of the children (66.7%) were breastfed soon after birth (within one hour) in lowland area compared to 48.9% in highland. Majority of children (74%) in lowland were exclusively breastfed for six months and compared to 65.2% in highland areas. Majority of the children (64 and 54%) were breastfed up to the age of two years in lowland and highland areas respectively. Majority of the children (69 and 61.7%) were introduced to complementary foods at the age of six months in lowland and highland areas respectively and majority (67 and 77.3%) were fed three meals per day in lowland and highland areas respectively.

Table 4: Young children feeding practices in the lowland and highland areas

Variable	Lowland (N=200)		Highland (N=141)		Total (N=341)	
	n	%	n	%	n	%
Breast feeding						
No	2	1	0	0	2	0.6
Yes	198	99	141	100	339	99.4
Total	**200**	**100**	**141**	**100**	**341**	**100**
Initiation of breast feeding						
I don’t know	2	1	7	5	9	2.6
Within 1 hour	132	66.7	63	47.7	199	57.2
1-6 hours	64	32.3	69	48.9	134	39
More than 6 hours	2	1	2	1.4	4	1.2
Total	**200**	**100**	**141**	**100**	**341**	**100**
Frequency of breastfeeding/ day						
On demand	195	97.5	138	97.9	333	97.7
Twice	0	0	1	0.7	1	0.3
Three times	1	0.5	0	0	1	0.3
Four times	4	2	2	1.4	6	1.7
Total	**200**	**100**	**141**	**100**	**341**	**100**
Exclusive breastfeeding(6 months)						
No	52	26	49	34.8	101	29.6
Yes	148	74	92	65.2	240	70.4
Total	**200**	**100**	**141**	**100**	**341**	**100**
Breastfeeding duration						
7-12 months	4	2	3	2.1	7	2.1
13-18 months	16	8	15	10.6	31	9.1
24+ months	128	64	76	54	204	59.8
Were continue breastfeeding	52	26	47	33.3	99	29
Total	**200**	**100**	**141**	**100**	**341**	**100**
Time started complementary food						
< 6 months	52	26	49	34.8	101	29.6
On 6 months	138	69	87	61.7	225	66
>6 months	10	5	5	3.5	15	4.4
Total	**200**	**100**	**141**	**100**	**341**	**100**
No. of meals per day						
One	6	3	2	1.4	8	2.4
Two meals	25	12.5	23	16.3	48	14.1
Three meals	134	67	109	77.3	243	71.2
Four meals	22	11	5	3.6	27	7.9
More than four meals	13	6.5	2	1.4	15	4.4
Total	**200**	**100**	**141**	**100**	**341**	**100**

4.4 Hygiene, Sanitation and Illness Cases

Findings on hygiene practices are presented in Table 5. Different types of latrines are used in surveyed households in Kilosa District: majority (90.5 and 99.3%) use pit latrines in lowland and highland areas respectively. In the lowland 92% were using tap water and 35.5% were treating drinking water while in the highland the main source of water was river/stream (42.6%) and 55.3% were treating drinking water by boiling. Two weeks prior to survey 33.5 and 45.4% of children were sick in the lowland and highland respectively.

Table 5: Hygiene and sanitation practices and illness cases

Variables	Lowland (N=200)		Highland (N=141)		Total (N=341)	
	n	%	n	%	n	%
Type of latrine						
Own flash toilet	18	9	1	0.7	19	5.6
Pit latrine	181	90.5	140	99.3	321	94.1
No latrine / bush	1	0.5	0	0.0	1	0.3
Total	**200**	**100**	**141**	**100**	**341**	**100**
Main water sources						
Tap water	184	92	35	24.8	219	64.2
River/stream	12	6	60	42.6	72	21.1
Well	4	2	46	32.6	50	14.7
Total	**200**	**100**	**141**	**100**	**341**	**100**
Treating drinking water						
No	129	64.5	63	44.7	192	56.3
Yes	71	35.5	78	55.3	149	43.7
Total	**200**	**100**	**141**	**100**	**341**	**100**
Child sick past 2 weeks						
No	133	66.5	77	54.6	210	61.6
Yes	67	33.5	64	45.4	131	38.4
Total	**200**	**100**	**141**	**100**	**341**	**100**

4.5 Dietary Intake

4.5.1 Dietary intake in the lowland area

The dietary intake of children in the lowland area is summarized in Table 6. The mean and standard deviation of each nutrient intake in each age group (6-12, 13-36 and 37-59 months) in comparison with their daily recommendation are shown. The mean intake of majority of children fell below RDA. All age groups did not meet the RDA for calcium.

Generally majority (43%) met their RDA for protein. All of infants (6-12 months of age) did not meet the RDA for fat, vitamin A, calcium and iron.

Table 6: Nutrient intake of children 6-59 months in lowland area

	Nutrients						
	Protein (g)	**Fat(g)**	**CHO (g)**	**Vit. A (μg)**	**Calcium (mg)**	**Iron (mg)**	**Zinc (mg)**
6-12 months							
Mean	8.7	5.5	61.0	121.0	52.5	2.8	1.4
SD	7.5	5.7	33.8	177.2	51.8	2.1	0.9
n(%) who met RDA	7(28)	0(0)	4(16)	0(0)	0(0)	0(0)	2(8)
13-36 months							
Mean	18.4	14.7	116.5	234.9	80.5	6.5	3.1
SD	14.1	10.8	64.3	282.5	46.3	4.4	2.0
n(%) who met RDA	54(54)	6(6)	27(27)	34(34)	0(0)	19(19)	38(38)
37-59 months							
Mean	19.8	13.7	129.2	343.7	94.8	6.7	3.5
SD	9.4	5.2	43.9	322.3	39.6	2.3	1.4
n(%) who met RDA	25(33.3)	1(1.3)	29(38.7)	29(38.7)	0(0)	3(4)	9(12)
Total							
Mean	17.8	13.3	114.0	263.8	82.4	6.1	3.0
SD	13.1	9.7	61.9	300.4	47.9	4.0	1.9
n(%) who met RDA	86(43)	7(3.5)	60(30)	63(31.5)	0(0)	22(11)	49(24.5)

4.5.2 Dietary intake in the highland area

Dietary intake for children in the highland area is summarized in Table 7. Mean intakes of almost all nutrients in nearly all age categories fell below RDA. The general mean for protein, fat, carbohydrate, vitamin A, calcium, iron and zinc was 15.5, 11.4, 108.7, 272.3, 80.5, 5.7 and 2.9 respectively. Generally 44.7% of the children met their RDA for protein and none of the respondent met the RDA for calcium. In group of infants (6-12 months of age) very few (5.6%) met RDA for vitamin A but none met RDA for fat, calcium, iron and zinc. Majority of the children of aged 13-36 month were met their RDA of protein, vitamin A, iron and zinc compared to other age group.

Table 7: Dietary intake of 6-59 months children in highland area

	Nutrients						
	Protein (g)	**Fat (g)**	**CHO (g)**	**Vit. A (µg)**	**Calcium (mg)**	**Iron (mg)**	**Zinc (mg)**
6-12 months							
Mean	6.4	3.0	69.7	37.1	30.4	2.6	1.3
SD	5.1	2.3	57.9	105.6	23.1	1.6	0.8
n(%) who met RDA	3(16.7)	0(0)	5(27.8)	1(5.6)	0(0)	0(0)	0(0)
13-36 months							
Mean	15.4	11.4	110.5	290.8	81.8	5.6	2.9
SD	7.6	5.6	38.8	215.0	37.0	1.9	1.1
n(%) who met RDA	40(51.9)	1(1.3)	24(31.2)	37(48.1)	0(0)	13(16.9)	35(45.5)
37-59 months							
Mean	19.2	14.8	121.1	333.4	98.0	7.1	3.6
SD	5.7	5.1	36.2	280.3	38.2	1.9	0.9
n(%) who met RDA	20(43.5)	1(2.2)	17(37.0)	17(37.0)	0(0)	6(13.0)	3(6.5)
Total							
Mean	15.5	11.4	108.7	272.3	80.5	5.7	2.9
SD	7.7	6.2	43.5	245.4	41.2	2.3	1.2
n(%) who met RDA	63(44.7)	2(1.4)	46(32.6)	55(39.0)	0(0)	19(20.6)	38(27.0)

4.5.3 Dietary energy intake

Fig .9 presents percentages of children who met RDA for energy. Generally, only 20.5% of children meet their RDA for energy. More than half of the children below 24 months of age met their RDA for energy compared to older children (24 months and above). Based on location, majority of children (85.7%) aged 9-11 months in highland met their RDA for energy compared to their peers in lowland area (62.5%).

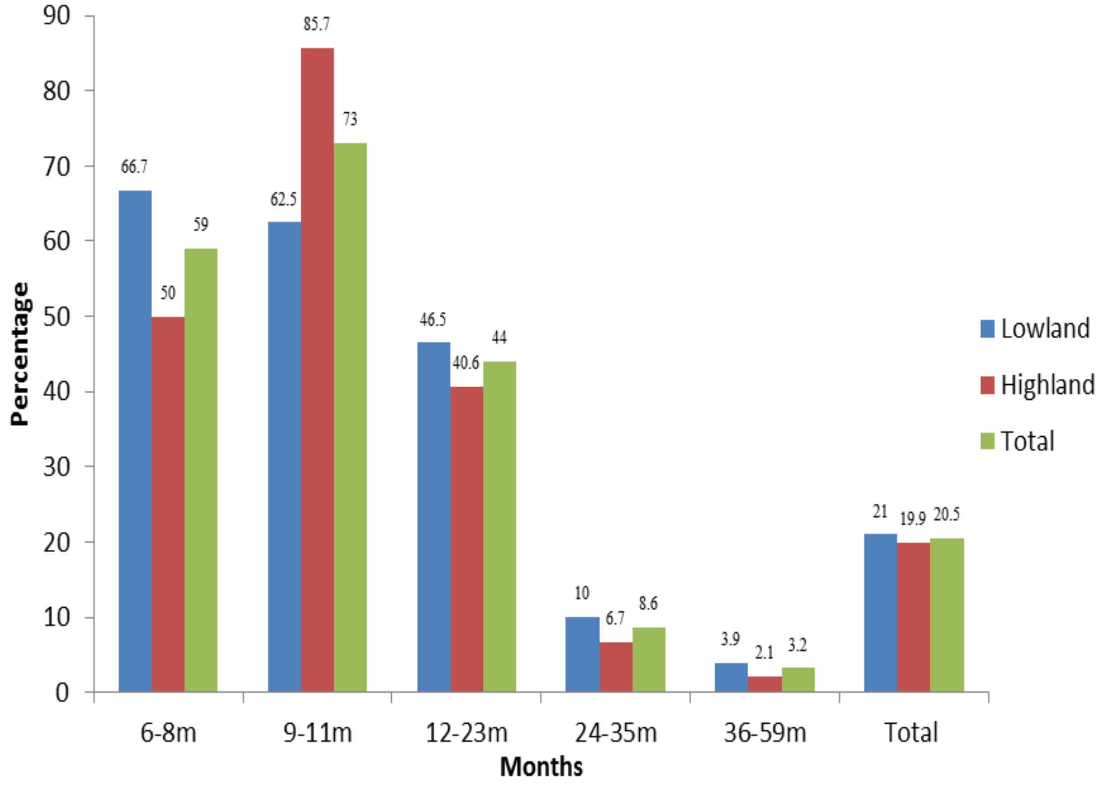

Figure 9: Percentage of children who met RDA for energy intake

4.5.4 Nutrients intake between lowland and highland areas

Dietary intake was compared between lowland and highland areas (Table 8); there was a significant difference only in fat intake in children aged 1-3 years between the lowland and highland areas. Differences in other nutrients between lowland and highland areas were observed although the difference was not significant.

Table 8: Comparison on nutrients intake between lowland and highland

Age	Energy M±SD	Protein M±SD	Fat M±SD	CHO M±SD
Lowland				
6-12 months	300.3±188.8[a]	7.4±7.0[a]	4.9±5.3[a]	59.3±36.3[a]
13-36 months	642.6±368.6[a]	18.2 ± 13.9[a]	14.5±10.7[a]	113.9±64.4[a]
39-59 months	705.9±213.7[a]	19.7±9.3[a]	13.7±5.3[a]	129.1±43.4[a]
Highland				
6-12 months	320.7±246.8[a]	6.4±5.1[a]	3.0±2.3[a]	69.7± 57.9[a]
13-36 months	588.6±201.3[a]	15.4± 7.6[a]	11.5±5.7[b]	109.7±38.5[a]
39-59 months	680.9±162.2[a]	19.1±5.7[a]	14.6±5.1[a]	122.0±36.4[a]
	Calcium	**Iron**	**Zinc**	**Vitamin A**
Lowland				
6-12 months	35.9±39.9[a]	2.5±2.1[a]	0.8±0.7[a]	73.9±147.8[a]
13-36 months	82.6±46.9[a]	6.4 ±4.4[a]	3.1±1.9[a]	243.1±278.8[a]
37-59 months	91.7±35.1[a]	6.7±2.3[a]	3.5±1.4[a]	334.8±322.8[a]
Highland				
6-12 months	30.4±23.1[a]	2.6±1.6[a]	1.0±0.6[a]	37.1±105.6[a]
13-36 months	82.2±37.0[a]	5.6 ±1.9[a]	2.8±1.1[a]	294.1±214.5[a]
37-59 months	101.1±42.2[a]	7.1±1.9[a]	3.6±0.9[a]	327.2±280.5[a]

Values followed by the same superscript letters within the column do not differ significantly at $p \leq 0.05$ according to Tukey's Honest Significant difference.

4.5.5 Dietary diversity

Figure 10 below summarizes the food groups consumed in the lowland and highland areas as obtained by 24 dietary recall questionnaires. Foods were grouped into seven groups: grains, roots and tubers, legumes and nuts, vegetables, fruits, dairy products, flesh foods and eggs. Grain, roots and tubers were the most popular food groups consumed by children, followed by legumes and nuts and vegetables 99.1, 64.2 and 60.7% respectively. Eggs and dairy products were the least consumed, at 1.2 and 2.3% respectively. Similarly, in the lowland and highland areas the most consumed food groups were grains, roots and tubers (98.5 and 100%) respectively. Consumption of vegetables was more in the highland area (66%) compared to the lowland area (57%) while legumes and nuts were consumed more in the lowland (68%) compared to the highland area (58.9%).

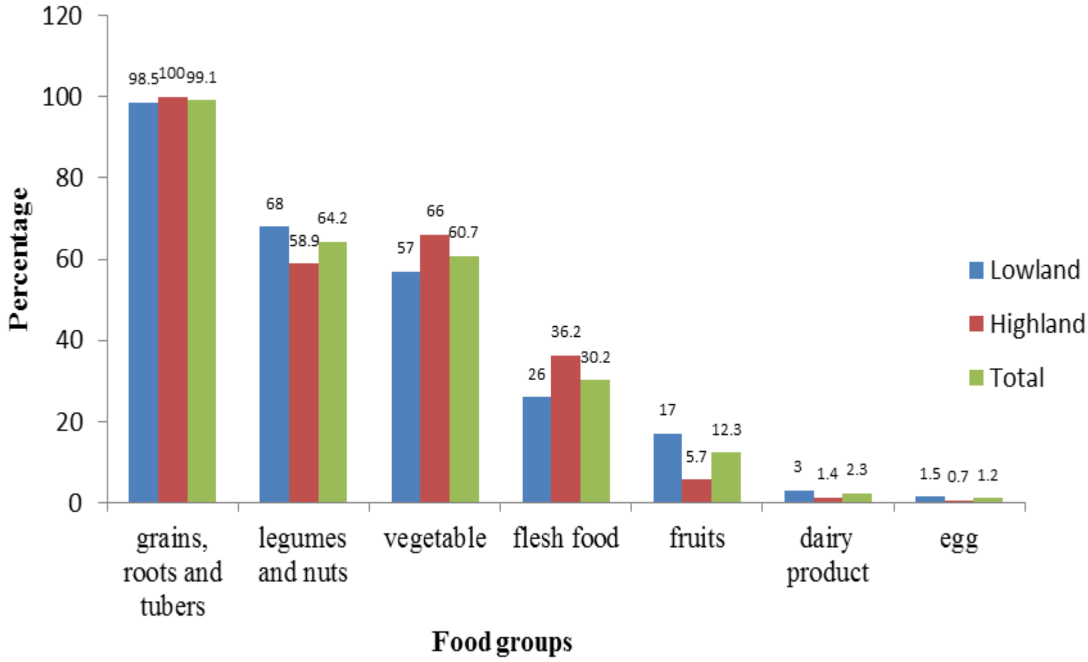

Figure 10: Distribution of children by food group consumed in lowland and highland

4.5.6 Dietary diversity score

Dietary diversity scores of children in the lowland and highland areas are summarized in Table 9. Majority (80.6%) of children consumed less than four food groups. only 19.4% met a minimum of four or more food groups. Similarly, majority in the lowland and highland areas consumed less than four groups of food. Children in the lowland area had more diversified diet compared to the highland area children. There was an association between area of residence and dietary diversity (p=0.04).

Table 9: Dietary diversity scores in lowland and highland

	Lowland (N=200)		Highland (N=141)				
	n	**%**	**n**	**%**	χ^2	**DF**	***P* value**
Dietary diversity scores							
<4 food groups	154	77	121	85.8	4.12	1	0.04*
≥4 groups and above	46	23	20	14.2			
Total	**200**	**100**	**141**	**100**			

*significant at $p<0.05$

4.6 Nutrient Content in Foods

4.6.1 Macronutrients content

Macronutrients of different cooked foods from the lowland and highland areas are presented in Table 10. Highest amount of ash (4.9 g/100g) was observed in beans and lowest in maize flour porridge with sugar (0.17 g/100g). Sweet potato leaves had the highest amount of fibre (6.47 g/100g) and the lowest observed in maize flour porridge with salt. The highest amount of crude protein (3.84 g/100g) was observed in beans but was not significantly different from the one observed in maize flour stiff porridge while the lowest amount was observed in maize flour porridge with salt. Highest amount of crude fat was observed in sweet potato leaves (5.7 g/100g) and the lowest was in maize porridge with salt (0.18 g/100g). The highest amount of carbohydrate (24.5 g/100g) was observed in rice and the lowest was 4.09 g/100g which was observed in sweet potato leaves. There was a significance difference in crude fibre and crude protein in food samples from the lowland and highland areas.

Table 10: Nutrient content of cooked food (g/100g edible portion) wet basis

Foods	Ash M±SD	Crude Fibre M±SD	Crude Protein M±SD	Crude fat M±SD	CHO M±SD
Lowland					
Porridge with sugar	0.17±0.04^{g}	1.06±0.03^{de}	2.81±0.03^{efg}	0.18±0.02^{f}	11.87±0.39^{bcd}
Porridge with salt	0.28±0.002^{g}	0.69±0.001^{e}	2.61±0.002^{g}	0.97±0.01^{cde}	6.77±0.41^{cd}
Pumpkin leaves	3.77±0.004^{b}	3.76±0.19^{c}	2.85±0.001^{defg}	1.13±0.01^{c}	5.23±0.49^{d}
S/potato leaves	2.19±0.005^{de}	6.47±0.28^{a}	2.84±0.02^{efg}	5.7±0.71^{a}	5.9±1.21^{d}
Stiff porridge	0.67±0.002^{fg}	1.89±0.13^{d}	3.45±0.02^{ab}	0.23±0.00^{def}	24.12±0.36^{a}
Beans	4.9±0.01^{a}	4.55±0.28^{bc}	3.41±0.05^{bc}	0.79±0.06^{cdef}	11.02±0.16^{bcd}
Rice	1.94±0.007^{e}	1.16±0.01^{de}	3.15±0.23^{bcde}	0.96±0.12^{cdef}	21.31±10.1^{ab}
Highland					
Porridge with sugar	0.22±0.002^{g}	1.58±0.68^{de}	2.83±0.001^{efg}	0.19±0.01^{ef}	8.32±3.51^{cd}
Porridge with salt	1.04±0.02^{f}	0.68±0.01^{e}	2.63±0.03^{fg}	0.98±0.07^{cd}	6.23±0.71^{d}
Pumpkin leaves	2.68±0.004^{cd}	3.82±0.03^{c}	3.01±0.01^{cdef}	1.22±0.07^{c}	6.61±0.55^{cd}
S/potato leaves	2.54±0.49^{d}	5.24±0.08^{b}	2.78±0.01^{efg}	2.06±0.02^{b}	4.09±0.36^{d}
Stiff porridge	0.29±0.001^{g}	1.29±0.04^{de}	3.24±0.07^{bcd}	0.29±0.04^{def}	21.04±0.15^{ab}
Beans	3.19±0.01^{c}	3.7±0.1^{c}	3.84±0.27^{a}	2.42±0.01^{b}	18.13±0.58^{abc}
Rice	0.51±0.005^{g}	1.16±0.14^{de}	3.17±0.06^{bcde}	2.47±0.08^{b}	24.5±0.8^{a}

Values followed by the same superscript letters within the column do not differ significantly at $p \leq 0.05$ according to Tukey's Honestly Significant difference.

4.6.2 Micronutrients content

Micronutrients content of different food samples from the lowland and highland areas are shown in Table 11. Nutrients which were analysed were calcium, Iron, zinc and vitamin A. The highest amount of calcium observed was 187.51 mg/100g in pumpkin leaves but was not significantly different from that observed in sweet potato leaves and the lowest amount was 16.73 mg/100g from rice. Amount of iron observed in sweet potato leaves was highest (2.44 mg/100g) compared to other food samples and lowest was -0.14 mg/100g from maize porridge with sugar. Amount of zinc ranged from 0.73 to 0.09 mg/100g and the highest was observed in beans and lowest in maize porridge with sugar. Pumpkin leaves was observed to have the highest amount of vitamin A (634.27 µg/100g) compared to other foods where the lowest was observed in kidney beans (-2.52 µg/100g). (Negative values could be due to very low amount of the respective nutrient in a sample so when fitted in equation (mg/ml=Y-0.0542/0.0915) it gives negative value).

Table 11: Micronutrients content of cooked food (mg/100g edible portion) wet basis

Sample food	Calcium	Iron	Zinc	Vitamin A (µg/100g)
Foods	**M±SD**	**M±SD**	**M±SD**	**M±SD**
Lowland				
Porridge with sugar	30.22 ± 2.66^{cd}	-0.14 ± 0.01^{f}	0.09 ± 0.01^{f}	5.31 ± 0.52^{d}
Porridge with salt	135.13 ± 119.22^{abcd}	1.99 ± 0.01^{abc}	0.69 ± 0.01^{a}	2.02 ± 0.34^{d}
pumpkin leaves	134.39 ± 3.01^{abcd}	1.24 ± 0.09^{de}	0.34 ± 0.02^{cd}	620.33 ± 3.79^{a}
S/potato leaves	173.62 ± 6.57^{ab}	2.32 ± 0.25^{ab}	0.37 ± 0.04^{cd}	182.74 ± 1.69^{c}
Stiff porridge	23.78 ± 6.11^{d}	0.18 ± 0.18^{f}	0.18 ± 0.08^{ef}	2.71 ± 0.45^{d}
Beans	59.19 ± 3.9^{acd}	1.5 ± 0.15^{cd}	0.73 ± 0.04^{a}	-2.52 ± 0.33^{d}
Rice	19.27 ± 1.93^{d}	0.09 ± 0.06^{f}	0.37 ± 0.03^{cd}	4.02 ± 0.73^{d}
Highland				
Porridge with sugar	23.5 ± 5.12^{d}	-0.09 ± 0.07^{f}	0.19 ± 0.05^{ef}	-0.19 ± 2.53^{d}
Porridge with salt	28.61 ± 0.39^{cd}	0.25 ± 0.08^{f}	0.28 ± 0.02^{de}	0.91 ± 1.90^{d}
Pumpkin leaves	187.51 ± 0.46^{a}	1.88 ± 0.21^{bc}	0.55 ± 0.01^{b}	634.27 ± 1.32^{a}
S/potato leaves	154.31 ± 0.28^{abc}	2.44 ± 0.12^{a}	0.27 ± 0.01^{de}	445.73 ± 82.00^{b}
Stiff porridge	25.81 ± 1.48^{d}	0.89 ± 0.11^{e}	0.26 ± 0.02^{de}	-0.77 ± 0.44^{d}
Beans	47.08 ± 2.07^{bcd}	1.78 ± 0.06^{c}	0.71 ± 0.03^{a}	4.78 ± 0.87^{d}
Rice	16.73 ± 0.84^{d}	0.34 ± 0.05^{f}	0.44 ± 0.004^{bc}	3.57 ± 0.13^{d}

Values followed by the same superscript letters within the column do not differ significantly at $p\leq0.05$ according to Tukey's Honestly Significant difference.

4.7 Food Consumed and Its Relation to RDA

Recommended dietary intake differs between nutrients and age of children. Percent contributed by each consumed foods on RDA of carbohydrate, fat, protein, calcium, iron, zinc and vitamin A in each age were calculated.

$$\%\text{ RDA contributed} = \frac{\%\text{nutrients (per 100g)}}{\text{RDA for each nutrient}} \times 100$$

4.7.1 Contribution of food intakes to RDA of macronutrients

The amount of nutrients in relation to recommended daily allowance (RDA) for protein, fat and carbohydrate (per 100g consumed) to child aged 6-59 months is shown in Table 12. Kidney bean contributes 32.3 percent of protein per 100g among all analysed foods. Sweet potato leaves contribute 19% of fat which mark the highest contribution and rice (100g) contributes 25.8% of carbohydrate.

Table 12: Foods content in relation to percent contribute on RDA of macronutrients

	Protein			Fat			Carbohydrate		
	Child age in months								
Foods	**6-12**	**13-36**	**37-59**	**6-12**	**13-36**	**37-59**	**6-12**	**13-36**	**37-59**
Lowland									
Porridge with sugar	23.6	21.6	14.8	0.6	0.6	0.6	12.5	8.5	8.5
Porridge with salt	21.9	20.1	13.7	3.2	3.2	3.2	7.1	5.2	5.2
Pumpkin leaves	23.9	21.9	15.0	3.8	3.8	3.8	5.5	4.0	4.0
S/potato leaves	23.9	21.8	14.9	19.0	19.0	19.0	6.2	4.5	4.5
Stiff porridge	29.0	26.5	18.2	0.8	0.8	0.8	25.4	18.6	18.6
Beans	28.7	26.2	17.9	2.6	2.6	2.6	11.6	8.6	8.6
Rice	26.5	24.2	16.6	3.2	3.2	3.2	22.5	16.4	16.4
Highland									
Porridge with sugar	23.8	21.8	14.9	0.6	0.6	0.6	8.8	6.4	6.4
Porridge with salt	22.1	20.2	13.8	3.2	3.2	3.3	6.6	4.8	4.8
Pumpkin leaves	25.3	23.2	15.8	3.9	3.9	4.1	7.0	5.1	5.1
S/potato leaves	23.4	21.4	14.6	6.6	6.6	6.9	4.3	3.1	3.1
Stiff porridge	27.2	24.9	17.1	0.9	0.9	1.0	22.2	16.2	16.2
Beans	32.3	29.5	20.2	7.8	7.8	8.1	19.1	13.9	13.9
Rice	26.6	24.4	16.7	8.0	8.0	8.2	25.8	18.8	18.8

4.7.2 Food analysis and their contribution to RDA of calcium and iron

Percentage contributed by analysed foods on RDA of calcium and iron on children aged 6-59 months is show in Table 13. Food samples collected from the lowland and highland areas which were mostly consumed by children are able to contribute 2.1 to 69.4% on RDA for calcium on children aged 6-59 months where the highest percentage is contributed by pumpkin leaves (per 100g). Sweet potato leaves (100g) contributes up to 34.9% on RDA of iron to children.

Table 13: Analysed food in relation to percent contributes on RDA for calcium and iron

	Calcium			Iron		
	Child age in months					
Foods	**6-12**	**13-36**	**37-59**	**6-12**	**13-36**	**37-59**
Lowland						
Porridge with sugar	11.2	4.3	3.0	-1.3	-2.0	-1.4
Porridge with salt	50.0	19.3	13.5	18.1	28.4	19.9
Pumpkin leaves	49.8	19.2	13.4	11.3	17.7	12.4
S/potato leaves	64.3	24.8	17.4	21.1	33.1	23.2
Stiff porridge	8.8	3.4	2.4	1.6	2.6	1.8
Beans	21.9	8.5	5.9	13.6	21.4	15.0
Rice	7.1	2.8	1.9	0.8	1.3	0.9
Highland						
Porridge with sugar	8.7	3.4	2.4	-0.8	-1.3	-0.9
Porridge with salt	10.6	4.1	2.9	2.3	3.6	2.5
Pumpkin leaves	69.4	26.8	18.8	17.1	26.9	18.8
S/potato leaves	57.2	22.0	15.4	22.2	34.9	24.4
Stiff porridge	9.6	3.7	2.6	8.1	12.7	8.9
Beans	17.4	6.7	4.7	16.2	25.4	17.8
Rice	6.2	2.4	1.7	3.1	4.9	3.4

4.7.3 Food analysis and their contribution to RDA of zinc and vitamin A

Percentage contributed by food on recommended daily allowance (RDA) of zinc and vitamin A to the children aged 6-59 months are shown in Table 14. Foods consumed by children in the lowland and highland areas (per 100g) contribute 1.8 to 24.3% on RDA of zinc where the highest percentage is contributed by beans. Pumpkin leaves and sweet potato leaves can contribute more than 100% on RDA for vitamin A if 100g are consumed by children aged 6-59 months.

Table 14: **Analysed foods content in relation to percent it's contribute on RDA for zinc and vitamin A**

	Zinc				Vitamin A	
			Child age in months			
Foods	**6-12**	**13-36**	**37-59**	**6-12**	**13-36**	**37-59**
Lowland						
Porridge with sugar	3	3	1.8	1.1	1.8	1.3
porridge with salt	23	23	13.8	0.4	0.7	0.5
pumpkin leaves	11.3	11.3	6.8	124.1	206.8	155.1
S/potato leaves	12.3	12.3	7.4	36.5	60.9	45.7
Stiff porridge	6.0	6.0	3.6	0.5	0.9	0.7
Beans	24.3	24.3	14.6	-0.5	-0.8	-0.6
Rice	12.3	12.3	7.4	0.8	1.3	1.0
Highland						
Porridge with sugar	6.3	6.3	3.8	0.0	-0.1	0.0
Porridge with salt	9.3	9.3	5.6	0.2	0.3	0.2
pumpkin leaves	18.3	18.3	11.0	126.9	211.4	158.6
s/potato leaves	9.0	9.0	5.4	89.1	148.6	111.4
Stiff porridge	8.7	8.7	5.2	-0.2	-0.3	-0.2
Beans	23.7	23.7	14.2	1.0	1.6	1.2
Rice	14.7	14.7	8.8	0.7	1.2	0.9

4.8 Determinants of Undernutrition

4.8.1 Determinants of underweight

Table 15 shows crude and adjusted odds ratio for determinants for underweight. Areas of residence, children age and children birth weight were significant determinants for underweight. Children who live in the highlands area were twice more likely to be underweight (OR 2.17, 95% CI: 1.20-3.91) compared to children in the lowland area. Children aged 36-59 months were twice likely to be underweight (OR 2.14, 95% CI: 1.04-4.39) compared to younger children (6-23 months). Children with low birth weight (<2.5 kg) were three times likely to be underweight (OR 2.95, 95% CI: 1.37-6.34) compared to those with normal birth weight (≥2.5 kg). Other factors such as marital status, mother's occupation, maternal age, sex of head of household, major source of income, sex of children, parity, birth interval, household source of fuel, dietary diversity and types of latrines used by household members did not show a significant association with underweight. Adjusted OR with all factors mentioned above increase the risk for underweight in highland area from OR 2.17, 95% CI: 1.20-3.91to AOR 4.21, 95% CI: 1.62-10.9 and remained a significant determinant for underweight. Also children's age and child birth weights were significant determinants for underweight with AOR 5.85, 95% CI: 1.81-18.97 and AOR, 4.98 95% CI: 1.65-15.05 respectively.

Table 15: Crude and adjusted odds ratio for underweight in lowland and highland (reference is lowland

Variable	Underweight n	Underweight %	Normal n	Normal %	Crude OR (CI)	Adjusted OR (CI)
WAZ						
Location						
Lowland	23	11.5	177	88.5	1	
Highland	31	22	110	78	2.17(1.20-3.91)**	4.21(1.62-10.91)**
Marital status						
Single	9	14.8	52	85.2	1	
Married	45	16.1	235	83.9	1.11(0.51-2.40)	2.48(0.60-10.21)
Education level						
informal	11	18	50	82	1.69(0.43-6.63)	1.20(0.08-17.37)
Primary	40	15.7	214	84.3	1.43(0.41-5.00)	0.72(0.26-2.02)
Secondary	3	11.3	23	88.5	1	
Mother' occupation						
Farmer	53	17	259	83	2.25(0.29-17.81)	NS
Employed	0	0	5	100	NS	NS
Housewife	0	0	12	100	NS	NS
Business	1	8.3	11	91.7	1	
Age of mother						
14-24	24	21.2	89	78.8	1.39(0.64-3.07)	1.01(0.20-5.06)
25-34	19	11.9	141	88.1	0.69(0.31-1.56)	0.29(0.08-1.06)
35-70	11	16.2	57	83.8	1	
Source of income						
Salary/wage	0	0	9	100	NS	NS
Agriculture	30	17	146	83	1.02(0.56-1.85)	1.09(0.46-2.57)
Business	1	5.3	18	94.7	0.28(0.04-2.17)	NS
Casual labour	23	16.8	114	83.2	1	
Sex of HH						
Male	44	15.5	240	84.5	1	NS
Female	10	17.5	47	82.5	1.16(0.55-2.47)	
Sex of child						
Boys	30	17.2	144	82.8	1.24(0.69-2.23)	1.56(0.67-3.65)
Girls	24	14.4	143	85.6	1	
Child age						
6-23 months	13	11.4	101	88.6	1	
25-35 months	14	13.7	88	86.3	1.24(0.55-2.77)	1.99(0.54-7.41)
36-59 months	27	21.6	98	78.4	2.14(1.04-4.39)*	5.85(1.81-18-97)*
Parity						
1-2	27	17.3	129	82.7	1.03(0.46-2.28)	0.91(0.16-5.01)
3-4	17	13.5	109	86.5	0.76(0.33-1.79)	1.19(0.33-4.31)
5+	10	16.9	49	83.1	1	
Birth interval						
<2	4	30.8	9	69.2	3.19(0.74-13.65)	1.79(0.24-13.30)
2-3	31	14.7	180	85.3	1.23(0.48-3.15)	1.22(0.32-4.72)
>3	6	12.2	43	87.8	1	
Birth weight						
<2.5	12	31.6	26	68.4	2.95(1.37-6.34)**	4.98(1.65-15.05)**
≥2.5	38	13.5	243	86.5	1	
Fuel used						
Firewood	48	16.2	248	83.8	1.26(0.51-3.14)	1.28(0.05-30.68)
Charcoal	6	13.3	39	86.7	1	
Access firewood						
Bought	3	16.7	15	83.3	1.05(0.29-3.77)	8.36(0.33-212.68)
Collected	47	16.0	247	84.0	1	
Dietary diversity						
<4food group	10	16.7	50	83.3	1.08(0.51-2.28)	2.28(0.76-6.78)
≥4food group	44	15.7	237	84.3	1	
Type latrine						
Water/flush	2	10.5	17	89.5	1	
Pit latrine	52	16.2	269	83.8	1.64(0.37-7.33)	0.46(0.05-4.15)
No latrine					NS	NS

*significant at $p<0.05$
**significant at $p< 0.01$
NS- Not significant

Table 16 shows crude and adjusted odd ratio for determinants for stunting. Area of residence, maternal marital status and sex of head of household were significant determinants for stunting. Children who lived in the highland area were twice more likely to be stunted (OR 2.62, 95% CI: 1.68-4.09) compared to those in the lowland area. Children living with single parent had increased risk of being stunted (OR 2.11, 95% CI: 1.18-3.75). Also children living in female headed household had increased risk of being stunted (OR 2.01, 95% CI: 1.11-3.64) compared to those in male headed household. Stunting was not significantly associated with maternal education level, maternal occupation, and maternal age, major source of income sex of child, parity, birth interval, and children birth weight, source of cooking fuel, dietary score and type of latrine used by household though all those factors increased the risk of stunting. Adjusted odd ratio with all mentioned factors above, area of residence was significant determinant for stunting where children had increased risk of being stunted (AOR, 2.77 95% CI: 1.43-5.36). Maternal age also was a significant determinant for stunting where children whose mothers had 25-34 years had reduced risk of being stunted (AOR, 0.33 95% CI: 0.14-0.79). Also boys had increased risk of being stunted (AOR, 1.89 95% CI: 1.03-3.50) compared to girls and children with low birth weight were three times more likely to be stunted (AOR, 3.29 95% CI: 1.21-8.97) compared to those with normal birth weight.

Table 16: Crude and adjusted odds ratios for stunting in lowland and highland (reference is lowland)

Variable	Stunting n	%	Normal n	%	Crude OR (CI)	Adjusted OR (CI)
Areas						
Lowland	82	41.0	118	59	1	1
Highland	91	64.5	50	35.5	2.62(1.68-4.08)***	2.77(1.43-5.36)**
Marital status						
Single	40	65.6	21	34.4	2.11(1.18-3.75)**	1.84(0.79-4.28)
Married	133	47.5	147	52.5	1	
Education level						1
informal	33	54.1	28	45.9	1.61(0.64-4.06)	3.64(0.49-27.17)
Primary	129	50.8	125	49.2	1.41(0.62-3.17)	3.19(0.46-22.02)
Secondary/Univ	11	42.3	15	57.7	1	NS
Mother occupation						
Farmer	164	52.6	148	47.4	1.11(0.35-3.51)	NS
Employed	1	20	4	80	0.25(0.02-2.95)	0.19(0.19-1.96)
Housewife	2	16.7	10	83.3	0.20(0.03-1.33)	NS
Business	6	50	6	50	1	
Age of mother						1
14-24	74	65.5	39	34.5	1.69(0.91-3.12)	1.58(0.49-5.09)
25-34	63	39.4	97	60.6	0.58(0.33-1.02)	0.33(0.14-0.79)*
35-70	36	52.9	32	47.1	1	
Source of income						
Salary/wage	3	33.3	6	66.7	1	1
Agriculture	85	48.3	91	51.7	1.87(0.45-7.71)	NS
Business	7	36.8	12	63.1	1.17(0.22-6.19)	NS
Casual labour	78	56.9	59	43.1	2.64(0.64-11.01)	NS
Sex of HH						
Male	136	47.9	148	52.1	1	
Female	37	64.9	20	35	2.01(1.11-3.64)*	
Sex of child						
Boys	97	55.7	77	44.3	1.51(0.98-2.31)	1.89(1.03-3.50)*
Girls	76	45.5	91	54.5	1	1
Parity						
1-2	85	54.5	71	45.5	1.08(0.6-2.0)	0.94(0.29-2.98)
3-4	57	45.2	69	54.8	0.75(0.4-1.9)	0.97(0.39-2.42)
5+	31	52.5	28	47.5	1	1
Birth interval						
<2	7	53.8	6	46.2	1.69(0.5-5.8)	0.49(0.10-2.47)
2-3	104	49.3	107	50.7	1.41(0.8-2.6)	0.77(0.31-1.92)
>3	20	40.8	29	59.2	1	1
Birth weight						
<2.5	21	55.3	17	44.7	1.24(0.6-2.5)	3.29(1.21-8.97)**
≥2.5	140	49.8	141	50.2	1	1
Fuel used						
Firewood	155	52.4	141	47.6	1.65(0.9-3.1)	5.15(0.43-61-96)
Charcoal	18	40.9	27	60	1	1
Access firewood						
Bought	5	27.8	13	72.2	1	1
Collected	154	52.4	140	47.6	2.86(1.0-8.2)	0.40(0.04-3.84)
Dietary diversity						
<4food group	31	51.7	29	48.3	1.05(0.6-1.8)	1.82(0.79-4.14)
≥4food group	142	50.5	139	49.5	1	
Type latrine						
Water/flush	7	36.8	12	63.2	1	1
Pit latrine	166	51.7	155	48.3	1.8(0.7-4.8)	0.56(0.13-2.44
No latrine	0	0	1	100	NS	NS

NS- not significant
***significant at $p< 0.001$
**significant at $p<0.01$
*significant at $p<0.05$

4.8.2 Determinant for stunting in lowland and highland areas

Determinants for stunting by area of residence are shown in Table 17. Determinants for stunting in the lowland and highland areas differed and risk ratios also differed. Many determinants were significant in the lowland areas. Significant determinants for stunting in the lowland area were marital status, sex of head of household, child age and maternal age. Children living with single parent (mother only) were two times more stunted (OR 2.61, 95% CI: 1.212-5.602) compared to those in married mothers. Children living in female headed household were more stunted (OR 2. 27, 95% CI: 1.04-4.95) compared to those living in male headed household. Children between the age of 6-23 and 24-35 months were more stunted compared to older (aged 36-59 months) children with OR 2.08, 95% CI: 1.05-4.15 and OR 2.14, 95% CI: 1.06-4.32 respectively. Children whose mothers were at the age of 25-34 years had reduced risk of being stunted (OR 0.37, 95% CI: 0.19-0.74) compared to children whose mothers were at the age of 14-24 years.

In the highland area significant determinant for stunting was only maternal age; children whose mothers were between the age of 25-34 years had a reduced risk of being stunted with OR 0.35, 95% CI: 0.16-0.76 compared to children whose mothers were between the age of 14-24 years.

Table 17: Determinant for stunting in lowland and highland

Variable	Lowland OR(CI)	Highland OR(CI)
Marital status		
Single	2.61(1.21-5.60)*	1.48(0.59-3.60)
Married	1	1
Education level		
Informal	4.00(0.41-39.37)	1
Primary	2.68(0.29-24.59)	1.26(0.52-3.08)
Secondary	2.00(0.16-24.32)	1.33(0.27-6.61)
University	1	
Mother occupation		
Farmer	1.15(0.31-4.21)	1
Employed	0.38(0.31-4.71)	NS
Housewife	0.30(0.04-2.17	1.49(0.74-2.99)
Business	1	
Age of mother		
14-24	1	1
25-34	0.37(0.19-0.74)*	0.35(0.16-0.76)*
35-70	0.62(0.28-1.36)	0.87(0.29-2.65)
Sex of HH		
Male	1	1
Female	2.27(1.04-4.95)*	1.62(0.63-4.17)
Sex of child		
Boys	1.73(0.98-3.07)	1.48(0.74-2.96)
Girls	1	1
Child age		
6-23	2.08(1.05-4.15)*	1
24-35	2.14(1.06-4.32)*	0.72(0.31-1.67)
36-59	1	1.03(0.44-2.41)
Parity		
1-2	1	1.28(0.52-3.15)
3-4	0.69(0.37-1.29)	2.21(0.89-5.50)
5+	1.31(0.56-3.04)	1
Birth interval		
<2	1.07(0.22-5.17)	2.66(0.21-33.49)
2-3	1.05(0.49-2.24)	1.14(0.30-4.29)
>3	1	1
Birth weight		
<2.5	1	2.47(0.77-7.88)
≥2.5	2.33(0.73-7.42)	1
Fuel used		
Firewood	1.22(0.61-2.45)	NS
Charcoal	1	
Access firewood		
Bought	1	
Collected	1.88(0.64-5.53	NS
Dietary diversity		
<4food group	1.07(0.50-2.29)	1
≥4food group	1	1.09(0.46-2.59)
Type latrine		
Water/flush	1	
Pit latrine	1.45(0.52-4.03)	NS
No latrine		
Child sick past weeks		
No	1	1
Yes	0.87(0.48-1.57)	1.51(0.76-3.02)

NS- Not significant
*significant at $p<0.05$

4.9 Nutritional Status of Children

Prevalence of underweight, stunting and wasting of the children is shown in Table 18. About 15.8% of children were underweight where 2.6% were severely underweight. Half of the children were stunted (50.7%) where 19.9% were severely stunted. Overall wasting was 2.1% and only 0.9% was severely wasted. Underweight in lowland was 11.5% whereby 10% were moderately underweight and 1.5% was severely underweight. In highland area 22% of the children were underweight in which 17.7% were moderately underweight and 4.3% were severely underweight. In terms of height-for-age (HAZ), 59 and 35% of the children had normal nutritional status in the lowland and highland areas respectively. Severe stunting was twice as much (29.1%) in the highland area as compared to lowland area (13.5%). Majority of the children (97.5 and 98.6%) had normal nutritional status in terms of weight-for-height in lowland and highland areas respectively. Prevalence of wasting was slightly higher in the lowland area compared to highland area in terms of moderate and severe wasting (1 and 1.5%) and (0.7 and 0.7%) respectively.

Table 18**: Nutritional status of children in the lowland and highland areas**

Nutritional status	**Location**					
	Lowland		**Highland**		**Overall Prevalence n (%)**	
	n	**%**	**n**	**%**	**n**	**%**
Weight-for-Age (WAZ)						
overall underweight	23	11.5	31	22	53	15.8
Severe underweight	3	1.5	6	4.3	9	2.6
Moderate underweight	20	10	25	17.7	45	13.2
Normal	177	88.5	110	78	287	84.2
Total	**200**	**100**	**141**	**100**	**341**	**100**
Height-for-Age (HAZ)						
Overall stunting	82	41	91	64.6	173	50.7
Severe stunting	27	13.5	41	29.1	68	19.9
Moderate stunting	55	27.5	50	35.5	105	30.8
Normal	118	59	50	35.5	168	49.3
Total	**200**	**100**	**141**	**100**	**341**	**100**
Weight-for-Height (WHZ)						
Overall wasting	5	2.5	2	1.4	7	2.1
Severe wasting	3	1.5	1	0.7	4	1.2
Moderate wasting	2	1	1	0.7	3	0.9
Normal	195	97.5	139	98.6	334	97.9
Total	**200**	**100**	**141**	**100**	**341**	**100**

4.10 Nutritional Status Based on Sex of Children

The results on nutritional status of children by sex are shown in Table 19. The findings show that in the lowland area boys were more underweight (12.3%) compared to girls (7.4%). Similarly, in the highland area boys were more underweight where 19.1% were moderately underweight compared to girls (16.4%). Boys were more stunted where 16.1 and 31.1% were severely and moderately stunted compared to girls 10.6 and 23.4% respectively in the lowland area. Similarly, boys in the highland area were more stunted where 33.8% were severely stunted compared to 24.7% of girls.

Table 19: Nutritional status based on sex of the child

Nutritional status	Sex of children					
	Boys (N=106)		Girls (N=94)		Total (N=200)	
	n	%	n	%	n	%
Lowland						
Weight-for-age (WAZ)						
Severe underweight	1	0.9	2	2.1	3	1.5
Moderate underweight	13	12.3	7	7.4	20	10
Normal	92	86.8	85	90.4	177	88.5
Total	**106**	**100**	**94**	**100**	**200**	**100**
Height-for-age (HAZ)						
Severe stunting	17	16.1	10	10.6	27	13.5
Moderate stunting	33	31.1	22	23.4	55	27.5
Normal	56	52.8	62	66	118	59
Total	**106**	**100**	**94**	**100**	**200**	**100**
Weight-for-height (WHZ)						
Severe wasting	1	0.9	2	2.1	3	1.5
Moderate wasting	2	1.9	0	0	2	1
Normal	103	97.2	92	97.9	195	97.5
Total	**106**	**100**	**94**	**100**	**200**	**100**
Highland	**Boys (N=68)**		**Girls (N=73)**		**Total (N=141)**	
Weight-for-age (WAZ)						
Severe underweight	3	4.4	3	4.1	6	4.3
Moderate underweight	13	19.1	12	16.4	25	17.7
Normal	52	76.5	58	79.5	110	78
Total	**68**	**100**	**73**	**100**	**141**	**100**
Height-for-age (HAZ)						
Severe stunting	23	33.8	18	24.7	41	29
Moderate stunting	24	35.3	26	35.6	50	35.5
Normal	21	30.9	29	39.7	50	35.5
Total	**68**	**100**	**73**	**100**	**141**	**100**
Weight-for-height (WHZ)						
Severe wasting	1	1.5	0	0	1	0.7
Moderate wasting	0	0	1	1.4	1	0.7
Normal	67	98.5	72	98.6	139	98.6
Total	**68**	**100**	**73**	**100**	**141**	**100**

4.11 Nutritional Status of Children by Age

Results of nutritional status by age of children in the lowland and highland areas are shown in Table 20. Ages of children were categorized in three groups: 6-23 months, 24-35 months and 36-59 months of age. Prevalence based on weight-for-age z-score, height-for-age z-score and weight-for-height z-score in each age group were analysed and the following results were obtained:

Older children (36-59 months) were more underweight (15.2%) compared to younger children (6-23 months) (7.9%) in the lowland area. Similar results were observed in the highland area where older children aged 36-59 months were more underweight (28.3%) compared to younger children (11.8%) in terms of moderate underweight. In the lowland area children at age range between 24- 35months were more stunted where 20.7 and 27.6% were severely and moderately stunted respectively while in the highland area older children (35-59 months) where 23.9 and 43.5% were severely and moderately stunted respectively.

Table 20: Nutritional status of children by age

	Age of children in months					
	6-23 (N=63)		24-35 (N=58)		36-59 (N=79)	
Nutritional status	**n**	**%**	**n**	**%**	**n**	**%**
Lowland area						
Weight-for-age (waz)						
Severe underweight	0	0	2	3.4	1	1.3
Moderate underweight	5	7.9	3	5.2	12	15.2
Normal	58	92.1	53	91.4	66	83.5
Total	**63**	**100**	**58**	**100**	**79**	**100**
Height-for-age (haz)						
Severe stunting	8	12.7	12	20.7	7	8.9
Moderate stunting	22	34.9	16	27.6	17	21.5
Normal	33	52.4	30	51.7	55	69.6
Total	**63**	**100**	**58**	**100**	**79**	**100**
Weight-for-height (whz)						
Severe wasting	1	1.6	1	1.7	1	1.3
Moderate wasting	1	1.6	0	0	1	1.3
Normal	61	96.8	57	98.3	77	97.4
Total	**63**	**100**	**58**	**100**	**79**	**100**
Highland area						
Weight-for-age (waz)						
Severe underweight	2	3.9	3	6.8	1	2.1
Moderate underweight	6	11.8	6	13.6	13	28.3
Normal	43	84.3	35	79.6	32	69.6
Total	**51**	**100**	**44**	**100**	**46**	**100**
Height-for-age (haz)						
Severe stunting	15	29.4	15	34.1	11	23.9
Moderate stunting	19	37.3	11	25	20	43.5
Normal	17	33.3	18	40.9	15	32.6
Total	**51**	**100**	**44**	**100**	**46**	**100**
Weight-for-height (whz)						
Severe wasting	1	2	0	0	0	0
Moderate wasting	0	0	0	0	1	2.2
Normal	50	98	44	100	45	97.8
Total	**51**	**100**	**44**	**100**	**46**	**100**

4.12 Comparison of Nutritional Status in Lowland and Highland (Independent t test)

Comparison on nutritional status of children by area of residence and sex are shown in Table 21. There was a significant difference in nutritional status between children in lowland and highland on weight-for-age and height-for-age indices (p=0.000), but there was no significant difference in nutritional status between boys and girls in lowland and highland areas.

Table 21: Comparison of nutritional status of children by location and sex

	Mean	SD	t	p	CI
WAZ					
Lowland (N=200)	-0.76	1.03	4.34	0.000***	0.27-0.72
Highland (N=141)	-1.25	1.01			
HAZ					
Lowland	-1.58	1.49	5.49	0.000***	0.55-1.16
Highland	-2.44	1.29			
WHZ					
Lowland	0.16	1.19	0.11	0.91	-0.24-0.26
Highland	0.14	1.09			
WAZ					
Male (N=174)	-1.07	0.99	-1.91	0.57	-0.44-0.006
Female (N=167)	-0.85	1.1			
HAZ					
Male	-2.06	1.44	-1.56	0.12	-0.56-0.06
Female	-1.81	1.51			
WHZ					
Male	0.07	1.18	-1.31	0.19	-0.41-0.81
Female	0.23	1.12			

*****significant at $p<0.001$**

CHAPTER FIVE

5.0 DISCUSSION

This chapter presents discussion on children nutritional status (underweight, stunting and wasting), determinants of undernutrition (underweight and stunting), dietary intake and nutrient content in foods consumed by children in lowland and highland areas.

5.1 Dietary Intake

Macronutrients and micronutrients are required for adequate growth among children. Majority of children did not meet some recommended macronutrient and micronutrient intake in both lowland and highland areas. As recommended by WHO, infant and young child feeding (IYCF) practices, majority of children were breastfed in both lowland and highland areas where 74.4 and 66.2% were exclusively breastfed for six months in lowland and highland areas respectively. Exclusive breastfeeding rate increased in Tanzania from 41% in 2004-05, 50% in 2010 to 59% in 2015 (TDHS-MIS, 2015-16). In lowland most children were breastfed within the first hour after births while in highland were breastfeed after one hour but in both areas children were breastfed on demand.

More than half of children were introduced to complementary food at the age of 6 months in the lowland and highland areas and continued to be breastfed up to the age of 2 years. Though majority introduced complementary food at the right time still the food introduced was not nutritious and did not meet bodily needs for metabolic activities as a result undernutrition remains a big problem. Generally grains, roots and tubers were the popular consumed food group in both lowland and highland areas, followed by legumes and nuts and green vegetable. This could be due to the fact that the interviewed population engaged in agriculture where grains (maize and rice), legumes (beans and cowpeas) and different green vegetable are grown. Also due to poverty many households cannot afford to buy other foods that they do not produce.

Nearly, all the infants failed to meet RDA for almost all nutrients except dietary energy. The reason could be that most of the infants were only fed maize flour porridge with sugar or salt and rice porridge which are poor sources of other nutrients such as protein and fat. Also intake of vitamin A rich food like eggs, fruits and yellow, red and green vegetable were limited in this age group of the children. This was proved by nutritional status in which young children (6-23 months) had high prevalence of stunting compared to older children.

Some of the children aged above one year met RDA for protein, carbohydrate and vitamin A. This group eats family food in which stiff porridge and rice are the good sources of carbohydrate. Kidney bean is a good source of protein and also vitamin came from sweet potato leaves, pumpkin leaves and amaranth. Similarly to infants, none in this group met RDA for calcium because foods rich in calcium like eggs and milk were rarely consumed. Egg and dairy products were least consumed and only 1.2 and 2.3% of the children studied consumed those foods. This can be due to availability or poor maternal nutritional education. This study concurs with a study conducted in Kenya, where it was confirmed that the diets of the children were predominantly based on starchy staples (Badake *et al.*, 2014). Also the similar results were reported in Tanzania that, there was limited inclusion of other nutrient-dense foods (e.g. legumes, beef, fish, sardines, vegetables) in the meals and only few infants consumed these foods (Kulwa *et al.*, 2015). WHO recommended that complementary foods need to be nutritionally adequate, safe, and properly fed in order to meet the young child’s energy and nutrient needs. WHO also reported the problems on complementary feeding are foods being too dilute, not fed often enough or in too small amounts, or replacing breast milk while being of an inferior quality (WHO, 2009).

Dietary diversity was a big problem in the interviewed areas where 80.6% failed to meet a minimum diversity of four or more food groups. Reason for this can be due to poor knowledge on nutrition. For example, the period of data collection was mango's season and almost all households had mango tree but the fruits are not given to children especially for those who are under two years and are not able to pick on their own. Only 12.3% of the children consumed fruits where intake in the lowland area was slightly higher compared to the highland area. Similar results were reported in Tanzania that although infants and young children are commonly given fruit and vegetables rich in vitamin A, their complementary foods are insufficiently diversified; in particular, consumption of animal foods, which are rich in essential micronutrients, especially vitamin A, iron and calcium, is not widespread even in the older age group (FAO, 2008).

5.2 Nutrient Content in the Food

Food consumed by children in the lowland and highland areas were taken for laboratory analysis for their nutrients content (fibre, crude protein, crude fat, carbohydrate, calcium, iron, zinc and vitamin A). The foods analysed included were maize flour porridge with sugar, maize flour porridge with salt, maize flour stiff porridge (ugali), rice, sweet potato leaves, pumpkin leaves and kidney beans.

Fibre content in the sampled foods ranged from 0.68 to 6.47 g /100g where the highest content was observed in sweet potato leaves from the highland and was significantly higher than in all food samples. The lowest content was observed in maize flour porridge with salt from the highland area but was not significantly different with that observed in maize flour porridge with sugar from lowland area. Comparing the lowland and highland, fibre content was only significantly different in sweet potato leaves where the highest amount was observed in sweet potato leaves from lowland. Fibre content in maize flour porridge with sugar, maize flour porridge with salt and rice from the lowland area and maize flour porridge with salt, kidney beans and rice from highland area were quite the same with that in the Tanzania Food Composition Table (Lukmanji *et al*., 2008). Fibre content in pumpkin leaves, sweet potato leaves and kidney beans from lowland area and maize flour porridge with sugar, pumpkin leaves and sweet potato leaves from highland had higher amount compared to value in the Tanzania Food Composition Table (Lukmanji *et al*., 2008).

Protein content in the food ranged from 2.61 to 3.8 g /100g where the highest amount was observed in kidney beans. Crude protein in beans was significantly higher in all foods except maize flour stiff porridge. Crude protein was significantly higher in kidney beans from the highland area compared to that from lowland areas. This difference could be due to ingredients added where kidney beans from the lowland area were cooked with coconut milk and onion while that from the highland area were cooked with oil and onion. The amount of protein observed in kidney beans cooked with oil was slightly lower compared to that reported by Tanzania Food Composition Table while protein in kidney beans cooked with coconut milk was slightly higher compared to that of Tanzania Food Composition Table (Lukmanji *et al*., 2008).

Highest amount of crude fat was observed in sweet potato leaves from the lowland area and the lowest was observed in maize flour porridge with sugar from the lowland area. A significant high amount of crude fat was observed in sweet potato leaves from the lowland area compared to that in the highland area. Though the cooking method of sweet potato leaves from the lowland and highland area was the same (stir frying), this difference in fat content may be due to amount of oil/fat added. Also kidney beans and rice from the highland area had a significant higher amount of crude fat compared to that from the lowland area. The kidney beans from highland area were relished with oil; this can be a contributing factor for kidney beans from the highland area to had higher fat compared to kidney beans from the lowland area which was relished with coconut milk only.

There was no significant difference observed in carbohydrate content in food samples from the lowland and highland areas. Compared to Tanzania Food Composition Table (Lukmanji *et al*., 2008), maize flour porridge with salt, pumpkin leaves and maize flour stiff porridge from the lowland area had approximately equal amount while that of maize flour porridge with sugar was half to that of Tanzania Food Composition Table (Lukmanji *et al*., 2008). Carbohydrate content in maize flour stiff porridge from the highland area was very low (8.32 g/100g) compared to value in the Tanzania Food Composition Table (22.7 g/100g) (Lukmanji *et al*., 2008). This could be due to different amount of sugar added.

Calcium ranged from 16.73 to187.51 mg/100g. Pumpkin leaves from the highland area had higher calcium compared to other foods. Sweet potato leaves and pumpkin leaves were good source of calcium in both lowland and highland areas. Calcium content in all food from the lowland and highland areas was higher compared to that reported in the Tanzania Food Composition Table (Lukmanji *et al*., 2008). This difference could be due to soil composition in where crops were grown and water used in cooking (Kulwa *et al.*, 2015). Although there was high calcium in dark green vegetable it was reported that its bioavailability is low due to presence of oxalates compared to animal sources

(FAO/WHO/UNU, 2002). There was no significant difference in calcium content in any food from the lowland and highland areas.

Iron content in the analysed foods ranged from 2.44 to -0.14 mg/100g in which the highest amount was observed in sweet potato leaves. Sweet potato leaves were a good source of iron in both lowland and highland areas. There was a significant difference in iron content in maize flour porridge with salt, pumpkin leaves and maize flour stiff porridge between the lowland and highland areas. Maize flour porridge with salt from the lowland area had higher amount compared to maize flour porridge from the highland while iron content in pumpkin leaves and maize flour stiff porridge from the highland area was significantly higher compared to that from the lowland area. Iron content in all food samples except in maize flour porridge with sugar and rice from the lowland and highland areas was slightly higher compared to that in the Tanzania Food Composition Table (Lukmanji *et al*., 2008).

High amount of zinc was observed in maize flour porridge with salt where maize flour porridge from the lowland area had higher amount compared to maize flour porridge from the highland area. Also pumpkin leaves from the highland area had higher zinc content compared to that from the lowland area. This difference may be contributed by the added ingredients in which pumpkin leaves in the lowland area were relished with oil, tomato and onion while in the highland area were relished with groundnut, tomato and onion. The zinc content in maize flour porridge with salt from the lowland was higher compared to that in the Tanzania Food Composition (Lukmanji *et al*., 2008), and was approximately the same in sweet potato leaves and kidney beans. Zinc content in maize flour porridge with sugar, pumpkin leaves, maize flour stiff porridge and in rice was lower compared to that in Tanzania Food Composition Table (Lukmanji *et al*., 2008). Despite high amount of iron, zinc and calcium which observed in the food consumed by children in the lowland and highland areas especially from vegetable it is recommended to take more than RDA because its bioavailability is low compared to animal sources (FAO/WHO/UNU, 2002).

Vitamin A was high in green vegetables where the highest amount was observed in pumpkin leaves. A significant difference in vitamin A content between the lowland and highland areas was observed in sweet potato leaves where the one from the highland area had higher amount compared to that from the lowland area. Vitamin A content in cooked pumpkin leaves were twice higher (634.27 µg/100g) compared to that in the Tanzania Food Composition Table (324.6 µg/100g) also was higher compared to raw pumpkin leaves (550 µg/100g). Vitamin A in a sweet potato leaves was lower compared to value in Tanzania Food Composition Table (Lukmanji *et al*., 2008).

Nutrient-dense foods such as beef, fish, sardines and milk were not sampled for analysis because few children consumed these foods and another reason was limited fund for carrying out the analysis. Low consumption of animal source foods has also been reported in Tanzania (Kulwa *et al.*, 2015) resulting in inadequate dietary intake and poor growth. Low consumption may be attributed to household food insecurity, poverty, or limited nutritional knowledge. Due to poor nutritional knowledge mothers feed their young children with plain maize flour porridge and rice porridge without any relish while green vegetable like pumpkin leaves, sweet potato leaves, amaranth and spinach are available. Pumpkin leaves and sweet potato leaves are good sources of vitamin A, calcium, iron and zinc. Pumpkin leaves contribute up to 69% on RDA for calcium, 24% for iron and 100% for vitamin A (per 100g of consumed food) . Similarly, sweet potato leaves contribute up to 100% on RDA for vitamin A, 64% for calcium and 34.9% for iron (per 100g of consumed food). If this green vegetable consumed in adequate amount every day can meet body requirement and improve child growth.

Protein is very important for child growth. Most of the households cannot access animal sources of protein due to high cost. This can be replaced with kidney beans which contribute up 32% on RDA for protein (per 100g food consumed). Also kidney beans contribute up to 24.3% on RDA for zinc. If education on nutrition is given to mothers and other household members on how to balance the use of all available local foods in preparing food for the children below five years will reduce the problem of undernutrition and improve nutritional status of children.

5.3 Determinants for Undernutrition

5.3.1 Determinants for underweight

Area of residence was significantly associated with underweight where children who live in the highlands were twice more likely to be underweight. People living in the highland area had poor health services, for example hospitals, health centre and dispensary all are available in the lowland area. Due to poverty, poor transport and long walking distance majority of the mothers cannot access health services. This contributes to large number of women who give birth at home and unable to visit postnatal clinic for child vaccination which leads to low immunity and increased risk for infection to children and results to underweight. Also soils in highland area are less fertile which lead to low agricultural production and affect their dietary intake (Owen and Gregory, 2000).

Child age also was significant determinant of underweight where older children (35-59 months) were more underweight compared to younger children (6-23 months). Underweight describes the current dietary intake; this can be explained by complementary food introduced to a child. Older children were stopped from breastfeeding and only depended on complementary foods to get all essential nutrients needed by body for health growth. This could be due to poor complementary food where the main complementary was staple (maize flour porridge with salt or sugar and maize flour stiff porridge) which are less nutritious. Animal foods such as milk, fish, meats and eggs were rarely eaten. Despite poor complementary also older children were fed less number of meals per day (two to three times per day) instead of four to five meals plus two healthy snacks as recommended; at the same time children at this age are at rapid growth and a lot of nutrients are required. This can be a contributing factor to high prevalence of underweight observed (WHO, 2009). Another reason could be that older children are engaged in active exercises such as running, jumping and playing football where a lot of calories are used compared to younger children. It is recommended that high quality complementary food should be provided from about the sixth month onward as a key component of good nutrition. If complementary foods are not introduced around the age of 6 months, or if they are given inadequately, an infant's growth may falter (TFNC, 2013).

Birth weight was also a significant determinant for underweight; children who were born with low birth weight (<2.5 kg) were three times more underweight compared to those born with normal birth weight (≥2.5 kg). The children with low birth weight are at a disadvantage in terms of physical growth and are also more vulnerable to infections compared to normal birth weight children and result into underweight. Underweight does not distinguish between acute malnutrition (wasting) and chronic malnutrition (stunting). Children can be underweight for their age because they are stunted, wasted or both. Also it is possible to speculate that environmental enteropathy is also compromising the utilization of nutrients in these children, contributing to the association between low birth weight and physical growth deficit. Similar results reported; low birth weight associated with undernutrition and has effect in adult life (Arifeen, 2000; Black *et al.*, 2013). Maternal health has high impact on child birth weight; mother with low BMI has high probability of having low birth weight child (NBS, 2010).

5.3.2 Determinants of stunting

Area of residence was one of the determinants of stunting: children living in highland area were twice more stunted compared to those who live in the lowland area. Stunting as a result of poor infant feeding might manifest later in life, since it is a chronic condition. The stunting recorded might not necessarily be associated with feeding, but could be due to disease and food insecurity. Food insecurity can be contributed by poor soil and lead to poor production. Other studies carried in Ecuador and Guatemala also reported area of residence was significant determinants of stunting (Katuli *et al*., 2012; USAID, 2014).

Marital status and sex of head of households were significantly associated with stunting. Children who live with single parent (mothers only) were twice more stunted compare to those who live with both parents (married mothers) and female headed household increased the risk for stunting. This could be due to multiple responsibility of the mother on reproduction, production, household chores and child care. Children depend on the mother only to get all basic needs such as nutritious food, clothes and care. Due to this reason, mothers are engaged in small income generating activities where they work for long time and cannot spare time to care for child timely. A study by Hallman *et al*. (2002) in Guatemala reported the similar results. Due to little earning and lack of support from child's fathers and other relatives, mothers cannot afford to buy nutritious food such as animal products (meat, milk, fish and eggs) for the children results to high rate of stunting observed (Gurmu and Etana, 2013).

The age of the mother was also a significant determinant of stunting; risk for stunting is reduced in children living with mothers aged 25 years and above compared to mothers aged less than 25 years. Mothers below 25 years are still in adolescent, a transition period between childhood and adulthood which is also the time of rapid growth and development, demanding extra energy and micronutrients. So the mother and the growing foetus compete for nutrients to support their rapid growth. This could have contributed to high rate of stunting observed as stunting starts during pregnancy (Rah *et al.*, 2008). Also most of the mothers with low age have no reliable and have no a source of income. This affects their dietary intake which leads to poor nutrition status and also affects unborn child nutrition status. A study conducted in Tanzania reported that children whose mothers had BMI <18.5 were more stunted (Chirande *et al.*, 2015).

Birth weight was a significant determinant of stunting; children with low birth weight were three times more stunted compared to those with normal birth weight. The link between low birth weight and child malnutrition could possibly be described by the increased vulnerability of children with low birth weight to infections, such as, diarrhoea and lower respiratory infections and the increased risk of complications including sleep apnea, jaundice, anaemia, chronic lung disorders, fatigue and loss of appetite compared to children with normal birth weights. Other studies reported high rate of undernutrition in children with low birth weights (Anand *et al*., 2003; Romero *et al*., 2012; Khanal *et al*., 2014; Rahman *et al*., 2016).

Another significant determinant for stunting was sex of children; boys were more stunted compared to girls. This could be due to bad believes that boys eat much compared to girls and are not fully satisfied by breastfeeding only so were given supplementary foods at earlier age (before six months) which increases the cases of diarrhoea and lead to stunting. Also could be explained by behavioural patterns employed by girls such as spending their time with their mothers in kitchen and eat a lot compared to boys who are hyperactive and spend their time outside their home and skip several meals. It was reported that 39% of children under age 6 months in Tanzania were given something other than exclusively breast milk (TDHS-MIS, 2015-16). This finding concurs with that of Chirande *et al.* (2015) who reported boys were more stunted compared to the girls in the rural central in Tanzania.

This study compared prevalence of undernutrition in lowland and highland areas. Stunting in the highland area was twice higher than in lowland area. Surprisingly, only maternal age was the significant determinant for stunting in the highland area while in the lowland area four determinants were significantly associated with stunting (marital status, sex of head of household, children age and maternal age). Despite many factors being significantly associated with stunting the prevalence was low compared to the highland area. This indicates that the area of residence affects more nutritional status of children below five years than other factors.

5.4 Nutrition status: Differences Between Highland and Lowland Areas

The overall prevalence of underweight was 15.8% with relatively high prevalence in the highland area compared to the lowland area. Being one of the rural districts, high prevalence of underweight observed could be contributed by food insecurity and poverty. Since underweight can be a result of short term inadequate intake, another reason could be the time the study was conducted which was a lean season. It was reported that nutrition status of children can vary according to seasons, with relative high prevalence of underweight in the lean season compared to harvest season (Roba *et al.*, 2016). Other studies conducted in other rural districts in Tanzania showed high prevalence of underweight (safari *et al*., 2015; Mgongo *et al*., 2017). The prevalence of underweight obtained in this study was similar to national average which was 16% (TDHS-MIS, 2015-16).

Based on World Health Organization (WHO) category, children were in the medium rates (10-19%) of underweight in the lowland area and high rates (20-29%) of underweight in the highland area. The results concur with a study conducted by Katuli *et al*. (2012) in Ecuador who found that highland area children were more underweight than their lowland area peers. High prevalence of underweight was observed in boys compared to girls though not significantly different. The reason could be that boys are more exposed in infections and diseases compared to girls because boys mature more slowly which results into delay in strengthening of their immunity. The level of underweight was higher to older children compared to younger children. This could be due to adequate nutrients that young children get from breast milk which is safe as a result young children become disease free (Gurmu and Etana, 2013).

The overall prevalence of stunting was 50.7% with high prevalence in the highland area compared to the lowland area. Stunting represents the long-term effects of malnutrition in a population and is not sensitive to recent, short term changes in dietary intake. High prevalence of stunting could be due to poor feeding practices which include delay in initiation of breastfeeding and poor exclusive breastfeeding practices. Delaying initiation of breast feeding deprives infant nutritional benefit of colostrum and impedes nutritional status. Inappropriate breastfeeding and delaying on initiation of breastfeeding was reported in Tanzania (Safari *et al*., 2015). According to TDHS-MIS (2015-16) 59% of children are exclusively breastfed in Tanzania. Another reason could be due to poverty and ignorance where most complementary foods provided to young children lacks essential nutrients for child growth where young children are always given porridge with sugar or salt only without even milk which is low in nutritional quality. Similar findings were reported by Kulwa *et al*. (2015) in the study conducted in rural central Tanzania.

Stunting levels observed in this study are above the WHO critical levels thresholds of 40 percent. The stunting rates especially in the highland area call for integrated response to reduce the prevalence and the resultant longer-term effect of stunting. The prevalence of stunting observed was higher compared to national average (34%) and Morogoro Region (33.4%) (TDHS-MIS, 2015-16). These results concur with those of UNICEF (2012) which reported that children in Hijja mountainous were more stunted compared to those in lowland area. Boys were more stunted compared to girls though not statistically significant ($p>0.05$), at the same time young children (6-23 months) were more stunted compared to older children (36-59 months). For children below the age of 2-3 years low height-for-age reflects a continuing process of failing to grow. Stunting usually results from prolonged inadequate intake of food as well as diseases making infants to have low height for their age. The problem can start even during pregnancy (WHO, 2009). The overall prevalence of wasting was 2.1%. Prevalence of wasting was high in the lowland area compared to the highland area; however the difference was not statistically significant. Wasting represents the failure to receive adequate nutrition in the period immediately preceding the survey and may be the result of inadequate food intake or a recent episode of illness causing loss of weight and the onset of malnutrition. According to WHO, wasting rates of less than 5 percent it is acceptable. Due to this reason wasting was not a significant problem in Kilosa District. The prevalence was lower than the regional average (6%) and national average 5% (TDHS-MIS, 2015-16). Low rates of wasting could also be explained by high rate of stunting. Since most children were shorter for their age, the weight for height showed that majority were normal.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The present study aimed to assess the dietary intake, nutrient content, determinants of undernutrition and its prevalence among children aged 6-59 months in the lowland and highland areas in Kilosa District. It observed that most complementary foods were cereal based and majority had poor dietary diversity (<4 food groups) hence inadequate intake of important micronutrients which are very crucial for child growth which leads to high prevalence of undernutrition (underweight and stunting). Moreover, there were some differences in nutrient composition in cooked foods given to children in lowland and highland areas specifically protein, fat, iron, zinc and vitamin A. However, in both areas, the foods contain important nutrients for child growth, if prepared and consumed properly may reduce the problem of undernutrition and improve nutritional status of the children in the two areas.

The determinants of stunting were different between the lowland and highland areas of Kilosa District where many determinants such as marital status, sex of household head, child age and maternal age were significant in the lowland area while only maternal age was significant in highland area. Maternal age was a significant determinant in both lowland and highland areas and risk for child undernutrition increase with decrease in maternal age. Living in the highlands of Kilosa is a predisposing factor to poor nutritional status (underweight and stunting) in these children. Stunting was the biggest problem which was above 40% which is very high according to WHO prevalence rate which indicates an emergency nutrition situation hence a need for emergency response.

6.2 Recommendations

i. From the findings, discussion and conclusion of this study the following are recommendations:

ii. Nutritional education based on proper complementary feeding (quality, frequency and time) should be emphasized to mothers in order to reduce the problem of undernutrition.

iii. In order to reduce the problem of low birth weight, the government and NGOs should provide education to women of child bearing age on the importance of having a healthy weight before conception.

iv. Government and NGOs should establish special programs and campaigns to combat teenage pregnancies because the prevalence of undernutrition decreases with increase in mother's age.

v. The facts that children from highland are more malnourished compared to lowland, the government and NGOs projects aiming to combat undernutrition should focus more on children living in highland area.

vi. The Ministry of Health, Community Development, Gender, Elderly and Children should establish the policies and programs which cut across sectors for integrated efforts to reduce levels of child malnutrition because of the diverse nature of the factors that impact child nutritional status specifically targeting children at their early ages.

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APPENDIX

Appendix 1: **Questionnaire for mother and child**

My name is **…………………** *(mention your name)* a Masters student from Sokoine University of Agriculture, pursuing M.Sc. in Human Nutrition. I am conducting a research on titled "Prevalence and determinants of undernutrition among 6-59 months children in Highland and Lowland in Kilosa District in Morogoro Region". Kindly, I request for your cooperation and assistance to make this work to be real. I assure you that all the information provided during this interview will be treated confidentially and be used for academic purpose only.

Section A Questionnaire for mother

Please give correct answer to the following questions

Name of Interviewee…………………………. Respondent no……..

Date…………….. Division …………… … Ward……………

Village…………………………………………………….

Information about the youngest child		
	Mothers recall	Recorded in the card
Date of birth		
Birth weight		

I. **Demographic Information**		
s/n	**Questions**	**Options**
1.	Age of the mother	………………….(years)
2.	Marital Status of mother	A. Single B. Married-monogamous C. Married -polygamous D. Widowed E. Divorced
3.	What is the highest level of education that you attained?	A. Informal education B. Primary education C. Secondary education D. University education
4.	Occupation of the mother	A. Farmer B. Employed C. Unemployed D. Business E. Others (specify)
5.	What is the major source of income for your family	A. Salary/wages B. Agriculture D. business E Casual labor F. Others (specify)

6.	Who is the head of household?	A. Male B. Female
	II. Food security	
7.	Do you engage in agriculture activities? (if no go no 15)	A. Yes B. No
8.	If yes, how many acres?	............................acres
9.	. What crops are you cultivate?	A. Food crops B. Cash crops C. Both
10.	Which food crops are you producing?	A. maize B. Beans C. Sunflower D. Rice E. Potatoes
11.	How many bags you produce per acre?	……………. bags
12.	How many bags you sold?	……………..bags
13.	How much did you get?	…………. Tshs
14.	How many bags you stored for food?	…………..bags
15.	If no where do you obtain your food	A. Bought B. Begging from friends and relatives C. Given by your relatives/your children D. Others specify
16.	Do you keep animals?	A. Yes B. No
17.	If yes what animas do you keep?	A. Cattle B. Goat C. Sheep D. Rabbit E. Chicken F. pig G. Others (specify)
18.	If you do keep animals do you take as food?	A. Yes B. No
19.	If yes how frequent you feed your baby animal sources food?	A. Every day B. Twice a week C. Four times a week D. Weekly E. Twice a month D. Monthly 7. Others (specify)
20.	Have you ever experienced food shortage in your household?	A. Yes B. No
21.	If yes how long do you experience food shortage?	A. One month B. two months C. Three months D. Four months E. Five months F. More than five months
22.	For what reasons do you experience food shortage	A. Low production B. Large number of dependent C. Low income and purchasing power D. Overselling of crops E. Others (specify)
	IV. Workload of mother.	
23.	Who helps you with the household work?	A. Older children B. Husband C. Housemaid D. Myself, E. Others (specify)
24.	What type of fuel do you use for cooking?	A. Firewood B. Charcoal C. Kerosene D. Electricity E. Gas F. other (specify)
25.	If firewood how do you get it?	A. It is bought B. It is collected

26.	If collected how far do you have to walk to collect it?	A. Less than 1 km. B. 1-2 km C. 3-4 km. D. More than 4 km.
27.		

	V. **Reproductive Health: Prenatal service**	
28.	Did you attend clinic during your last pregnant?	A. Yes B. No
29.	If yes, how many times? (*observe the clinic card if available*)	A. Once B. Twice C. Three times D. Four times E. More than four times
30.	If no, why?	A. long distance B. Wait service for long time C. No need D. Poor services E. No reason F. Others (specify)
31.	During your last pregnancy, were you given folic acid/iron tablets?	A. Yes B. No
32.	If yes, did you drink them?	A. Yes throughout the pregnancy B Yes, for sometime during pregnancy C. No
33.	If no why?	A. Nausea B. Vomiting C. Bad smell D. Not necessary E. Others (specify)
34.	Did you reduce your work load because of pregnancy	A. Yes B. No
35.	If yes why?	A. To rest B. Sick C. Advised D. Norm
36.	If no why?	A. No need B. No helper C. Obligation/responsibilities D. norm E. Others (specify)
37.	At what stage of pregnancy did you reduce your work load?	A. Entire period B. 1st trimester C. 2nd trimester D. 3rd trimester E. Never reduced workload
38.	Were you given special foods during pregnancy?	A. Yes B. No
39.	If yes, what is the type of food given?	A………………………………. B…………………………………
40.	During your last pregnancy, did a health officer/professional do the following at least once? i. Weighed you ii. Measured your blood pressure iii. Took urine sample iv. Take Blood sample v. Gave you malaria tablets vi. Tested for HIV vii. Counseled you on HIV and AIDS viii. Gave you Iron and Folic acid tablets	 i. A. Yes B. No C. Don't know ii. A. Yes B. No C. Don't know iii. A. Yes B. No C. Don't know iv. A. Yes B. No C. Don't know v. A. Yes B. No C. Don't know vi. A. Yes B. No C. Don't know vii. A. Yes B. No C. Don't know A. Yes B. No C. Don't know
41.	Place of giving birth of your young child	A. Hospital B. Dispensary C. Home D. Others (specify)
42.	Who assisted the delivery	A. Doctor B. Midwives

		C. Nurse D. traditional midwives E. Others (specify?
43.	Do you know about family planning?	A. Yes B. No
44.	Are you currently using any family planning method?	A. Yes B. No

45.	Which method are you using?	A. Calendar B. Pills C. Implants D. Intrauterine device (IUD): E. Male/female condoms F. Female sterilization G. Basal body temperature H. Emergency contraception (levonorgestrel I. Monthly injectables or combined injectable contraceptives J. Others (specify)
46.	How long normally you take between one child and another? (Child spacing)	A. one year B. Two years C. Three years D. More than three years
47.	Parity of mother	Alive; male ………… Female………. Dead; male ………. Female……….
48.	How old were you when you got your first pregnancy?	…………
Section B. Child Information **I. Feeding Practices**		
49.	Have you breastfeed your baby?	A. Yes B. No
50.	How soon did you start breast-feeding after delivery?	A. within one hour B. 1-6 hours C. After 6 -12 hours D. more than 12 hours E. I don't know
51.	Did you give your child anything soon after delivery rather than breast milk?	A. Yes B. No C. Does not know
52.	If yes, what was it?	A. Water (glucose) B. Infant formula C. Porridge/milk D. Does not know E. Other (specify)
53.	Are you currently breastfeeding	A. Yes 2. No
54.	If Yes, how many times do you breast-feed your baby during the day time?	A. Anytime she/he wants B. Once per day C. Twice per day D.Three times per day E. Four times per day F. Others (specify)
55.	If no, What are the reasons for not breastfeeding	A. baby refused to suckle B. No enough milk C. Illness of the mother D. Illness of the child E. The child is older than two yrs E. Other (specify)
56.	When did you start giving your child other	A. Within one month

	foods/water…	B. Two to three months C. Four to five months D. After six months

57.	If is less than six months (ask why?)	A. Not having enough milk B. Baby crying too much C. Baby refusing to breastfeed D. sore nipples E. Health problems F. Others (specify)
58.	How old was the baby when he/she stopped breast-feeding?	A. Less than 1 month B. 2 - 6 months C. 7 - 12 months D. 13 - 18 months E. 19 - 24 months F. Above 24 months.
59.	Why did you stopped to breast fed your baby?	A. Mother had to go away B. Mother was sick C. Baby was sick D. Baby was old enough E. No enough milk F. Pregnancy G. Others (specify)
60.	Do you continue breast-feeding your child when he/she is sick?	A. Yes B. No
61.	If no why?	A. She/he refuses to eat B. She/he will vomit C. She /he will become worse D. It is bad for the child E. It is bad for the mother F. Others (specify)
II. Complementary feeding		
62.	At what age you started to give food other than breast milk to your baby?	A. Less than a month B. 2-3 months C. 4-6 months D. 7-9 months E. Above 9 months
63.	What first food other than breast milk you gave your baby?	A. Cow’s milk B. Fruit juice C. Porridge D. Soup E. Water F. Others (specify)
64.	Who feeds the baby?	A. Myself B. Older children C. Housemaid D. Other (specify)
65.	What type of complementary foods do you give to your baby?	………………… …………………..
66.	How many times do you feed your baby per day?	A. Once per day B. Twice per day C. Three times per day D. Four times per day. E. More than four meals.
67.	Portion size for a single meal	A. Four table spoon B. ¼ of cup C. ½ a cup D. ¾ a cup E. 1 cup F. 1½ cup G. 2 cups H. Other (specify)

68.	Is the baby still breast feed?	A. Yes B. No
69.	Who is responsible in preparing food for a baby?	A. Mother B. Older children C. Housemaid D. Other (specify)

III. Infection and diseases		
70.	Was your child sick in the past two weeks	(A. Yes B. No)
71.	If Yes, what was your child suffer from?	A. Diarrhea B. Malaria C. Pneumonia D. fever E. Cold F. Others (specify)
72.	If your child was sick, where did you go to seek assistance?	A. Hospital/Dispensary B. Pharmacy C. Traditional healer D. Your parents E. Self-treatment based on traditional knowledge F. Other specify
73.	How do you feed your baby during illness?	A. I give more liquid food B. I give less liquid food C. More breast feed D. More solid food E. I give no food at all F. Others (specify)
IV. Reproduction and child health (RCH) clinic and immunization		
74.	Are you taking your baby to RCH clinic?	A. Yes B. No
75.	If no why	A. Staying far away from RCH clinic B. No time C. There is no need D. Others (specify)
76.	If Yes, Does baby have growth monitoring card? (*if Yes request to see the card*)	A. Yes B. No
77.	Has your child been immunized?	A. Yes B. No.
78.	If yes, what type of immunization? (read in growth monitoring card)	A. BCG date…………… B. Polio date………………. C. DPT date ……………….. D. Measles date ………………. E. Others (specify)
79.	If no, why not?	A. Not available B. Not necessary C. Staying far away from RCH D. I do not know E. Others (specify)
Section C. Environmental sanitation and personal hygiene		
80.	Which kind of latrine does your household have?	A. Flush toilet: Own flush toilet B. Shared flush toilet C. Pit toilet D. No latrine /Bush/Field E. Others (specify)
81.	What happens to your household waste product?	A. Throw away to the public waste dump B. Burned C. Throw away to household waste dump and later buried D. Throw away at household

		cemented box E. Throw away any where

82.	Where do you obtain your water for drinking, washing and bathing?	A. Household tap B. Public water supply C. River/Stream D. Rain water E. Dam/Lake F. Pond G. Well/Spring
83.	How far is it from home?	A. Less than one Km B. 1km C. 2 km D. More than 3km
84.	Are you treat water before drink?	A. Yes B. No
85.	If yes, how?	A. Boiling and filter B. Boiling C. Filter D. Use water guard E. Let it settle F. Other (specify)

Section D: 24 hours dietary recall for the child

86. Usual number of meals per day for your child…………………….

What did your child eat yesterday (from morning when she/he woke up until bed time?)

Time	Food	Ingredients	Amount consumed
Morning			
Mid morning			
Afternoon			
Mid afternoon			
Evening			

	Dietary Diversity Score for the child below five years (this may be done later in the evening before submission to supervisor)	
	From the foods reported in table…above, place 1 if there is any food consumed by the child/HH and zero if the foods in that particular group were not consumed.	Child
i.	Any food from cereals (eg. rice, wheat, stiff porridge, African donat, chapatti, bread, porridge)	
ii.	Any potatoes, yams, cassava, plantains, or any other foods Made from roots or tubers?	
iii.	Any vegetables	
iv.	Any fruits?	
v.	Any beef, pork, lamb, goat, rabbit, wild game, chicken, Duck, or other birds, liver, kidney, heart, or other organ Meats?	
vi.	Any eggs?	
vii.	Any fresh or dried fish or shellfish or sardines?	
viii.	Any foods made from beans, peas, lentils, or nuts?	
ix.	Any cheese, yogurt, milk or other milk products?	
x.	Any foods made with oil, fat, or butter?	
xi.	Any sugar or honey?	
xii.	Any other foods, such as condiments, coffee, tea?	

Section E: Anthropometric measurement

Age (months)……………..

Height (cm) ……………..

Weight (kg) ………………

MUAC (cm)…………………

THANK YOU VERY MUCH FOR YOUR GOOD COOPERATION