

**DIETARY ASSESSMENT AND NUTRITIONAL STATUS OF CHILDREN (6-23  
MONTHS) CONSUMING LOCAL FOOD RECIPES IN VIHIGA COUNTY, WESTERN  
KENYA**

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APPLIED HUMAN NUTRITION, DEPARTMENT OF FOOD SCIENCE, NUTRITION  
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## **DEDICATION**

It is with deepest gratitude and warmest affection that I dedicate this dissertation to my family who have been the greatest pillar of this work. My husband; Dr. Oscar Koech, Your love, support, faith and encouragement have been immeasurable. To my champion Brandon Kiprotich; you have been the driving force at every stage. Mummy has finally made it son!

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## **ABBREVIATIONS AND ACRONYMS**

BMI	Body Mass Index
CGIAR	Consultative Group on International Agricultural Research
CHWs	Community Health Workers
EBF	Exclusive Breastfeeding
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
GAIN	Global Alliance for Improved Nutrition
GAM	Global Acute Malnutrition
HFA	Height for Age
IYCF	Infant and Young Child Feeding
KDHS	Kenya Demographic and Health Survey
KNBS	Kenya National Bureau of Statistics
MAM	Moderate Acute Malnutrition
MUAC	Mid Upper Arm Circumference
PAHO	Pan America Health Organization
RDA	Recommended Daily Allowance
SAM	Severe Acute Malnutrition
SD	Standard Deviation
UNICEF	United Nations International Children's Fund
WB	World Bank
WFA	Weight for Age
WFH	Weight for Height
WFP	World Food Program
WHO	World Health Organization



## OPERATIONAL TERMS AND DEFINITIONS

**Dietary diversity:** This can be defined as the number of different foods or food groups consumed over a given reference period.

**Nutrient adequacy:** Is the comparison between the nutrient requirement and the intake of a certain individual or population.

**Under-nutrition:** Defined as a state of nutrition where the height for age Z scores (HAZ), Weight for Age Z score (WAZ) and Weight for Height Z score (WHZ) indices fall below -2 Z score.

**Nutrition status:** A measurement of the extent to which an individual's physiological needs for the nutrients are being met.

**Moderate Acute Malnutrition (MAM):** is identified by moderate wasting (WFH < -2 z-score and  $\geq$  -3 z-score for children under 5 years or MUAC < 125 mm and  $\geq$  115 mm for children 6-59 months).

**Severe Acute Malnutrition (SAM):** is identified by severe wasting (WFH < -3 z-score for children under 5 years or MUAC < 115 mm for children 6-59 months) or the presence of bilateral pitting edema.

**Global Acute Malnutrition (GAM):** is the prevalence of both MAM and SAM in a population.

**Complementary foods:** are defined as any solid or liquid foods with nutritional value other than breast milk, offered to breast-fed infants.

## GENERAL ABSTRACT

Complementary feeding still remains a challenge in Kenya today. Nutrient inadequacy is a key issue coupled with low diversity of foods used for preparation of complementary foods for children less than two years among other problems. Research on nutrition adequacy and diversity of local recipes used in preparation of complementary foods for children less than two years in Kenya is scarce. The objective of this study was to determine nutrient adequacy and nutrition status among children 6-59 months using local formulated recipes in Vihiga County, Western Kenya.

A cross sectional study was conducted on 341 households with children less than five years and their caregivers. A pretested semi-structured questionnaire was used to obtain information on socioeconomic and demographic characteristics of the study households. Also obtained were names and quantities of local ingredients used for preparation for foods for the children and individual dietary diversity questionnaire. Nutrition status of the children was entered and analyzed using (WHO Anthro 2005). Logistic regression was used to establish associations between socio-demographic variables and nutrition status of children. The level of significance was determined at  $p$  value  $< 0.05$ .

The average household size was  $5.54 \pm 2.24$  family members. The prevalence of wasting, stunting and underweight was 3.25%, 20.8% and 8 % respectively. The average dietary diversity scores for children were  $4.25 \pm 0.97$ . There were positive associations on mothers' educational level and stunting, mothers' educational level and dietary diversity, the number of children born to a mother also showed a positive association with stunting and wasting. These were determined at level of significance ( $p=0.034$ ;  $p=0.038$ ;  $p=0.059$ ), respectively. Number of children born to a

mother, mother's education level and marital status were found to be predictors for stunting for children ( $p < 0.05$ ).

Further analysis showed that most of the foods prepared in Vihiga identified Thiamine, Riboflavin, Calcium, Zinc, Iron and Niacin as nutrients not adequately met by the foods for the different age groups. After optimizing the diets using linear programming, all the nutrients were met.

This study found that there were diverse foods available in Vihiga County. But then, more focus needs to be drawn on proper food preparation and recipe combinations so as to conserve the nutrients in these foods. Hence more research needs to be done on the long term impact of the local food recipes on the nutrition status of the children. This will directly influence the nutrient and energy density of these foods. In addition, the mother's education level was seen to have a visible influence on the nutrition status of the children.

Nutrient adequacy of complementary foods locally available in Vihiga can be improved through integration of other ingredients especially in maize based porridges commonly fed to children less than two years.

**Keywords: Children, Vihiga, Local recipes, Nutrition status, Nutrient density, Stunting**

# CHAPTER ONE

## GENERAL INTRODUCTION

### 1.0 Background

Childhood malnutrition is still one of the key determinants of mortality in children in Kenya. About 26% of children under the age of five years are stunted (23.5% in Vihiga County), 11% are underweight (5.9% in Vihiga County) and 4% are wasted (2.6% in Vihiga County) (KDHS, 2014). Out of the children between 6-23 months, 21% consume an acceptable diet (KNBS, 2014). Other consequences are childhood infections, poor cognitive function and motor development (Nti *et al.*, 2014). Dewey, 2003 showed that the age bracket of below 2 years is the stage of growth faltering, micronutrient deficiencies, delayed milestones and common childhood illnesses. One of the major challenges to early exposure to malnutrition at the age of below two is stunting that occurred earlier in life which is impossible to reverse (Dewey, 2003).

The WHO/UNICEF Global Strategy for Infant and young child feeding emphasizes on total exclusive breastfeeding (EBF) from birth up to six months (WHO/UNICEF, 2003). This feeding has been documented to contribute much in control of diarrheal diseases in children (Wright *et al.*, 2016). It further documents on timely introduction of complementary foods when the child is at least six months of age. Complementary feeding is the period when a child transits from breastfeeding to introduction of weaning foods. This feeding is important and should contain all the nutritional constituents that allow healthy child growth (Motee *et al.*, 2013). Most commonly used food sources during complementary feeding are home-made and commercially available foods cereals, with most available as, ready-made in shops. This is also the stage when they are still developing body immunity (FAO, 2011). Furthermore, this is the period when the children experience optimal growth and development, hence good nutrition status is most crucial

at this growth stage. Therefore, safe, nutritious food supply and increased frequency of feeding becomes important for proper development of children at this developmental stage. Inappropriate complementary feeding has been seen to directly influence the occurrence of malnutrition in children under age of 2 years (Saaka *et al.*, 2016).

An estimate of around 6% of total mortalities in developing countries of children less than five years can be prevented by appropriate complementary feeding (Aemro, *et al.*, 2013), while a good dietary diversity and proper meal frequency play a key role in their nutrition status (Victor *et al.*, 2014; Roba *et al.*, 2016). Globally, under-nutrition is associated with 45% of all child mortality, where Africa has been documented to contribute to almost half (49.6%, 3.113 million) of the under 5 deaths worldwide in 2013 due to infectious diseases (Liu *et al.*, 2015).

The need to promote the utilization of biodiversity for enhanced food security in rural and urban areas has been an area of interest to many development partners. The main one being Bioversity international, which is an International research for development organization and a member of the Consultative Group on International Agricultural Research (CGIAR). The organization works to promote households incomes while improving food security by the sustainable exploitation of agricultural biodiversity to improve productivity. Among the important projects implemented by Bioversity international included; “Diagnostic study on Agro biodiversity and dietary diversity in Vihiga County Humid Tropic Systems CRP-Western Kenya.” This project was implemented with partners in Western Kenya, in the Humid Tropics. It was a CGIAR funded project on its third phase that aimed at supporting communities in developing and implementing their agricultural practices for nutrition interventions to improve dietary diversity. One of the project components was optimization of food recipes to improve

nutrition status of children in Vihiga County, Western Kenya, which was at the third phase of the main project. It entailed participatory intervention implementation.

### **1.1 Problem Statement**

There are many challenges facing complementary feeding of children in Kenya. There is nutrient inadequacy and low diversity of ingredients that are used for preparation of local food recipes for children less than five years. In addition, there is limited data on documented local recipes used for complementary feeding. Complementary feeding often begins too early or too late and the foods are often low in energy and micronutrients and in some instances are unsafe for children (GOK, 2007). Consequently, the children become malnourished and suffer many lifelong consequences. This is manifested in impaired developmental milestones and well-being of the children. Nutritional care and support is not well adhered to in regard of the different food types and feeding regimes. This shows the existence of poor feeding practices in many rural areas of western Kenya, which pose a danger to social and economic development (WHO, 2003).

There is insufficient information that gives the methods of tailoring recommendations on Infant and Young Child Feeding at the local context where many nutrition programmes are implemented (Locks *et al.*, 2015). A past study showed that less than a third of children aged between 6-23 months met the minimum criteria for dietary diversity, and only about half of the population studied received the least number of meals (Lutter *et al.*, 2011). This then shows how complementary feeding should be given more emphasis as far as nutrition status of children is concerned. In addition, effective health-sector-based nutrition interventions directed to childhood under-nutrition are available. This is offered to a small percentage of children who access health centers (Lutter *et al.*, 2011).

In Kenya, much focus in communities has been on intensification on the use of maize a staple food crop which has resulted to inadequate nutrient intake due to over dependence on starch-based diets during complementary feeding. Research has also shown that caregivers need skilled support to feed their children appropriately, by utilizing locally available biodiversity (WHO, 2016). The present study focuses on increasing dietary diversity of infant feeding using developed recipes based on locally available agricultural biodiversity to improve the nutrition status of children age between 6 to 23 months.

## **1.2 Justification**

The nutrient density of the diet given to young children is often insufficient to meet their nutrient requirements, and increasing the diversity of foods provided to young children, particularly meat, poultry, fish, eggs, fruits and vegetables, is recommended to improve micronutrient intakes (PAHO/WHO, 2003).

The declaration of world food summit (2009) emphasizes on intake of good nutritious foods that are available locally and improves on dietary diversity to prevent micronutrient and macronutrient deficiencies and other forms of malnutrition. Furthermore, nutrition and dietary diversity forms a platform for exploring more environmentally sustainable food systems. This study builds on the need shown in nutrition's important role during the initial growth and development of children, and the importance of proper feeding practices in achieving good health. This study was based on intuitive link between increasing the dietary diversity of children's diets and increased nutrient intake (Steyn *et. al.*, 2006). The study sought to provide information on nutrient adequacy and dietary diversity in children's diets. The information obtained will contribute to towards optimization of nutrients in various local foods too improve

the diet quality and diversity of children 6-23 months. Moreover, this information will aim at increasing the nutritional well-being of children, which will enhance growth and cognitive development and overall social development (WHO, 2003).

### **1.3 Aim of the study**

This study aimed at optimization of nutrients in various local foods to improve diet quality and diversity for children under the age of 2 years.

### **1.4 Purpose of the study**

The purpose of this study was to provide information on nutrient adequacy of local recipes used in Vihiga County and their contribution to nutrition and diet of children.

### **1.5 Study Objectives**

#### **1.5.1 Main Objective**

To determine nutrient adequacy of local food recipes and formulate nutritionally adequate foods and nutrition status among children 6-23 months.

#### **1.5.2 Specific Objectives**

1. To determine the socio-economic and demographic characteristics of the households in Vihiga County, Western Kenya.
2. To assess the nutrition status of children aged between 6-23 months consuming local foods in Vihiga County.
3. To generate the local food recipes based on nutritional adequacy and dietary diversity in diets of households in Vihiga County, Western Kenya.



4. To formulate nutritionally adequate complementary foods using linear programming model.

### **1.6 Study Hypotheses**

1. Socio-economic and demographic characteristics of the households in Vihiga County, determine the nutritional status of children aged 6-23 months
2. Local food recipes do not meet the nutritional requirements of children in Vihiga County.
3. Social economic and demographic factors do not determine the nutritional status of children in Vihiga County.
4. The nutritional status of children aged 6-23 months is influenced by individual dietary diversity in Vihiga County.

### **1.7 Assumptions**

1. The respondents will cooperate in giving the information required in the questionnaire.
2. There will be sufficient funds to carry out the study.

### **1.8 Benefits of the study**

1. The findings of this research may be used by the Vihiga county government to conduct nutrition education awareness campaigns and programs to emphasize on dietary diversification using the locally available food diversity.
2. Other researchers may use the information from the study as a source of baseline data for other surveys.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Malnutrition in developing countries

The term malnutrition can be used interchangeably to mean under-nutrition but it also refers to over-nutrition. Individuals become malnourished because the foods they consume are not able to meet their caloric requirements, while the proteins consumed are not adequate for growth and maintenance of their body tissues. In addition, Malnutrition could arise when one's body is unable to utilize foods consumed due to illness or an individual consumed excess food leading to over-nutrition (UNICEF, 2016)(a).

Under-nutrition is one of the causes of death in developing countries mostly affecting children. It is one of the major causes of death in children under five years in Asia and Africa (UNICEF 2016) (b). According to UNICEF-WHO-WB, (2015), the global trend in stunting prevalence declined between 1990 and 2014, from 39.6 per cent to 23.8 per cent. Overweight prevalence has been increasing for the past few years between 1990 and 2014 from 4.8 per cent to 6.1 per cent. In 2014, the percentage of children who were severely wasted was 2.4 per cent while the global figure for wasting was 7.5 per cent (UNICEF-WHO-WB, 2015).

Globally, 150 million children are stunted but the numbers are declining (UNICEF-WHO-WB, 2015). Surprisingly too, there are about 41 million overweight children in the world. Wasting still threatens the lives of many children across the world (UNICEF-WHO-WB, 2015). There exists very high prevalence of malnutrition in Sub-Saharan Africa, where one in six children is underweight and one in four children are stunted. For example, in Kenya, about 26% of children less than 5 years old are stunted, 11% are underweight and 4% are wasted (KDHS,

2014). These trends depict serious challenges of malnutrition as a major threat to households in developing countries in Africa.

## **2.2 Macronutrient Deficiency**

Protein Energy Malnutrition (PEM) is one of the common forms of malnutrition observed in children under 5 years. This is as a result of diets consumed being deficient in energy and protein sources as major macronutrients (carbohydrates, fats and proteins) (WFP, 2016). PEM predisposes children to various illnesses due to increasing exposure to disease conditions leading to deaths. This is mostly as a result of affected immune function of an individual (WHO, 2005). PEM is one of the key causes of secondary immunodeficiency in the world (Cunningham-Rundles *et al.*, 2004). Inadequate intake of Carbohydrates, Proteins, Fats or selected micronutrients, like zinc, selenium, iron, and Vitamins A, C and E have significant consequences on immune functions in children (Cunningham-Rundles *et al.*, 2005).

## **2.3 Micronutrient Deficiency**

Micronutrient malnutrition or in other words known as “hidden hunger” is one of the conditions found in populations that consume diets that are of poor-quality. The foods that the individuals also consume on a daily basis are from one or two food groups. Therefore, lacking key nutrients in their bodies (Shetty, 2011). More than 2 billion people globally are deficient of key vitamins and minerals, like, vitamin A, iodine, zinc and iron. These nutrients are obtained from fruits, green leafy vegetables, animal products and fortified foods. This commonly occurs due to inability to purchase the foods or unavailability of the foods locally. Micronutrient deficiencies greatly increase the risk of dying from the following conditions; diarrhea, measles, malaria and pneumonia (WHO, 2007).

There are four methods of controlling micronutrient malnutrition. These are increasing the variety of foods eaten, food fortification, supplementation and prevention and control of diseases. Food based interventions are diet diversification and food fortification (FAO, 1998).

#### **2.4. Minimum dietary diversity**

Dietary diversity has been seen to be a proxy measurement of adequate micronutrient-density of foods (WHO, 2010). A review of dietary data for children 6-23 months in developing countries has shown that consumption of foods from at least four food groups means that the child ate one animal source food, one fruit or vegetable in addition to the staples (FANTA, 2006; FANTA 2007). There are seven groups of foods used for calculation of minimum dietary diversity.

#### **2.5. Minimum meal frequency**

This is the number of the children breastfed and non-breastfed aged 6-23 Months, who receive solid, semi-solid, or soft foods but including milk feeds for non-breastfed children. It is the minimum number of times of the meals the child takes or even more (WHO, 2010).

#### **2.6 Minimum acceptable diet**

This is a measure of the percentage of children of the age group 6–23 months who receive the minimum acceptable diet apart from the breast milk that they consume. This measure serves to track the extent to which multiple dimensions of appropriate child feeding are met. This measure serves to combine the dietary diversity indicator and feeding frequency indicator (WHO, 2010).

#### **2.7 Dietary Diversity and Nutrition status in children**

Dietary diversity has been one of the key indicators of high quality diets recognized by nutritionists worldwide. It is a simple count of food items or food groups used in the household

or by the individual over a period, and have been considered a potential ‘proxy’ indicator to reflect nutrient adequacy (Ruel, 2002). Most dietary guidelines point out to increasing the variety of foods taken (WHO, FAO 1996; Drewnowski *et al.*, 1997) this serves to improve overall nutrition of an individual and health at large. According to (Nti, 2014), high dietary diversity showed improved energy and nutrient intakes, growth of the children and overall nutrition status in a study in Ghana.

According to studies reviewed by Ruel, dietary diversity was found to have strong associations with nutritional status and growth in children in developing countries (Ruel, 2003). Individual dietary diversity scores have shown to be an efficient means of estimating nutrient adequacy of the diets consumed (Steyn *et al.*, 2005).

## **2.8 Dietary diversity and Nutrient adequacy in children**

According to World Health Organization, the indicators of proper complementary feeding are starting of solid, semi-solid or soft foods, minimum meal frequency, minimum dietary diversity, minimum acceptable diet, and consumption of iron-rich or iron-fortified foods (WHO, 2009).

Every individual needs a variety of foods so as to meet the essential nutrients and the importance of dietary diversity has been widely recognized. In developing countries, lack of diversity is a common problem because of overdependence mainly on starchy staples and often include a few or no animal based products and only seasonal fruits and vegetables (Arimond and Ruel, 2004).

According to Ruel (2003), when the number of food is increased in an individual’s diet, this leads to increased nutrient adequacy. Several studies have also indicated positive associations between intake of various nutrients and dietary diversity (Onyango *et al.*, 1998; Tarini and Delisle 1999).

Nutrient densities of most diets given to children are often insufficient in meeting the nutrient requirements, and increasing the diversity of foods given to young children, particularly fruits, vegetables, meats, poultry and eggs are important in meeting their micronutrient intakes (PAHO/WHO, 2003). Despite the instinctive link between increasing dietary diversity and increased nutrient intake, the relationship between dietary diversity and adequate micronutrient intake has not been sufficiently proven in different cultural settings among the different age groups (Steyn *et al.*, 2006).

## **2.9 The Link between Complementary feeding and Biodiversity**

The declaration on the world food summit (2009) highlighted on the importance of actively encouraging intake of nutritious foods to reduce child deaths related to nutrition. Therefore, there is need for better understanding and more strengthening on the link between biodiversity and nutrition that requires dynamic systems approach in which the diversity of species and nutrients from production to consumption plays a central role. Agricultural biodiversity utilization has been fronted as a potential remedy for the increasing nutritional challenges where malnutrition and obesity have become a big challenge in communities (Fanzo *et al.*, 2013). The world's population is expected to hit 9 billion people in 2050 that are expected to be fed on quality diets produced in a sustainable manner, which will be highly pegged on biodiversity (Hunter *et al.*, 2016). Biodiversity will continue playing a noble role in ensuring food security in rural and urban setting in Africa (Charrondière *et al.*, 2013; Orsini *et al.*, 2014; Smith *et al.*, 2015).

Complementary feeding is very essential in children below two years and emphasis should be put on the locally available foods (Paul *et al.*, 2012). This has also been emphasized as a strategy during nutritional interventions under complementary feeding programmes (UNICEF,

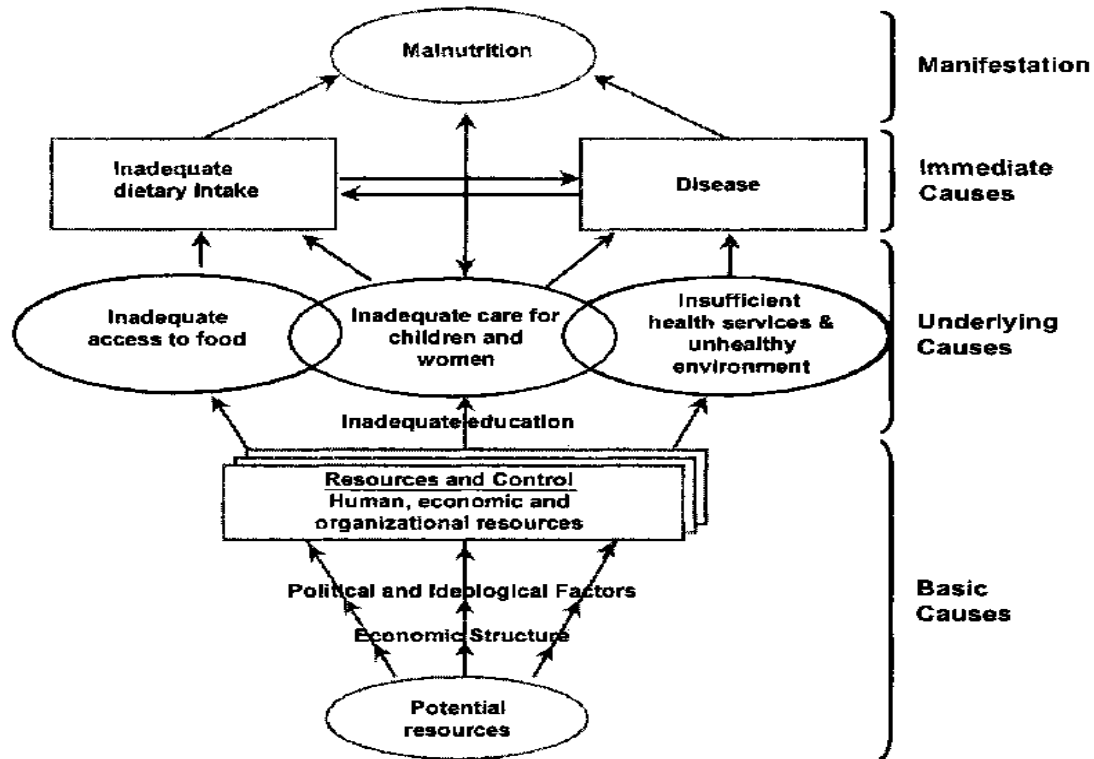
2012). When the locally available foods are inadequate in macro and micronutrients, most common with iron, recommendations may be made for supplementation using locally available food known to be high in these elements. Special recipes may be developed to provide children with diverse nutrient sources to enhance efforts to reduce malnutrition (Lazzerini *et al.*, 2013). All these measures are centered towards improving nutrition status of infants and the young children. In addition, where food insecurity is greatly experienced and foods available at the community level are inadequate to provide macronutrients and micronutrients, external food sources are recommended and supplements may be provided (UNICEF, 2012).

There are over 10,000 plant species worldwide that can be used as human foods, only about 150 have been commercially cultivated and out of these, only four, namely maize, rice, wheat and potato, supply 50% of the world's energy supply (FAO, 2010). Less familiar foods, such as underutilized species or varieties and foods from the wild are often not captured in seasonal food availability calendars or national data. For example, the use of wild edible plants and their derived products used as food has been seen to improve the nutrition status of individuals in a study in Lebanon (Batal and Hunter, 2007). In Africa, traditional vegetables have been estimated to contribute to about 30% in addressing the hidden hunger of malnutrition (Grubben *et al.*, 2014; Bvenura and Afolayan, 2015). The importance of the diverse foods sources in decreasing seasonal food gaps cannot be ignored in the modern study and planned interventions.

## **2.10 Causes of malnutrition**

The conceptual framework developed in 1990 by UNICEF shows that the causes of malnutrition are cross-cutting ranging from the food eaten, health status and child caring practices by the

caregiver (Fig 2.1). They are classified into three main categories; immediate causes, underlying causes and basic causes. This illustrates that factors at one level influences the factors in another level. Basically, the framework is used in planning and addressing nutrition action plans from local levels to national levels. It serves as a guide in assessing and analyzing the causes of the nutrition problem and appropriate action plans to address the nutrition problem.



**Figure 2.1: Conceptual Framework of Malnutrition**

### 2.10.1 Immediate Causes

The two most important immediate causes of malnutrition are inadequate dietary intake and illness than tend to create a vicious circle: A malnourished child, whose resistance to illness is compromised, falls ill, and malnutrition worsens. Children who enter this malnutrition-infection cycle can quickly fall into a potentially fatal spiral as one condition feeds off the other (Fig. 2.1).



Malnutrition also lowers the body's ability to resist infections by undermining the functioning of the main immune-response mechanisms. This leads to longer, more severe and more frequent episodes of illness.

Infections cause loss of appetite, malabsorption and metabolic and behavioral changes. These, in turn, increase the body's requirements for nutrients, which further affects young children's eating patterns and how they are cared for (UNICEF, 1998).

### **2.10.2 Underlying Causes**

Three clusters of underlying causes lead to inadequate dietary intake and infectious disease: inadequate access to food in a household; insufficient health services and an unhealthy environment; and inadequate care for children and women (UNICEF, 1998).

#### **2.10.2.1 Inadequate Access to Food in a Household**

Household food security depends on access to food -- financial, physical and social -- as distinct from its availability. For instance, there may be abundant food available on the market, but poor families that cannot afford it are not food secure. For the poor, therefore, household food security is often extremely precarious. Agricultural production varies with the season and longer-term environmental conditions. Families selling crops may find themselves paid fluctuating prices depending on a variety of factors beyond their control, while those who need to buy food may encounter exorbitant prices (UNICEF, 1998).

### **2.10.2.2 Insufficient health services and an unhealthful environment**

Access to curative and preventive health services that are affordable and of good quality are an essential element of good health. Lack of ready access to a safe water supply and proper sanitation and the unhygienic handling of food as well as the unhygienic conditions in and around homes, which cause most childhood diarrhoea, have significant implications for the spread of infectious diseases (UNICEF, 1998).

### **2.10.2.3 Inadequate care for children and women**

Care encompasses all measures and behaviours that translate to available food and health resources into good child growth and development. This complex of caring behaviours is often mistakenly assumed to be the exclusive domain of mothers. It is, in fact, the responsibility and domain of the entire family and the community, and both mothers and children require the care of their families and communities. In communities where mothers are supported and cared for, they are, in turn, better able to care for young children. Among the range of caring behaviours that affects child nutrition and health, the following are most critical, these are; feeding of the children, protecting the child's health, support and cognitive stimulation for children and care and support for mothers (UNICEF, 1998).

### **2.10.3 Basic causes**

Lack of resources exacerbates malnutrition although different types of resources are necessary for good nutrition and also the factors that affect a family's ability to obtain and control these resources. Political, legal and cultural factors at the national and regional levels may defeat the best efforts of households to attain good nutrition for all members. These include the degree to which the rights of women and girls are protected by law and custom; the political and economic

system that determines how income and assets are distributed; and the ideologies and policies that govern the social sectors (UNICEF, 1998).

## **2.11 Nutrition status assessment**

Nutrition status can be assessed by use of the following methods:

- Anthropometry
- Biochemical assessment
- Clinical assessment
- Dietary assessment

### **2.11.1 Anthropometric assessment**

This is the measurement of variations of physical dimensions. Some of the techniques for measuring body fat and lean body mass include anthropometry and bioelectric impedance analysis. The measurements taken are presented as indices, they include; height-for-age (HFA) or stunting, weight-for-age (WFA) or underweight, weight-for-height (WFH) or wasting, MUAC-for-age, and body mass index (BMI)-for-age.

A child's z-score or Mid Upper Arm Circumference measurement can be used to classify and determine how malnourished a child is.

#### **2.11.1.1 Weight for Age**

This indicator relates the body mass of an individual in relation to their age. This indicator can also be used to refer to "lightness" and reflects a pathological process known as "underweight". This is a result of gaining minimal weight in relation to an individual's age, or due to weight loss (WHO, 1995). This indicator is widely used in low income countries for children aged 6 months

to 7 years due to availability of scales in most health centers. One key disadvantage of using this indicator is that it indicates both wasting and stunting., For example, in Kenya where stunting levels are high and wasting levels are low (26% prevalence of stunting and 4% prevalence of wasting) (KDHS, 2014). Therefore the effects of using weight-for-age to estimate the levels of under-nutrition leads to gross underestimate of the nutrition situation (WHO, 1995).

#### **2.11.1.2. Weight for height**

This indicator measures body weight in relation to height. This can also be described as “thinness” and reflects a pathological process referred to as “wasting”. This is due to gaining weight that is not sufficient in relation to the height of the individual. High weight-for-height in children is termed as “overweight” and this is as a result of gaining excessive weight in relation to an individual’s height (WHO, 1995).

Children with poor nutritional status are classified as “normal” based on weight-for-height stature alone. Wasting develops in a very short time span but can be rapidly corrected within a short period through correct intervention. Thus, this method is not an ideal measure to use for populations that are chronically malnourished.

#### **2.11.1.3 Height for age**

This is a measure of achieved linear growth for quite a period and can be used to determine health and nutrition status. This is also referred to as “stunting” or gaining insufficient height relative to an individual’s age (WHO, 1995). Stunting results due to lack of food or long periods of consuming poor quality food and high incidence of morbidity. One of the major limitations of this index is that a deficit in height especially for children below 24 months takes some time to develop in terms of the stature. Thus when used solely, it is not a good indicator of acute

malnutrition and therefore results to gross underestimation of malnutrition among infants. Furthermore, Height may be influenced by genetics and this may lead to misclassification of children as malnourished when on the contrary they are not (Gibson, 2005).

#### **2.11.1.4 Circumference at Mid-Point of the Upper Arm (MUAC)**

This is the total circumference at mid-point of the upper arm. It is preferred as an additional measure of weight and height as it reflects the mass of three tissues; bone, muscle and fat. MUAC measurements are taken using a TALC tape. To locate the mid-point of the upper arm, the clients' left arm is bent at the elbow at 90° angle. The tip of the shoulder bone and ulnar bone should be located using a finger and marked with a pen. The distance between the two points measured and the mid-point is marked. The arm is then allowed to hang loosely, and the tape wrapped firmly but gently around the mid-point. Measurements are taken to the nearest 0.1cm. MUAC is quite an easy measure and that it is a good predictor of immediate risk of death. It is used for rapid screening of acute malnutrition for children 6-59 months age range. MUAC is also recommended for use in assessment adult under-nutrition at the population level (Cogill, 2003).

#### **2.11.2 Biochemical assessment**

This is a measure of the amount of nutrients in some of the body fluids e.g. blood and urine .When compared to other methods of biochemical assessment it provide most objective and quantitative data on nutrition status. They provide indications of nutrition deficits long before clinical manifestations and signs appear (Gibson, 2005).

#### **2.11.3 Clinical assessments**

Consists of routine medical history followed by a physical examination to detect and record symptoms (manifestations reported by the patient) and physical signs (observations made by a

qualified examiner) associated with malnutrition. Different parts of the body can be examined for signs and symptoms for certain disease conditions (Gibson, 2005).

#### **2.11.4 Dietary assessment**

This involves assessing the amounts and types of foods consumed within a given period of time. The data of the foods given gives an overview of the nutrient intake (Gibson, 2005). Interpretation of data from dietary intake involves the use of food consumption tables and nutrient analysis software's e.g. Nutri survey, Lucille, etc. It complements anthropometric, biochemical and clinical data. Lucille software was one of the softwares used to process food intake data, it was developed by university of Ghent, and it offers a level of flexibility and convenience that is needed as far as food intake studies are concerned.

**Diet Record:** Subjects record all food and beverages consumed over three consecutive days (two weekdays and one weekend day). The consumed items can be measured using a scale or other household items, such as measuring cups or spoons, or estimated using a portion-size guide. Trained staff must provide detailed instructions on how to record intake and the completed records need to be entered into a software program, such as Nutrition Data System for Research (NDSR), for analysis (Thompson and Bayers, 1994).

**24-Hour Recall:** Subjects are asked to report all foods and beverages consumed in the past 24 hours. This can be done via telephone or face-to-face interview. Trained staff must conduct the interview to prompt for details, such as cooking methods and portion sizes (Thompson and Bayers, 1994).

**Food Frequency Questionnaire (FFQ):** Subjects report how frequently certain food and beverage items were consumed over a specific period of time. Most FFQ versions ask portion

size questions of every food item, as well as general questions about common cooking practices (e.g. type of fat typically added while cooking). Most FFQs are available in paper or electronic format and take about 1 hour to complete (Thompson and Bayers, 1994).

#### **2.11.5 Household Dietary Diversity Score**

This is the number of foods eaten in a household in the past 24 hours. This tool is used for measuring household accessibility to food, especially when other methods and resources for undertaking such measurement are scarce (Swindale *et al.*, 2006). It indicates that increase in dietary diversity is due to improve in socio-economic status and increased household food security (Hoddinot and Yohannes, 2002).

#### **2.11.6 Individual Dietary Diversity Score**

This measure is aimed at reflecting nutrient adequacy by specific individuals. Past research has shown that increased individual dietary diversity scores is directly linked to increased dietary adequacy of the diets (FAO, 2011).

### **2.12 Infant feeding and Nutrition**

Complementary feeding is the period when a child transits from breast milk to eating family foods. This normally happens for children between 6- 23 months old. In addition, children of this age are very vulnerable to malnutrition due to increased nutrient needs from growth demands in the child's life (FAO, 2011). There is a very high chance of stunting in children less than two years during introduction of complementary foods that do not fully meet nutritional needs (Imdad *et al.*, 2011). Past studies have pointed out that inappropriate complementary feeding is

determined by lack of maternal knowledge and the economic challenges by households (Senarath *et al.*, 2013).

Strategies on complementary feeding encompass a combination of interventions that do not only improve the quality and quantity of the foods but also improve the feeding behaviors of the caregiver (Imdad *et al.*, 2011). Infants are particularly vulnerable during the period when they are introduced to family foods and the feeding should be; timely, adequate, and safe and should be properly fed to the children (WHO, 2003).

### **2.13 Recipe documentation for complementary foods**

Global Alliance for Improved Nutrition (GAIN) is one of the organizations that supports companies and agencies in the development, production and marketing of different complementary food supplements, fortified complementary foods and multiple micronutrient powders (MNP) to improve nutritional status of older infants and young children in several developing countries (GAIN, 2008). The Global strategy on Infant and Young Child feeding practices builds on the need of diversified approaches to guarantee access to foods that will adequately meet energy and nutrient needs of growing children. This can be achieved by use of local technologies for example, kitchen gardens and improvement of local agricultural production to increase the number of foods locally produced for better diets (WHO, 2003).

According to Dewey and Brown (2003), there is a crucial need for a participatory approach to improving complementary feeding. This should be highly effective in improving the nutrition status of young children. A study by Talavera *et al.*, (2014) was done in the Philippines on recipe trials to improve complementary feeding where a series of participatory cooking sessions with the caregivers of children of different age was prepared. The findings indicated the foods



prepared for the complementary feeding group was mainly rice-based porridge. This was accompanied by many poor preparation practices.

Bioversity International is a research organization that works with partners worldwide to conserve agricultural and forest biodiversity for improved livelihoods, nutrition, productivity for sustainability and resilient ecosystems. It is a member of the CGIAR Consortium. This project is a contribution to the bigger project under Bioversity international entitled 'Participatory approaches to improve dietary diversity through food systems innovations in Vihiga County, Western Kenya (2014-2016). This is part of the humid tropics and Agriculture for Nutrition and Health CGIAR Research Programs. They have been Implementing project on optimization of food recipes to increase dietary diversity and nutritional status of infants in Vihiga County in Western Kenya. The present study seeks to contribute to the efforts of Bioversity by analyzing the nutritional content of the collected recipes and compare daily nutrient intake from those recipes with daily nutrient requirements of the respective age groups. The study will also provide information on utilization of local biodiversity for food recipes used in infant feeding and nutritional status of children in Vihiga County.

#### **2.14. Knowledge Gaps**

There are gaps on science-tailored recommendations on proper infant and young child nutrition and feeding practices. These recommendations are clear, however, there is limited information to explain methods of customizing these recommendations to the local feeding context where programmes are implemented in the communities.

According to (GOK, 2007), it is a common practice in Kenya on use of complementary foods that are not nutritionally adequate, most commonly, cereal based porridges used for

feeding infants and young children. In addition, there is inadequate nutrition knowledge as far as infant feeding practices are concerned at local context, even after nutritional trainings have been done. This consequently puts at risk the nutrition status of infants and young children.

In addition, there is limited data on use of good nutritious foods for complementary foods available locally in rural Kenya.

## **CHAPTER THREE:**

### **RESEARCH METHODOLOGY**

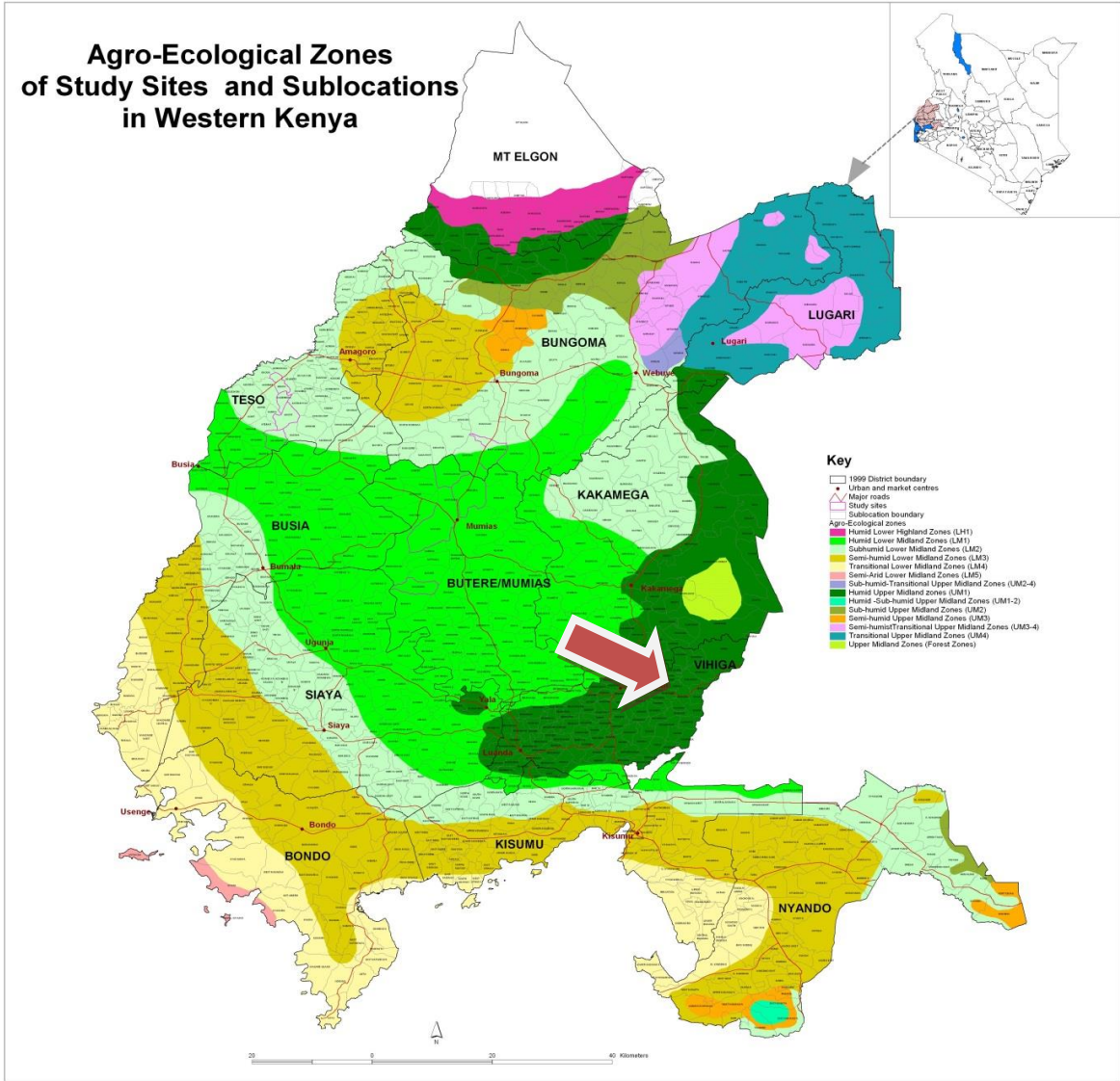
#### **3.1 Study Setting**

##### **3.1.1 Geographical Location**

Vihiga County is located on the Western region of Kenya, in the Lake Victoria basin. The county is divided into four administrative Sub-counties namely; Hamisi, Emuhaya, Sabatia and Vihiga. It is further divided into nine divisions, 37 locations and 129 sub-locations. Vihiga County mainly lies in the Upper Midland (UM) agro-ecological zone (Jaetzold *et al.*, 2005).

##### **3.1.2 Topography and climate of the area**

The county has mean annual temperature of between 18.5- 21.0°C, and altitude of between 1500 and 1900 meters above sea level and an annual rainfall ranging from 1800mm to above 2000mm. The rainfall in the county is bimodal with long rains from April to June and short rains from September to November. It is well suited for production of sugarcane, coffee and tea as cash crops, as well as staple food crops, such as maize, beans and cowpeas, among others. The soils are predominantly a combination of cambisols and lithosols (Jaetzold *et al.*, 2005).



**Figure 3.1: Map of Vihiga County**

**Source:** Bioversity International, 2016.

**3.1.3 Infrastructure**

Different infrastructure networks are found in Vihiga County these are: road networks, rail network, posts and telecommunication, banking and microcredit institutions and education institutions.

### **3.1.4 Political context**

The County has four sub-counties namely; Vihiga, Sabatia, Emuhaya, Luanda and Hamisi. These sub-counties are further sub divided into 9 divisions, 37 locations and 129 sub-locations. The county also has five electoral constituencies. All these are the under the administration of the County Governor's office together with its cabinet.

### **3.1.5 Demography**

In 2012, Vihiga County's population was projected to be 572,577 ( with 47.6% males and 52.2% females) the population is expected to rise to an estimate of 603, 856 people in 2017 .The population of children under five years was 86,339 with 42, 398 females and 43, 398 males according to (KDHS, 2014).

### **3.1.6 Socio-economic Context**

Vihiga County is one of the key employer counties in Kenya today, especially in the agricultural sector and rural development. The agricultural sector provides at least 70% of the employment. According to statistics in 2012, the county's labor force stood at 50% representing half of the total population. The total population that is employed in the county is 118, 893 people. The unemployment rate in Vihiga County at the present stands at over 65% (VCIDP 2013-2017).

### **3.1.7 Agriculture**

Agriculture is the main wage earner in the county both in the rural and urban areas with crop production taking the lead. The main crops grown in the county are beans and maize basically as food crops but mostly end up in the markets. Other crops grown are sweet potatoes, cassava,

bananas and sorghum. Livestock production also characterizes agriculture in Vihiga County with the main livestock bred are; zebu cattle, dairy breeds cattle and poultry (VCIDP 2013-2017).

### **3.1.8 Health systems and health status-morbidity patterns**

Vihiga County has one referral hospital, Vihiga County Hospital and Kaimosi Mission Hospital a faith-based facility. There are three sub-sub-County level four hospitals located in Sabatia, Emuhaya and Hamisi. In addition, there are also 18 health centers in the county, 32 dispensaries and 34 private and mission based facilities.

### **3.1.9 Nutrition status**

The prevalence of stunting for children less than five years stands at 28.4 per cent, prevalence of wasting in the county is at 2.6 per cent while the prevalence of underweight is at 14.8 per cent. This compares to the national figure where, 26% of children under five years are stunted, 4% are wasted and 11% are underweight (KDHS, 2014).

## **3.2 Research Methodology**

### **3.2.1 Study Design**

The study design was descriptive cross sectional with an analytical aspect.

### **3.2.2 Study Population**

The study population from whom the dietary data obtained to be used for local food recipes formulation and their nutritional adequacy comprised of respondents from five randomly selected sub-locations, being: Masana, Itumbu, Wanondi, Mambai and Essunza. The participants giving information on dietary data for recipe formulation were beneficiaries of intervention project entitled “Participatory approaches to improve dietary diversity in Vihiga County,

Western Kenya.” In each of the sub locations, four women 2 women were selected with the help of the Community Health Volunteers (CHVs) for every sub-location. The inclusion criteria used was;

- i. They had been active participants of the project since its inception and willing to bring foods from their homes for food recipe sessions and later have their money for purchase of the foods.
- ii. To take care of
- iii. gender sensitivity, two men and four women would be selected to take part in the cooking sessions for each study age group that is; 7-8 months, 9-11 months and 12-23 months
- iv. Mothers of reproductive age 15-44 years with children within the age bracket of 6-23 months.

The study population for cross sectional survey to assess the nutrition status and individual dietary diversity comprised of households with children of the age bracket 6-23 months. The participants were residents of then randomly selected sub locations, these were: Essunza, Wanondi, Mambai, Emanda, Masana, Vigulu, Emaloba, Itumbu, Mwitumbwi and Eburnangwe. They were selected to the study owing to the special nutritional needs that the children of this age group need. In addition, they were the most vulnerable in the society, given their low social status.

### **3.2.3 Sample Size Determination**

Sample size was calculated using Fishers *et al.*, (1991) as follows:

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

Where:

n= Desired sample size

Z= Standard normal deviate set at 1.96 which corresponds to 95% of confidence interval

P=the prevalence of stunting in Vihiga County (23.5%)

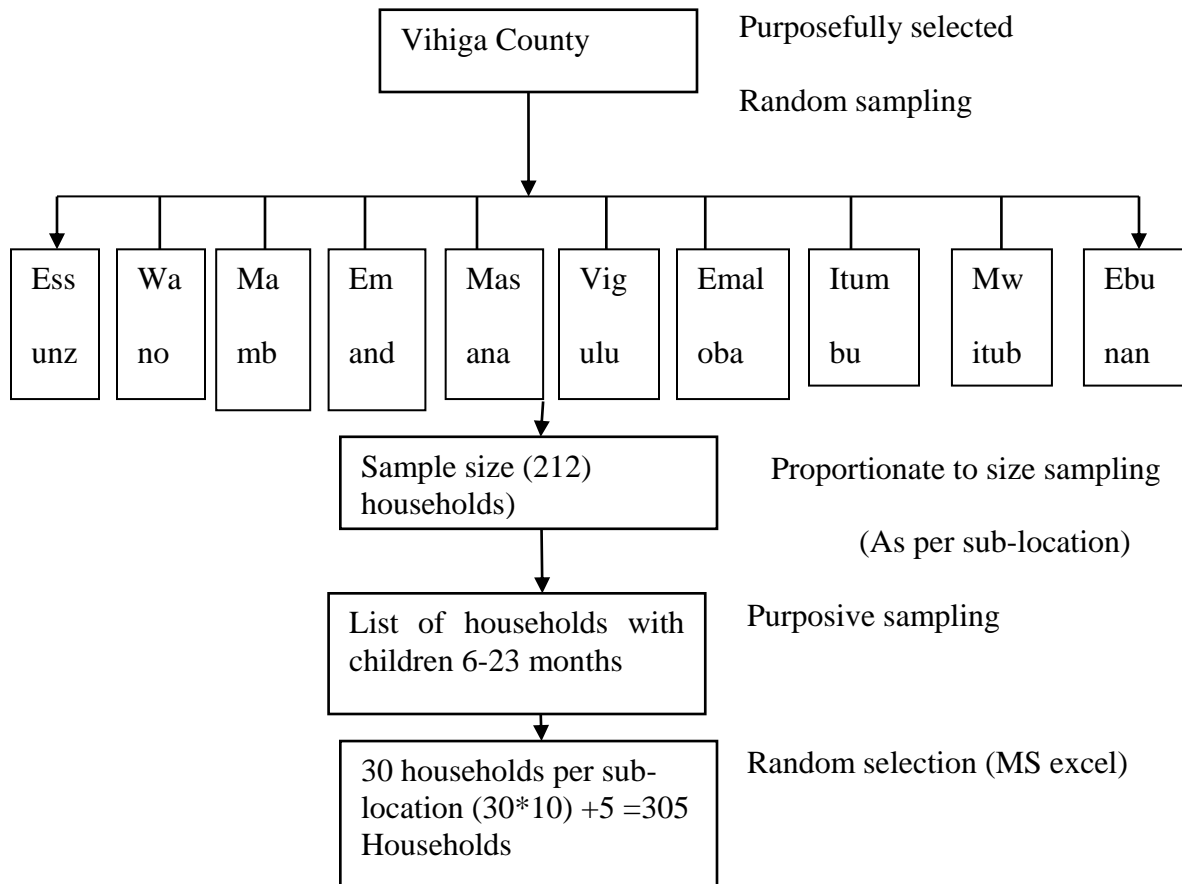
d=Degree of accuracy desired set at 5%

Therefore:

$$\frac{1.962 (0.235) (0.765)}{(0.05)^2} = 276.24$$

Add 10% attrition= 303

Therefore sample size of **303** respondents.



**Figure 3.2: Sampling schema for cross sectional survey**



### **3.2.4 Specific study methods for each objective**

#### **3.2.4.1 Objective 1: To determine the socio-economic and demographic characteristics of the households in Vihiga County, Western Kenya.**

A pre-tested semi structured questionnaire (Appendix 1) was used to obtain information on socio-economic and demographic characteristics of the households. The questionnaires were administered as interview schedules. The questionnaire contained the following socio-economic and demographic characteristics: Age, sex, education level of the household members, marital status, relation to the household head, Occupation/Employment of the household members, household size and income, age of the index child. This information was obtained through interview to the caregiver of the index child or the head of the household. Data obtained was analyzed in form of descriptive statistics.

#### **3.2.4.2 Objective 2: To assess the nutrition status of children aged between 6-23 months on local foods in Vihiga County.**

Data on anthropometric assessment was collected according to Gibson and Rosalind (2005). Three basic variables height and weight were used to determine nutrition status. Seca measuring scales and height/length boards were used. The indicators developed were wasting, underweight and stunting and their respective prevalence determined.

### **3.2.4.3 Objective 3: To formulate nutritionally adequate complementary foods using linear programming model.**

The participants were engaged in formulation and preparation of food recipes based on commonly consumed dishes using local ingredients. The documented findings included names and raw weights of edible portions of all food ingredients used in the recipes; the cooking method used, cooking time and the final weight of the cooked dish. The food preparation steps included; cleaning, cutting, cooking, storage and serving. The ingredients of the foods were calculated per 100g of the cooked food and entered in an excel sheet. The specific ingredients were then entered in Lucille software which then computed the specific nutrients of the different foods per 100g of cooked food. Nutri survey was used in the analysis of foods not available in the software which were included. The Kenya food composition table was also used to refer to specific foods not available in the nutri survey software.

A market survey was conducted in two local markets i.e., Majengo and Luanda markets with the help of field guides. Two enumerators bought two samples of food per market locally consumed by the children. The cost of the foods was directly calculated. For the foods that were cooked the raw ingredients were weighed individually and summed up to obtain the total cost of all the ingredients. The final cooked food was also weighed and the cost per 100g of the food obtained. The data obtained was used to define parameters in the linear programming

### **3.2.4.4 Objective 4: To generate the local food recipes based on nutritional adequacy and dietary diversity of households in Vihiga County, Western Kenya.**

**Sampling frame:** The sampling frame for this specific objective consisted of four women and two men assigned for each age group i.e. 6-8 months, 9-11 months and 12-23 months for all the

5 sub locations. They were selected based on their willingness to take part in the cooking demonstrations. The participants were caregivers and mothers of households with children of the mentioned age groups.

**Sampling Procedure:** Purposive sampling was used to select Vihiga County, with the five sub-locations namely; Essunza, Masana, Wanondi, Mambai and Itumbu randomly selected. The next stage was selecting the members purposively from households with children of the following age groups. (6-8 months, 9-11 months and 12-23 months) as earlier indicated. Each of the groups generated menus on their own according to how they usually prepare foods at their homes. Moreover, the groups brought foods from their kitchen gardens and those available at home to be used in the cooking demonstrations so as to make sure the foods were from the local set up. The following inclusion and exclusion criteria were used;

Inclusion criteria;

- Women/ caregivers in the households with children 6-23 months.
- Willingness of the individuals to participate in the cooking demonstrations

Data for this objective was collected with the use of a recipe collection questionnaire. The caregiver/mother was asked to list a menu for a child of the respective age group for the entire 24 hours. The foods should have included three main meals and two snacks where applicable. The foods were then listed with detailed information on description of the dish, ingredients used, and raw weights of the ingredients, edible portion, actual amount of food cooked and amount served to the child. Measures of the actual ingredients used were recorded and the amount of the food served to the child after cooking.

Raw data was entered in an excel sheet and conversions done per 100g of every ingredient used for the different foods prepared. The ingredients obtained per 100g of food were then fed to

Lucille software which earlier on, had been fed with nutrients of interest that is; Calcium, Iron, Folate, Proteins, Vitamin A, Vitamin C, Zinc and energy of locally available foods in Vihiga County (Sehmi, 1993; Lukmanji *et al.*, 2008).

The mentioned nutrients were then converted to per 100 kcal of the total amount of food cooked. The nutrients were then compared with those of (WHO, 1998) recipe recommendations for complementary foods for children. The nutrients were then determined whether the recipes met the nutrient recommendations for the selected nutrients.

Data on individual dietary diversity was collected using seven food groups dietary diversity questionnaire. The scores were used to determine the diversity and adequacy of the child's diet. The respondents/caregiver was asked to recall all the foods consumed by the child in the past 24 hour period for children who could talk, they were kept present during the interview to assist in indicating the foods eaten outside the home. The dietary diversity was determined by summing all the food groups consumed by the child. Seven food groups (Starchy staples, Legumes, seeds and nuts, dairy products, flesh foods, eggs, vitamin A rich fruits and vegetables and other vegetables) were used in the analysis. Dietary diversity score was awarded for every individual respondent..

### **3.3 Research Instruments**

Research tools used in this study included; questionnaires, height boards and weighing scales.

#### **3.3.1 Questionnaires**

A pre-tested semi structured questionnaire was used to collect data (Appendix I). The questionnaires were administered as interview schedules to the head of the household. The

responses given were recorded in the appropriate part of the questionnaire. The questionnaires contained the following sections:

- ❖ Socio-demographic and economic profile of the study household.
- ❖ Anthropometric data of the index child.
- ❖ Individual dietary diversity score.
- ❖ Recipes of locally consumed foods

### **3.3.2 Dietary diversity assessment**

Data on individual dietary diversity was collected using a seven - food group dietary diversity questionnaire. The interviewee was asked to name all the foods consumed by the child in the past 24hours, the child would be present during the interview to assist in indicating the foods eaten outside the home. Therefore, seven food groups were used in analyzing dietary diversity scores (FAO, 2010).

The individual dietary diversity was determined by summing all the food groups consumed by the child. 7 food groups Starchy staples, legumes, seeds and nuts, dairy products, flesh foods, eggs, vitamin A rich fruits and vegetables and other fruits and vegetables were used in analysis.

“Dietary diversity score was awarded to the individual respondent scores as follows:

<3 food groups showed low dietary inadequacy of the food groups taken, 3-7 food groups indicated moderate food adequacy and >7 food groups indicated high dietary adequacy.” (FAO, 2010).

### **3.3.3. Anthropometric measurements**

Weight and height were measured according to Gibson and Rosalind (2005). Weight was measured to the nearest 0.1kg with an electronic Seca<sup>®</sup> scale (Seca GmbH and Co. KG, Hamburg

Germany). Two basic variables height and weight were used to determine nutrition status of the children. Measurements were carried out according to standard techniques (Cogill, 2003).

The caregiver was asked to remove the child's heavy clothing in preparation of weighing. Recumbent length of the child 0-24 months was determined using a Seca stadiometer (Seca GmbH and Co. KG, Hamburg Germany) length board with a movable foot board. Vertical height will be taken for children >24 months with a height board. The caregiver/mother will assist in removing excess clothing and shoes prior to taking any measurement. The child was laid in a supine position where one person preferably the caregiver held the child's head against the backboard, with the Frankfort plane perpendicularly to the board. The principle investigator/research assistant would drag the foot board against the bottom of the feet while keeping child's leg straight and against the back board. The measurement was read to the nearest 0.1cm. The procedure was repeated for the same subject to get two new measurements then an average between the two measurements was computed and recorded.

#### **3.3.4 Pretesting of Tools**

The questionnaire was pretested for the different reasons: to check for consistency of the collected data with what was expected/desired, to make adjustments and reframe the questions, omit or add some of the questions to achieve the desired results. Pretesting was also done to find out the time taken to fill the questionnaire.

#### **3.4 Recruitment and Training of field assistants**

Four field assistants were be recruited. The minimum requirements included at least a bachelor in Food Nutrition and dietetics or any other related course, fluent in Swahili and English. They were also preferably residents of Vihiga County. They had to be individuals with nutritional

knowledge. They were briefed on the overall objectives of the study. They were trained on the purposes of data collection for the study. They were trained on use of the study tools (questionnaire and anthropometric equipment), filling in the questionnaires correctly, and taking of measurements. They were trained to countercheck the responses to find out whether they were consistent with the questions. At the end of the interview, they had to go through the questionnaire to check for unanswered questions.

### **3.5 Ethical Considerations**

The study was part of the bigger project “Participatory approach to improve dietary diversity in Vihiga County within the humid tropics CGIAR Research Project (CRP) – Western Kenya (2014 – 2017).” Egerton University Ethics Review Committee for the period 2014- 2017, covered this project. An informed consent was also provided to the respondent/caregivers so that they agree to be part of the study. The consent was provided to the respondents before the interview. The respondents were assured of confidentiality of the information if it would not be used for any other purposes except for the one stated as indicated in the consent forms. No names /participant identifiers would appear anywhere, be it the questionnaires or the final report.

### **3.6 Data Quality Assurance**

Quality of the data collected was ensured through a number of ways, which included; Pre-testing of the questionnaire to check for consistency of the collected data with what was desired and for adjustments, omission or addition of questions to achieve the desired results. In addition, data cleaning during collection was ensured through training research assistants, calibration of the equipment, taking anthropometric measurements twice and counter checking the responses. Data

from open-ended questions was pre coded before data entry, while close-ended questions will be pre coded during questionnaire design.

### **3.7. Data Analysis**

Data entry and cleaning was done using Statistical Package for social Sciences (SPSS version 20) computer software. Anthropometric data was analyzed using WHO Anthro (2005). Demographic data was analyzed using descriptive statistics. Simple counts/frequencies and proportions were computed on sex, age and education level of the study participants.

Data from the quantitative 24-hour recall were additionally entered and processed in Lucille dietary intake software developed by University of Ghent, Belgium. After uploading the Kenyan and Tanzanian food composition tables and entering quantitative food intake data per person per day, the software generated the actual nutrient intakes. The data was then transferred to an excel sheet to give the actual amounts of the nutrients in the recipes. The nutrients of individual foods were then compared with 1998 WHO recommendations for recipes according to the respective age groups. The nutrients of interest analyzed were: Energy, Vitamin A, Vitamin C, Calcium, Zinc, Folate and Iron.

Correlations were used to determine associations between nutrition status and the socio-demographic variables of age, occupation and education level and other variables.

## **3.8 DISSERTATION LAYOUT**

### **CHAPTER ONE: GENERAL INTRODUCTION.**

The chapter gives the background information and the basis around which the research concept was founded. It highlights inadequate dietary intake as an immediate cause of malnutrition in



children below two years and the importance of designing nutritionally adequate foods for those children.

## **CHAPTER TWO: LITERATURE REVIEW**

The chapter gives an overview of other studies done elsewhere that are related with the current research. It gives malnutrition overview globally up to the county level where the study was done. The review also gives a critique of the methodologies used in the study.

## **CHAPTER THREE: RESEARCH METHODOLOGY**

This chapter reviews the description of the study setting in terms of geographical location, the topographical features, climatic conditions and the demographical and socio-economic features of the population. The chapter also reviews the research methodology employed: sample size determination, sampling procedures and data collection tools for each specific objective and ethical procedures. In addition, this chapter includes data quality and analytical methods employed.

## **CHAPTER FOUR: DIETARY DIVERSITY AND NUTRIENT ADEQUACY OF LOCALLY PREPARED DIETS FOR COMPLEMENTARY FEEDING OF CHILDREN 6 – 23 MONTHS**

This chapter is divided into the following sections; abstract, introduction, methodology, results and discussion, conclusion and recommendations. It outlines the nutrient and energy densities of the local foods and dietary diversity scores of the children.

## **CHAPTER FIVE: LINKING SOCIO-ECONOMIC AND DEMOGRAPHIC PROFILES OF HOUSEHOLDS TO NUTRITIONAL STATUS OF CHILDREN IN VIHIGA, KENYA**

This chapter has an abstract, introduction, methodology, results and discussions, conclusion and recommendation sections. It explains the relationships between some of the socio demographic and economic variables to the nutrition status of children in Vihiga County, Kenya.

## **CHAPTER SIX: OPTIMIZATION OF NUTRIENT INTAKE OF LOCALLY CONSUMED FOODS FOR CHILDREN 6-23 MONTHS IN VIHIGA COUNTY USING LINEAR PROGRAMMING MODEL**

This chapter has an abstract, introduction, methodology, results and discussions, conclusion and recommendation sections. It makes use of the linear program model of nutria survey to formulate the foods for children 6-23 months that nutritionally adequate according to FAO and WHO (2004) recommended nutrient intakes.

## **CHAPTER SEVEN: GENERAL CONCLUSION AND RECOMMENDATIONS**

This chapter outlines the general conclusions against the research objectives. It also states Recommendations that can be pursued to heighten further opportunities on the same research line.

## CHAPTER FOUR

### DIETARY DIVERSITY AND NUTRIENT ADEQUACY OF LOCALLY PREPARED DIETS FOR COMPLEMENTARY FEEDING OF CHILDREN 6 – 23 MONTHS

#### 4.1 Abstract

Good nutrition status during infancy and early childhood is an essential requirement for optimal growth and development. Inappropriate complementary feeding has been shown to directly influence the occurrence of malnutrition in children below 2 years. The aim of the study was to analyze and document local food recipes used for complementary foods for children 6-23 in Vihiga County, Western Kenya. The nutrient adequacy of the foods in meeting the nutritional needs of infants and young children was established. The analysis and documentation of recipe formulation was conducted from five randomly selected sub locations within Vihiga County. A process flow analysis was established using commonly consumed dishes incorporating local ingredients using a process analysis flow. About 75 common recipes were analyzed and documented based on a process analysis. Results of commonly consumed foods indicated inadequacy of key nutrients particularly Calcium (38.75mg/100kcal), Iron (0.88mg/100kcal) and Zinc (0.39mg/100kcal) of the foods as per the WHO recommendations. Most of the recipes met the nutrient density WHO recommendations for Proteins and Folate in all the recipes. Most of the recipes met the minimum dietary energy densities with an average of 1 kcal/g for key foods selected. The average dietary diversity scores for children were  $4.25 \pm 0.965$ . This indicates that the local recipes used for complementary foods used in Vihiga County are not nutritionally adequate to meet the growth and development of children in Western Kenya.

**Key Words: Recipe, Nutrient adequacy, Children, Complementary foods, Kenya**

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## 4.2 Introduction

Adequate nutrition during early childhood is very crucial to development of young children and their health status afterwards (Dewey, 2003). Malnutrition is directly or indirectly linked to nearly half of all deaths of childhood deaths. Children aged six months to two years and more are at an increased risk of malnutrition since breast milk alone cannot meet increased nutrient needs and high incidences of infection (Dewey, 2013). Complementary feeding in developing countries starts too early or too late and in addition; the complementary foods are of less nutritional quality, they are given to the children in insufficient amounts hence leading to low dietary intake (WHO, 2002). Gastric capacity also limits the amount of food a child can eat in a meal in addition to frequent infections that lead to lack of appetite and inadequate dietary intake (Dewey, 2003).

Complementary feeding is important and should contain all the nutritional constituents that allow healthy child growth (Motee *et al.*, 2013). In Kenya, about 92% of breastfed children aged 6-23 months receive solid or semi-solid Complementary foods (KDHS, 2014). Appropriate complementary feeding depends on accurate information given from the health care system. Inappropriate knowledge about good nutritious complementary foods is a greater risk to malnutrition other than the lack of food in itself. There are various methods that can be used to tailor make increase in nutrient densities of locally available complementary foods (WHO, 2003). Research has shown that low-cost complementary foods prepared with locally available ingredients using suitable small-scale production technologies in community settings, can help to meet the nutritional needs of older infants and young children (WHO, 2003).

An estimate of around 6% of total mortalities in developing countries of children less than five years can be prevented by appropriate complementary feeding (Aemro *et al.*, 2013), while a

good dietary diversity and proper meal frequency play a key role in their nutrition status (Victor *et al.*, 2014; Roba *et al.*, 2016). Globally, under-nutrition is associated with 45% of all child mortality, where Africa has been documented to contribute to almost half (49.6%, 3.113 million) of the under 5 deaths worldwide in 2013 due to infectious diseases (Liu *et al.*, 2015).

The study aimed at collecting the food recipes for locally available foods in Vihiga County, Western Kenya and find out whether they met nutrients recommendations for the complementary foods per 100 kcal of the foods prepared. Furthermore, the study also assessed the dietary diversity of the foods the children less than two years in Vihiga County, Western, Kenya.

### **4.3 Study Setting and Methodology**

#### **4.3.1 Study setting**

Vihiga County is located on the Western region of Kenya, in the Lake Victoria basin. The county is divided into four administrative Sub-counties namely; Hamisi, Emuhaya, Sabatia and Vihiga. It is further divided into nine divisions, 37 locations and 129 sub-locations. Vihiga County mainly lies in the Upper Midland (UM) agro-ecological zone (Jaetzold *et al.*, 2005).

##### **4.3.1.1 Socioeconomic context of the study area**

The County has four sub-counties namely; Vihiga, Sabatia, Emuhaya, Luanda and Hamisi. These sub-counties are further sub divided into 9 divisions, 37 locations and 129 sub-locations. The county also has five electoral constituencies. All these are the under the administration of the County Governor's office together with its cabinet.

The county's population in 2012 was projected to be 572,577 ( with 47.6% males and 52.2% females) the population is expected to rise to an estimate of 603, 856 people in 2017 .The

population of children under five years was 86,339 with 42, 398 females and 43, 398 males according to (KNBS, 2013).

#### **4.3.1.2 Nutrition status**

The prevalence of stunting for children less than five years stands at 28.4 per cent, prevalence of wasting in the county is at 2.6 per cent while the prevalence of underweight is at 14.8 per cent. This compares to the national figure where, 26% of children under five years are stunted, 4% are wasted and 11% are underweight (KDHS, 2014).

#### **4.3.2 Study design**

The study was descriptive cross sectional study design with an analytical aspect.

#### **4.3.3 Study population**

The study population comprised of individuals from five sub-locations randomly selected, these were: Masana, Itumbu, Wanondi, Mambai and Essunza. The participants were beneficiaries of the intervention project entitled “Participatory approaches to improve dietary diversity in Vihiga County, Western Kenya.” In each of the sub locations, four women 2 men were selected with the help of the Community Health Volunteers (CHVs).

#### **4.3.4 Sampling Criteria**

##### **Inclusion criteria**

- i. The respondents had been active participants of the project since its inception and willing to bring foods from their homes for food recipe sessions.
- ii. Two men and four women were selected to take part in the cooking sessions.

- iii. Mothers of reproductive age 15-44 years with children aged 6-23 months.

### 4.3.5 Sampling

#### 4.3.5.1 Sample size determination

Sample size was calculated using fishers *et al.*, (1991) as follows:

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

Where:

n= Desired sample size

$Z^2_{1-\alpha/2}$  = Standard normal deviate set at 1.96 which corresponds to 95% of confidence interval

P=the prevalence of stunting in Vihiga County (23.5%)

d=Degree of accuracy desired set at 5%

Therefore:

$$\frac{1.96^2 (0.235) (0.765)}{(0.05)^2} = 276.24$$

Add 10% attrition= 303

Therefore sample size of **303** respondents.

### 4.4 Data tools

A semi structured questionnaire was used to collect information on the foods eaten by the children from the different age groups. An individual dietary diversity questionnaire was used to collect the foods the child had eaten from the preceding twenty-four hours. The foods were then listed with detailed information on description of the dish, the ingredients used and their fresh weights, names of ingredients, raw weight of the food before cooking, edible portion and actual

amount of the food cooked and amount served to the child. Measures of the actual ingredients used were recorded and amounts of food served to the child after cooking were all recorded.

#### **4.5 Recruitment and Training of research Assistants**

Two field assistants were recruited plus one Community Health Volunteer; the individuals had nutritional knowledge and were briefed on the overall objective of the study and trained for the purposes of data collection in the study. The minimum requirements included at least bachelors in Food science, Nutrition and Dietetics or any other related course, fluent in Swahili and English, they were also preferably residents of Vihiga County and had basic computer knowledge. They were trained on use of the study tool: questionnaire, and also proper and accurate weight measurements of the foods.

#### **4.6 Data Collection procedures**

Data was collected with use of a recipe collection questionnaire. The caregiver/mother was asked to develop a menu for a child of the respective age group for the entire 24 hours the foods included three main meals and two snacks where applicable. The foods were listed with detailed information on description of the dish, ingredients used, and fresh weights of the ingredients, edible portion, actual amount of food cooked and amount served to the child. Measures of the actual ingredients used were recorded and the amount of the food served to the child after cooking.

Raw data was entered in an excel sheet and conversions done per 100g of every ingredient used for the different foods prepared. The ingredients obtained per 100g of food were then fed to Lucille software which earlier on, had been fed with nutrients of interest that is; Calcium, Iron,



Folate, Proteins, Vitamin A, Vitamin C, Zinc and energy of locally available foods in Vihiga County. This was made possible with the help of Kenyan food composition table (Sehmi, 1993) and Tanzanian food composition tables (Lukmanji *et al.*, 2008).

The mentioned nutrients were then converted to per 100 kcal of the total amount of food cooked. The nutrients were then compared with those of (WHO, 1998) recipe recommendations for complementary foods for children. The nutrients were then determined whether the recipes nutrient recommendations for the selected nutrients.

#### **4.7 Data analysis , management and quality control**

Quality of the data collected was ensured through a number of ways, which included; Pre-testing of the questionnaire to check for consistency of the collected data with what was desired and for adjustments/reframing, omission or addition of questions to achieve the desired results. In addition, data cleaning during collection was ensured through training research assistants, calibration of the equipment, counter checking all the measurements are correct.

Data for the recipes collected were first entered in an excel sheet thereafter they were entered and processed in Lucille dietary intake software developed by University of Ghent, Belgium. After uploading the Kenyan and Tanzanian food composition tables and entering quantitative food intake data per person per day, the software generated the actual nutrient intakes. The data was then transferred to an excel sheet to give the actual amounts of the nutrients in the recipes.

Actual nutrients of the foods obtained per 100 kcal of food were compared with those of (WHO, 1998: WHO, 2002) recommendations for Complementary foods for children and determined whether the recipes met the selected nutrients or not by average level of usual breast milk intake

for the respective age groups. The nutrients of interest analyzed were: Energy, Vitamin A, Vitamin C, Calcium, Zinc, Folate and Iron.

The energy density of the commonly prepared foods was also analyzed using Lucille food intake software developed by the U Gent Research Group Food Chemistry and Human Nutrition in partnership with the Nutrition and Child Health Unit of the Institute of Tropical Medicine, Belgium [www.foodintake.ugent.be](http://www.foodintake.ugent.be). Conversions were done in kcal per gram of the individual foods as shown in appendix 6.

## **4.10 Results and Discussion**

### **4.10.1 Nutrient Density of local foods**

Table 4.1 shows nutrient densities of commonly prepared foods as compared to those of (WHO, 1998) recommendations. A few of the foods selected and analyzed met specific nutrient density recommendations especially for folate (Maize porridge with milk 4.66g/100kcal) and Proteins (Irish potatoes mixed with green bananas 2.35g/100kcal) and some for Vitamin A (mixed pumpkin leaves with Irish potatoes 49.03µgRE) . However, most the foods prepared did not meet micronutrient density recommendations for calcium (cooked green bananas 4.52mg/100kcal), iron (rice mixed with Irish potatoes (0.23mg/100kcal) and zinc (cooked green bananas 0.11mg/100kcal).

**Table 4. 1: Energy and nutrient density (per 100kcal) of selected complementary foods**

Food	Energy (kcal/g)	Proteins (g/100kcal)	Fats (g/100kcal)	CHO (g/100kcal)	Ca (mg/100kcal)	Fe (mg/100kcal)	Fo (g/100kcal)	Vit C (mg/100kcal)	Vit A (µgRE/100kcal)	Zn(mg/100kcal)
1.Maize porridge(with milk)	1.66	2.28	1.2	20.86	17.27	0.81	4.66	0.46	3.87	0
2.Maize porridge(without milk)	0.56	1.55	1.58	20.62	1.21	0.68	3.35	0	0	0.34
3. Milk tea	0.33	1.83	1.89	19.48	66	0.07	2.86	0	16.02	0.23
4. Cooked green bananas	1.01	0.85	4.84	15.59	4.52	0.25	13.26	7.16	13.87	0.11
5. Rice plain	1.49	1.51	2.84	16.95	3.57	0.15	1.28	0	0	0.26
6. Irish potatoes + green banana Mixture	0.72	2.35	0.25	21.25	6.94	0.4	60.4	16.4	1.61	0.29
7. Pumpkin + Irish potato mixture	0.32	4.15	0.29	23.31	45.47	1.88	3.04	16.8	782.59	0.86
8. Pumpkin leaves + Irish potatoes	1.09	2.23	7.17		13.27	0.34	53.49	14.49	49.03	0.28
9. Fried eggs	3.44	2.63	10.06	0.23	10.59	0.25	6.9	0	35.34	0.23
10.Rice + Irish Potatoes Mixture	1.29	1.72	3.34	15.93	4.72	0.23	13.31	3.81	4.8	0.27
11. Jute mallow (Mrenda)+Amaranth (Zimboga) Mixture	0.09	5.94	7.3	8.68	219.07	3.81	70.88	41.69	184.14	0.49
12. 'Ugali'	1.74	2.24	0.99	21.24	1.65	0.96	4.84	0	0	0.49
13. 'Ugali' + Amaranth (Zimboga) + Jute mallow (Mrenda)	1.59	3.69	2.89	20.09	86.45	2.08	30.59	16.26	71.81	0.49
14. Pumpkin leaves	0.29	4.79	10.39	6.47	78.33	0.44	60.55	12.76	357.48	0.75
15. 'Ugali' + Pumpkin leaves	1.49	3.39	11.21	5.12	35.4	0.74	29.39	5.61	157.29	0.61
16. 'Omena' Soup + 'Ugali'	1.29	2.87	11.23	22.21	32.23	0.77	4.52	0.23	0.94	0.49
17. (Jute mallow) Mrenda + Cowpea leaves (Kunde) Soup + 'Ugali'	1.53	2.63	9.23	23.21	32	1.12	17.08	9.37	77.24	0.47

Findings from this study corroborate with (Vossenaar and Solomons, 2012; Dewey 2013) where nutrient densities of complementary foods in developing countries are quite low. (Dewey and Vitta 2013) reported that there are two problematic micronutrients; Iron and Zinc, which their nutrient density recommendations seem difficult to be met by complementary foods in developing countries. Low nutrient density of complementary of foods was also seen in a study in Bangladesh (Kimmons *et al*, 2005). These results also coincided with that of another study of complementary foods in developing countries when nutrient densities were expressed (per 100kcal) and their nutrient densities being low (Gibson *et al.*, 1998). Assuming the average breast milk intake observed in developing countries. Findings from this study are in line with those of (GOK; MPHS, 2007) whereby in Kenya, there is widespread use inadequate complementary feeds and what is commonly used is starch based porridges.

This shows that there increased need to mobilize caregivers to prepare nutritious foods in meeting the nutrient requirements for the children of this age. Nutrition education is very crucial in safe preparation of complementary foods so as to boost the nutrition status of the children (Dewey, 2003).

From (WHO, 1998) recommendations, the amount of energy density required from complementary foods was divided by the number of meals providing these foods and by an assumed gastric capacity of 30g/kg body weight per day to estimate the minimum appropriate energy density for that number of meals (Dewey and Brown, 2003). The minimum energy density for complementary foods is 0.8 kcal/g taking consideration of the gastric capacity of every individual child (Dewey and Brown, 2002).

Use of locally available nutritious foods has the potential of increasing dietary diversity in any given set up (WHO and UNICEF, 2008; Dewey and Adu-Afarwuah, 2008). Therefore promotion of utilization of locally available foods is important in increasing dietary diversity.

#### **4.10.2 Energy density of commonly prepared foods**

Recommendations used were those of minimum dietary energy density (kcal/g) required to attain the level of energy needed from complementary foods in four meals per day by children in developing countries with an average level of breast milk energy intake (Dewey, 2003). The energy densities of the foods selected were generally consistent with the recommendations except for some foods like milk tea and pumpkin + Irish potato mixture. Such foods could be enriched by addition energy and micronutrient enriched foods e.g. groundnut flour and cooking for porridge prepared (Laura *et al.*, 1999).

#### **4.10.3 Nutrient densities for different recipe combinations**

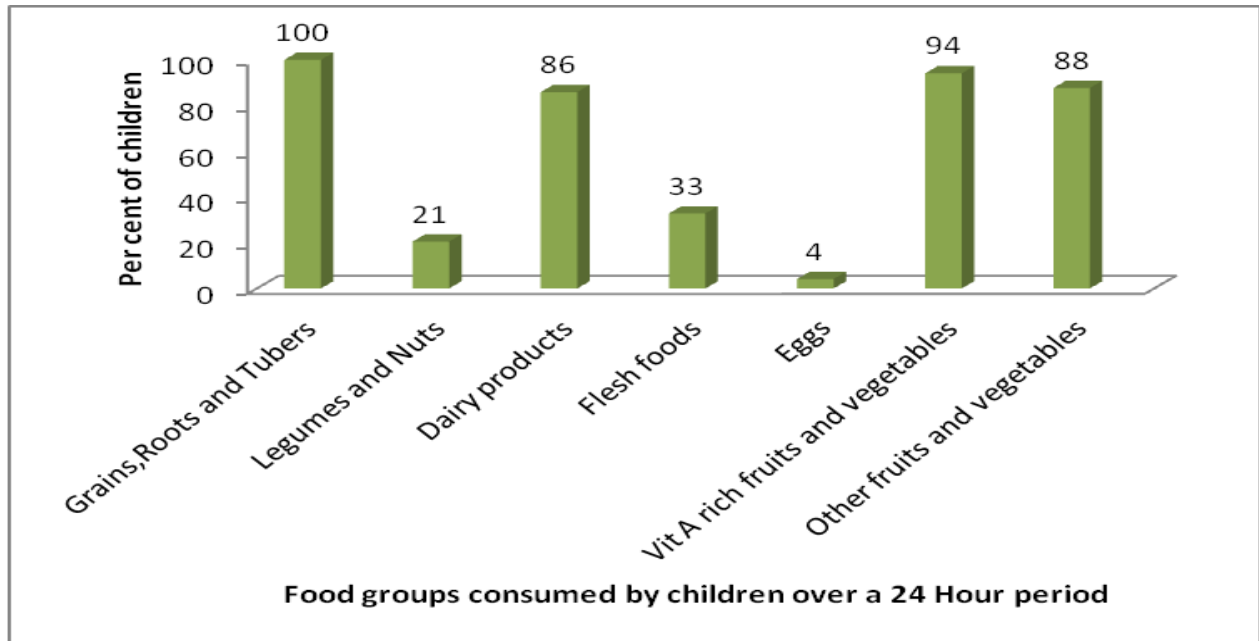
Table 4.1 shows some of the different food combinations consumed on the same plate. Considerations were made for the different portions sizes of the foods eaten on the same plate to obtain the different portion sizes of the foods when they are eaten. Calculations were done for nutrients of the individual foods in Table 4.1 and the nutrients when the foods are taken as a combination. Although not a single food combination met all the nutrient recommendations but the foods nutritional value is increased when taken as a together. For vulnerable children, they need nutrient and energy dense foods to grow both physically and mentally to live a healthy life (Arimond and Ruel, 2004).

Since most of these foods are eaten together, they do meet most of the nutrient requirements especially for; calcium, folate, protein and vitamin A and vitamin C. Iron is seen to lack in most of the recipes, which is still a problematic micronutrient according to (Dewey and Vitta, 2013).

#### **4.10.4 Dietary diversity scores for the children over a 24 Hour period**

The children's dietary diversity scores were calculated based on seven food groups as described by FAO (2011). Figure 4.1 shows the types of foods consumed by the children for the past 24 hours preceding the interview. The mean dietary diversity scores for the children were 4.25 (SD 0.965) while the highest and the lowest dietary diversity scores were 1 and 6 food groups respectively. Children consuming  $\leq 3$  food groups were considered to have low Individual Dietary Diversity Score (IDDS) while those consuming 4 or 5 and  $\geq 6$  were considered to have medium and high IDDS respectively.

As shown in figure 4.1 the main food group consumed by the children is the starchy foods (100%) , followed by Vitamin A rich fruits and vegetables (94.1%), Other fruits and vegetables (87.7%), dairy products 85.9%, legumes and nuts (20.5%), flesh foods 32.8% and eggs 4.1%) respectively. Foods of animal origin especially the meats were consumed sparingly with dairy products being consumed most often as compared to other foods of animal origin (85.9%). It is interesting to see that most of the children consumed vitamin A rich fruits and vegetables in the households sampled (94.1%).



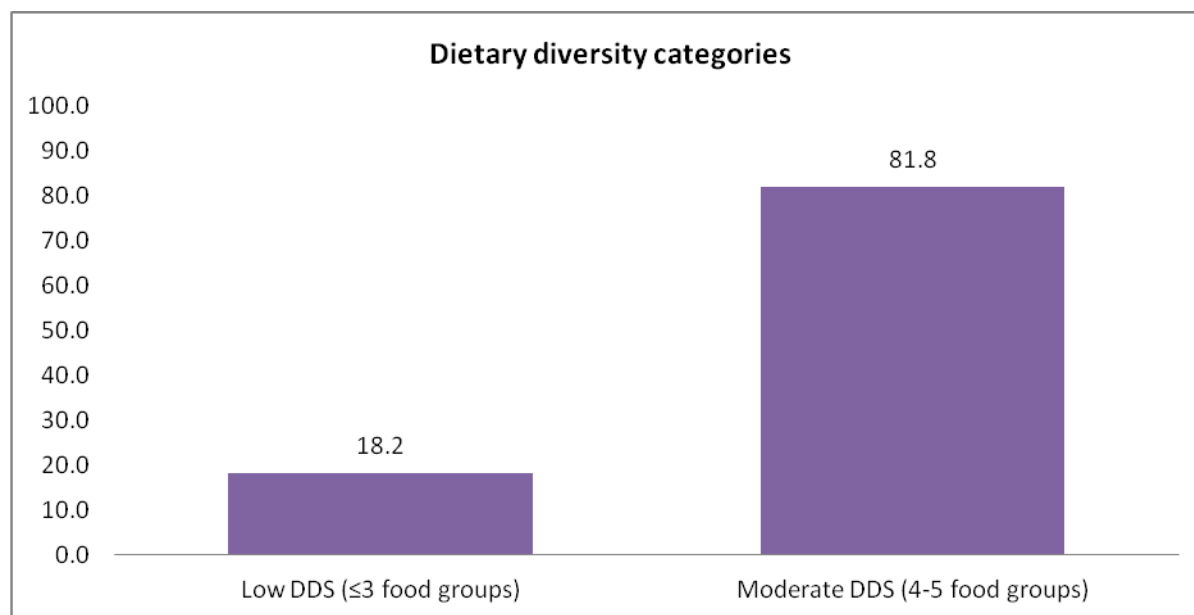
**Figure 4.1: Food groups consumed by children over a 24-hour period**

The results compare with the results of a study by (Mbogori, 2013) where cereals and tubers consumed was 81.6%, Fruits and vegetables that were not Vitamin A rich 56%, milk and milk products 56%, Legumes 27.2%, meats 28% and Vitamin A rich fruits and vegetables 37% was consumed.

Findings from KDHS, 2014 states that in Kenya, most common foods given to breastfeeding children aged 6-23 months are foods made from grains (80%), Vitamin A rich fruits and vegetables (64%), other fruits and vegetables (33%), protein rich foods (25%), flesh foods e.g. meat, fish and poultry (21%) and eggs (17%). These shows that there was a high consumption of Vitamin A rich fruits and vegetables in the area, intake of protein rich foods, meat, fish and poultry are compared with the national figures. Egg consumption was very low as compared to the national figure of 17%. High intake of fruits and vegetables could have been caused by the biodiversity and climatic conditions that favor cultivation of different crops.

Lack of dietary diversity is a major problem for developing nations where diets are based predominantly on starchy staples and rarely foods from animal origin and sometimes-seasonal availability of fruits and vegetables (Arimond and Ruel, 2004). This is evidently seen from the results of this study. Dietary diversity of children in many different settings is associated with linear growth as reported in several studies (Ruel and Menon, 2002; Arimond and Ruel, 2004 and Rah *et al.*, 2010).

As shown in figure 4.2, out of 341 households visited and dietary diversity of children obtained, about 81.8% of the children fell on the moderate dietary diversity scores category whereas 18.2% fell in the low DDS category. There was none of the children that had a high dietary diversity scores i.e. >7 food groups. The results of this study were similar with those of (Oduor, 2013; Gacheru, 2015). Although for this particular study none of the children had a high dietary diversity as per our classification.



**Figure 4.2: Distribution of children by dietary diversity categories**



#### **4.11 Conclusion**

Vihiga County has a great agricultural potential and food diversity for the inhabitants of the area, this is an untapped potential in enhancing greater dietary intake and improved intake of diverse complementary foods in the region. Findings from the study showed that most of the recipes met the nutrient recommendations for folate and protein except a few of the foods. Most of the foods did not meet the recipe recommendations for the specific nutrients across the three age groups that is; 6-8 months, 9-11 months and 12-23 months. The nutrients seen not to be met by the recipes were; Iron, Calcium, Vitamin A and Zinc. Dietary diversity is key in promoting good nutrition status of children less than five years. Most of the children ate at least 4-5 food groups in a day. Dietary diversity has been consistently associated with child nutritional status and growth in a variety of studies in developing countries.

#### **4.12 Recommendations**

- Proper preparation and cooking methods need to be emphasized so as to conserve the nutrients in the foods that were seen to be deficient. Also to increase other nutrient and energy densities of the foods.
- Nutrition education needs to be given to mothers on different recipe combinations so as to increase the nutrient density of the foods available in the region.
- Further research need to be done to evaluate the long term effects of these local food recipes on the nutritional status of the children.

## CHAPTER FIVE

### LINKING SOCIO-ECONOMIC AND DEMOGRAPHIC PROFILES OF HOUSEHOLDS TO NUTRITIONAL STATUS OF CHILDREN IN VIHIGA, KENYA

#### 5.1 Abstract

Adequate nutrition during infancy and early childhood is an essential requirement for optimal growth and development of children. Socioeconomic and demographic factors have a major effect on the nutrition outcomes and status of children. The objective of the study was to establish the socioeconomic and demographic characteristics of households and determine the nutrition status of children less than two years in Vihiga County, Western Kenya. Vihiga County was purposively selected with ten randomly selected sub locations within the county. A semi structured interview questionnaire was used to collect information from 341 study households. Data was analyzed for descriptive statistics using IBM SPSS software version 20 and anthropometric analysis done using WHO Anthro 2005 Beta version. Nutrition status was measured by wasting, stunting and underweight and the prevalence was 3.25%, 20.8% and 8% respectively. The average household size was 5.54 (SD 2.248). Majority of the respondents had reached the primary school level in their education. The average age of the primary caregivers of the children was 29.17 years (SD 8.792). Positive correlations were found on selected variables i.e. wasting and stunting were positively correlated with number of children born to a mother ( $p < 0.05$ ). Binary logistic regression was used to establish the relationship between selected socioeconomic and demographic characteristics and stunting levels of the children. Further analysis showed positive association between mothers' educational knowledge and stunting levels at ( $p < 0.05$ ). Findings from this study point out clear significance of malnutrition in children less than five years and the influence drawn by socioeconomic and demographic characteristics. Hence, special attention should be drawn to these influences.

**Key Words: Nutrition status, socioeconomic status, Children, Malnutrition, Stunting**

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## 5.2 Introduction

Childhood malnutrition is still one of the key determinants of mortality in children in Kenya. The Kenya Demographic and Health Survey in 2014 highlighted that about 26% of children under the age of five years are stunted (23.5% in Vihiga County), 11% are underweight (5.9% in Vihiga County) and 4% are wasted (2.6% in Vihiga County) (KDHS, 2014). Out of the children between 6-23 months, 21% consume an acceptable diet (KNBS, 2014). Childhood malnutrition is greatly linked to increased susceptibility to childhood infections, poor cognitive function and motor development (Nti *et al.*, 2014). Past studies have shown the age bracket of below 2 years is the stage of growth faltering, micronutrient deficiencies, delayed milestones and common childhood illnesses. One of the major challenges to early exposure to malnutrition at the age of below two is stunting that occurs earlier in life and is impossible to reverse (Dewey, 2003).

Socioeconomic status (SES) remains a great topic of interest to individuals studying child growth and development. This is because of the belief that households with high socioeconomic status can afford most of the social amenities and services to their children while those from the lower socioeconomic class cannot afford the same services hence their children's health status is at risk of suffering developmental problems (Bradley and Corwyn, 2002).

Stunting is a predictor of risk of the overall socioeconomic development for any given setting characterized by high poverty levels and low socioeconomic status (Pasricha and Biggs 2010; Jesmin *et al.*, 2011; Rahman and Chowdhury 2007).

Past studies have shown a mother's education level is a strong predictor her child's nutrition status. Children born to mothers who are well educated suffer less from malnutrition cases manifested as stunting, wasting and underweight than those mothers who are not well educated (Abuya *et al.*, 2011).

## **5.3 Methodology**

### **5.3.1 Study Setting**

Vihiga County is located in the Western region of Kenya, in the Lake Victoria basin. The county is divided into four administrative Sub-counties namely; Hamisi, Emuhaya, Sabatia and Vihiga. It is further divided into nine divisions, 37 locations and 129 sub-locations. Vihiga County mainly lies in the Upper Midland (UM) agro-ecological zone (Jaetzold *et al.*, 2005).

### **5.3.2 Sampling protocol**

Purposive sampling was used to select Vihiga County, with the ten sub-locations namely; Essunza, Masana, Wanondi, Mambai and Itumbu being randomly selected. The next stage was selection of members randomly from households with children of the following age groups. (7-8 months, 9-11 months and 12-23 months) from the five sub locations. They were then put into three groups according as per the children's age groups. Each of the groups developed menus of the children's foods and prepared the foods according to how they usually prepare at their homes. Moreover, the participants were asked to bring foods available from their kitchen gardens and if the foods were not available, they would buy the foods from the local market and later

## **Research Methodology**

### **5.3.3 Study Design**

The study was a descriptive cross sectional study design with an analytical aspect. `

### 5.3.4 Study Population

Vihiga County was purposively selected due to its climatic conditions in the Humid Tropics. The participants of the study were residents from ten randomly selected sub locations, these were: Essunza, Wanondi, Mambai, Emanda, Masana, Vigulu, Emaloba, Itumbu, Mwitumbwi and Eburnangwe. Proportionate to size sampling was used to obtain the numbers of households with children less than five years. Purposive sampling was used to selected households with children less than five years. They were selected to the study owing to the special nutritional needs that the children of this age group need. In addition, they were the most vulnerable in the society, given their low social status.

### 5.3.5 Sample Size Determination

Sample size was calculated using fishers *et al.*, (1991) as follows:

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

Where:

n= Desired sample size

Z<sup>2</sup> 1- $\alpha$ /2 = Standard normal deviate set at 1.96 which corresponds to 95% of confidence interval

P=the prevalence of stunting in Vihiga County (23.5%)

d=Degree of accuracy desired set at 5%

Therefore:

$$\frac{1.962 (0.235) (0.765)}{(0.05)^2} = 276.24$$

Add 10% attrition= 303

Therefore sample size of **303** respondents.

#### **5.4 Data collection Tools**

A pre-tested semi structured questionnaire was used to obtain information on socio-economic and demographic characteristics of the study households. The questionnaires were administered as interview schedules to the caregiver of the child. The questionnaire contained the following socio-economic and demographic characteristics: Age of the primary caregiver, sex of the child, mother's/father's education level, marital status, relation to the child, household age distribution, main source of income of the household, household size, and socioeconomic level.

#### **5.5 Statistical Analysis**

Descriptive analysis was done using IBM SPSS software version 20 for socio demographic and economic characteristics of the study households. Simple counts/frequencies and proportions were computed on sex of the children, age of the household head and mother's educational level. Anthropometric analysis was done using WHO Anthro 2005 Beta version where age, sex of the child, weight and height were entered and analyzed. Nutrition status indicators (Wasting, Stunting and Underweight) were obtained by use of z scores and categorized into severe acute malnutrition, moderate acute malnutrition and children who were normal. Demographic data was analyzed using descriptive statistics. Pearson correlations and logistic regression were used to establish associations and relationships between socio demographic and economic variables and nutrition status of the children.

## **5.6 Results and Discussion**

### **5.6.1 Socio Demographic and Economic Characteristics of the Study Households**

#### **5.6.1.1. Social- demographic Characteristics**

Table 1 shows selected socio- demographic characteristics of the study households. Out of the 341 households surveyed, 80.1% were from a married monogamous family set up, those from polygamous family set up were 3.2%, while widowed 1.8%, Divorced/ Separated 1.8% and single 13.2% respectively. The mean household size was 5.54 (SD 2.248), this household size compares to a study by (Ikamari *et al.*, 2013) with household members ranging from 1 to 13 members this was higher than 3.9 and 4.2 as reported by KDHS 2014 and KDHS 2008-2009 (KNBS and ICF Macro 2010) respectively. According to KDHS 2014 report, the rural households were higher in mean household size 4.4 than urban households which had 3.2 persons (KDHS 2014). This could probably explain this difference since the study was done in a rural set up. Majority of the mothers (60.7%) interviewed had attended up to primary school in their education level this finding correspond to (Abuya *et al.*, 2012) where 76.7% of the mothers' educational level was primary school and below. In the present study, 3.2% of the mothers had not attended school at all while 30.8% had reached secondary level and 5.3% tertiary level respectively. Quite a number of the primary caregivers were mothers (92.1%) of the children with a lesser percentage being grandmothers (7%), aunts (0.3%) and sisters (0.6%). The average age of the primary caregivers was 29.17 years (SD 8.792). These findings are quite differ with those of (Abuya *et al.*, 2012) where the mother's age was between 25-29 years. The youngest and the oldest caregivers were 14 and 65 years respectively.

99.4% of the study population was children under the age of five years. This could be explained by the selection criteria of the children less than five years recruited in the study. Sex of the children was 46.3% males and 53.7% females. Overall household age comprised of 69.8% children between the ages of 5-14 years, 94.7% adults between the ages of 15-64 years and 7.6% above 65 years.

**Table 5. 1: Selected socio-demographic characteristics of the study households**

<b>Household Characteristics</b>	<b>Frequency</b>	<b>Percent (N=341)</b>
<b>Household Profile</b>		
Married Monogamous	273	80.1
Married Polygamous	11	3.2
Widowed	6	1.8
Divorced/ separated	6	1.8
Single	45	13.2
<b>Mother's educational level</b>		
No schooling at all	11	3.2
Primary	206	60.7
Secondary	105	30.8
Tertiary	18	5.3
<b>Relation to Child</b>		
Mother	314	92.1
Grandmother	24	7.0
Sister	2	0.6
Aunt	1	0.3
<b>Age of the Primary Caregivers (Years)</b>		
14-19	26	7.6
20-29	172	50.6
30-39	108	31.7
40-49	24	7.1
Above 50	11	3
<b>Household age distribution(Years)</b>		
Below 5	339	99.4
Between 5-14	238	69.8
Between 15-64	323	94.7
Over 65	26	7.6
<b>Sex of Child</b>		
Male	158	46.3
Female	183	53.7



### 5.6.1.2 Socio-economic characteristics of the study households

Majority of the households were in the Low socioeconomic status 85.9%. The rest were in the middle socioeconomic status (12.6%) and high socioeconomic status (1.5%). Approximately 48.4% of the households studied relied on sale of crops as their main source of income as shown in table 2. Interestingly, 63.9% of the households depended on daily wages as their source of livelihood, 24% of the households studied also depended on small businesses while 1.8% which was the least source of income was sale/exchange of public transfers e.g. cash for work, food for work, food vouchers, fertilizer or seed vouchers and HSNP ( Hunger Safety Net Programmes).

**Table 5. 2: Selected socio-economic characteristics of study households**

<b>Household Characteristic</b>	<b>Frequency</b>	<b>Per cent(N=341)</b>
<b>Socioeconomic Level</b>		
Low SES*	293	85.9
Middle SES*	43	12.6
High SES*	5	1.5
<b>Main Source of Income</b>		
Sale of Crops	165	48.4
Sale of Animals	87	25.5
Income from gathered goods	43	12.6
Daily wages	218	63.9
Small business	82	24
Employed	63	18.5
Remittances from relatives	79	23.2
Sale/Exchange of public transfers	6	1.8
Subsistence farming	87	25.5

\*SES-Socioeconomic Status

### 5.6.2 Nutrition Status of study Children

#### 5.6.2.1 Wasting

Wasting in children is a sign of acute malnutrition especially due to inadequate dietary intake or as a result of infectious diseases most commonly diarrhoeal diseases. Wasting impairs the

functioning of the immune system and this leads to increased severity and high risk of death (WHO,2010). Wasting is low weight for height/length (WFH) Wasted children have weight for height of  $< -2$  SD of the WHO Child Growth Standards median (UNICEF, 2012). Eleven (3.25%) of the children were wasted as indicated by their Weight for height Z scores below  $-2$  SD in table 6. This compares to 4% from a study done in Western Kenya ( Kwena *et al.*, 2003). The findings of the present study corresponded to prevalence of 4.5% in rural Western Kenya (Bloss *et al.*, 2004) Prevalence of wasting from the present study was a bit lower than that of 16.7% from an Ethiopian study (Mengistu *et al.*, 2013). This difference could be explained due socioeconomic characteristics, the study period and health service delivery . Findings from the present study were consistent with those of (KDHS 2014) where 4% of the children were wasted. This prevalence is a bit lower as compared to (KDHS 2008-09) where the prevalence was 7%.The children who had Severe acute malnutrition (SAM), indicated by Weight For Height  $<-3$  standard deviations were 2 (0.6%) as shown in table 6.

**Table 5. 3: Per cent distribution of Wasting (Weight-for-Height  $<-2SD$ ) by sex**

<b>Wasting category</b>	<b>Females(%) (n=183)</b>	<b>Males(%) (n=158)</b>	<b>All (%) N=341</b>
Global	3.8	2.5	3.2
Moderate	3.3	1.9	2.6
Severe	0.5	0.6	0.6

Global=  $<-2$  Z score; Moderate= $<-2$  and  $<-3$  Z score; Severe= $<-3$  Z score and/or oedema

### **5.6.2.2 Stunting**

Stunting is defined as low length or height for age of the child and is determined by use of Height for Age Z-Score (HAZ). Height for Age Z-Scores  $<-2$  Standard Deviation of the reference population are indicative of stunting (UNICEF, 2012). It is a major global health

problem of greater magnitude than any other form of malnutrition (UNICEF, 2009) It is a sign of chronic nutritional disorder that has persisted for a very long time (WHO, 2010). The Height for Age Z Scores were determined using WHO Anthro nutritional software (2005) programme. Table 7 shows, 17 (5%) had HFA z scores less than -3 SD indicative of severe stunting. Moderate stunting was observed in 54 (15.8%) of the children and 270 (79.2%) of the children were normal. Prevalence of stunting for this study was 20.8% this was lower as compared to 35% and 26% for KDHS 2008-09 and KDHS 2014 respectively. Findings of the present study compare with those of a rural Indian study where the prevalence was 22% and 37% in the urban setting (Patil *et al.*,2017).

**Table 5. 4: Per cent distribution of stunting (Length-for-Age <-2SD) by sex**

<b>Stunting category</b>	<b>Females(%) (n=183)</b>	<b>Males(%) (n=158)</b>	<b>All (%) N=341</b>
Stunting	21.8	19.7	20.8
Moderate	16.9	14.6	15.8
Severe	4.9	5.1	5.0

Stunting= <-2 Z score; Moderate=<-2 and <-3 Z score; Severe=< -3 Z score and/or oedema

### **5.6.2.3 Underweight**

Underweight is a combination of acute and chronic malnutrition (WHO, 2006). It is indicated by low weight for age. A child who is underweight child has weight for age Z-Score of below -2SD of the reference population (UNICEF, 2012). Among the children under study, 3 (0.9%) had WFA Z scores less than -3 indicating severe underweight, 24 (7.1%) and 313 (92%) were moderately underweight and normal respectively. Prevalence of underweight stood at 8% as compared to 16% and 11% for KDHS 2008-09 and KDHS 2014 respectively this showed a lower per cent drop of underweight. Findings of the present study differed with a study done in Western Kenya where the prevalence was 20% ( Kwena *et al.*, 2003) and Ethiopia where the

prevalence of underweight was 14.6 % (Asres and Eidelman 2011) and but abit lower as compared to another study which was 30.9% ((Mengistu *et al.*, 2013). This could be explained due to the time factors when the different studies were done. The results of the present study seem to hint a good progress in achieving Sustainable Development Goals number two (SGDS) which is eradication hunger and achieving food security and improved nutrition (Waage *et al.*,2015).

**Table 5.5: Per cent distribution of Underweight (Weight-for-Age <-2SD) by sex**

<b>Underweight category</b>	<b>Females(%) (n=183)</b>	<b>Males(%) (n=158)</b>	<b>All (%) N=341</b>
Underweight	4.4	5.7	8.0
Moderate	3.3	5.1	7.1
Severe	1.1	0.6	0.9

Underweight= <-2 Z score; Moderate=<-2 and <-3 Z score; Severe=< -3 Z score and/or oedema

### **5.6.3 Association between socio demographic variables and nutritional status**

Table 5.6 shows relationships and associations between socio demographic variables and nutrition status (stunting), bivariate correlations were done and significant associations determined at 0.05 significance level. Data on dietary diversity scores of the children are published elsewhere. Findings from the present study on positive relationship between socioeconomic level and dietary diversity ( $r=0.107$ ,  $p=0.036$ ) these findings correspond to those by (Ruel, 2003) and (Hatloy *et al.*, 2000). The maternal education level plays a very crucial in dietary intake of a child according to (Braveman *et al.*, 2005). Mother’s education level showed a significant relationship with stunting levels of the children (Chi-square test=8.664, DF 3;  $p$ -value= 0.034). Correlation test also showed significant association ( $r=0.153$ ,  $p=0.045$ ). The number of children born to a mother had a significant inverse relationship with stunting ( $r=-0.05$ ,  $p=0.059$ ) and wasting( $r= -0.097$ ,  $p=0.055$ ) and underweight ( $r=-0.115$ ,  $p=0.059$ ). These findings are

confirmed by a Ghanaian study (Darteh, 2014) where households with children more than five were more likely to be stunted. This could be explained by a large portion of resources being consumed in the household (Giroux, 2008). The same study (Darteh, 2014), could not relate the number of children with wasting as in the present study. The results of the present study corroborate with other studies where children with many siblings were more likely to suffer from malnutrition (Hiena and Hoa, 2009; Cleland *et al.*, 2006). In addition, a mother who was either pregnant or lactating (Chi-square test=10.951, DF 2; p-value= 0.004) was more likely to have a child who was wasted. This was confirmed by a study on birth spacing and chronic malnutrition where they were statistically significant in 6 out of 14 surveys done in developing countries. The study reported that increased birth interval decreased the risk of malnutrition in children.

There was no positive association on dietary diversity, mother's education years, pregnant and lactating, age of the child and sex of the child on stunting level of the children.

**Table 5. 6: Associations and relationships between nutrition status and selected socio demographic variables**

Variable	X <sup>2</sup> value	Correlation Coefficient	Sig.
Age of mother	-	0.031	0.053*
Mother's education level	8.664	0.153	0.034*
Mother's education years	-	0.126	0.063
Number of children	-	-0.05	0.059*
Household size	-	-0.102	0.049*
Socioeconomic level	1.486	0.047	0.476*
Dietary diversity	209.356	-	0.75
Pregnant/ Lactating mother	0.432	-	0.806
Sex of the child	0.967	-	0.325
Age of the child		-0.068	0.054*

\*Association was significant at p<0.05

#### 5.6.4 Predictors of stunting for the children

Linear regression analysis was used to find out the predictors of stunting for the children. This was performed using “enter” method where a significant model emerged ( $F_{8, 283}=3.18, p<0.02$ , Adjusted R square=0.057). Statistically significant predictors of stunting for the children were number of children born to a mother, mother’s educational level and marital status (Table 5.7). Socioeconomic level has been found to be positively associated with stunting (Darapheak *et al.*, 2013) although findings from this study could prove this. Mother’s educational was predictive of stunting (Abubakar *et al.*,2012). Findings of this study are consistent with a study from Peru (Urke *et al.*, 2011) where children born to mothers who had attained secondary schooling and above were less likely to be stunted than those children born of mothers who had not attended any school at all.

**Table 5. 7: Predictors of stunting**

Model	Unstandardized Coefficients		Standardized Coefficients Beta	T	Sig.
	B	Std. Error			
Number of children	-0.082	0.025	-0.315	-3.309	0.020*
Mother's education level	0.098	0.050	0.120	1.965	0.021*
Marital status	-0.073	0.034	-0.178	-2.165	0.031*
Household size	-0.013	0.017	-0.055	1.575	0.116
DDS category	-0.078	0.083	-0.055	-0.950	0.343
Socioeconomic level	-0.048	0.082	-0.037	-0.588	0.557
Age of Mother	0.009	0.005	0.149	1.667	0.097

Dependent Variable: STUNTING

DDS= Dietary Diversity Score

\* Prediction is significant

### 5.6.5 Association between Stunting and Mothers Education level

Table 5.8 shows linear regression model used to compute for association between mothers' education level and stunting. This test indicated a positive relationship with a 2 tailed sigma of 0.009. Findings from the present study correspond to those reported by (Handa, 1999), in Bovile (Frost *et al.*, 2001), in Iran (Kavosi *et al.*, 2014), in Kenya (Kabubo and Ndege 2009) and (Abuya *et al.*, 2011). Maternal education has been reported to have an impact on the overall health and nutritional status of children since the mother is enlightened on the proper skills for child care and increase on her awareness on vast nutritional needs (Mengitsu *et al.*, 2013). A Tanzanian study results also corresponded to the ones of the present study by showing that the mothers educational level is a predictor of nutritional status of children, of which one one of it was stunting according to the present study (Abubakar *et al.*,2012).

According to KDHS (2008-09), mothers who have at least post primary education, have the likelihood of feeding their children according to recommended infant and young child feeding practices (KDHS, 2010). In addition, the mother's level of education has an inverse relationship with the levels of stunting (KDHS, 2010). Another study in Bangladesh also showed that nutrition status of children born of literate mothers was much better than nutrition status of children born of illiterate mothers (Rayhan and Khan, 2006).

**Table 5. 8:Relationship between mothers'educational level and stunting**

	$\beta$	R	$r^2$	Std.Error	Sig	Lower CI( $\beta$ )	Upper CI( $\beta$ )
Constant	2.579			0.068	0.000	2.445	2.714
Education level	0.118	0.141	0.02	0.045	<b>0.009*</b>	0.03	0.207

\*Association was significant at  $p < 0.05$

$\beta$ - Regression coefficient

r- Correlation coefficient

Sig- Significance level

## **5.7 Conclusion**

Findings from this study show that most of the mother's education level played a key role in the nutrition status of her child. This sheds some light on the importance of maternal literacy on the nutritional status of the children; this is a contribution to the many studies done on the same subject. In addition, this study found out that a mother who was either pregnant or lactating was more likely to have a child who was wasted hence the great importance of birth spacing in proper growth and development of young children. Socioeconomic status remains a great topic of interest to those studying child overall development. Findings from this study showed that the higher the economic status of a household the better the nutrition status of the child.

## **5.8 Recommendations**

- Reduction of stunting levels in Vihiga County is directly linked to better maternal education since it is a great contributing factor to good nutrition status of children.
- Improvement in socioeconomic level of households in Vihiga County translates to improved overall development of the children.



## CHAPTER SIX

### OPTIMIZATION OF LOCALLY CONSUMED FOODS FOR CHILDREN 6-23 MONTHS IN VIHIGA COUNTY USING LINEAR PROGRAMMING MODEL

#### 6.1 Abstract

Complementary feeding is a crucial period for proper growth and development of a young child and infants. This is the time when the child requires nutrient dense complementary foods. The objective of the study was to develop optimized diets for children 6-23 months using the local diets available in Vihiga County, Western Kenya for nutrient adequacy. Vihiga County was purposively selected with five randomly selected sub locations within the county. A semi structured recipe questionnaire was used to collect information on recipe formulation based on locally consumed foods, which involved four women, and two men from each sub location. Data was analyzed using linear programming model for nutri-survey software for analysis of different nutrients for the age groups 6-8months, 9-11 months and 12-23 months. Analysis of the local diets prepared in Vihiga County identified Thiamine, Riboflavin, Calcium, Zinc, Iron and Niacin as ‘problem’ nutrients in the locally available diets of the children of the various age groups according to WHO recommendations of 1998. After adjusting the diets, the nutrients were met with reaching 100% of recommended nutrient intake. Therefore, linear programming can be used to optimize and give recommendations for complementary foods that adequate in meeting the nutrient requirements for children less than two years. The model can also be used to optimize cost of the formulations hence minimize food waste of locally available foods.

**Key Words: Optimization; Nutrient adequacy; linear programming; Local recipes;**

**Complementary feeding**

## 6.2 Introduction

Poor feeding practices have a great influence on the nutrient intake of infants and young children in developing countries (Hlaing *et. al.*, 2016). Inappropriate complementary feeding practices are one of the major causes of malnutrition in children (Kabir *et. al.*, 2012). Sixty percent of all the deaths that occur to children below the age of five years are caused by malnutrition. Over two thirds of all deaths occurring during the first year of life and are linked to inappropriate feeding practices (WHO, 2003). During complementary feeding period, breast milk only provides less than fifty per cent of an infant's high nutrient needs for Vitamin B1, Vitamin B2, Calcium, Zinc and Iron (WHO, 1998). Hence, the need of high nutrient dense foods to meet the child's nutrient needs (WHO, 1998). The use of local foods has been greatly emphasized in the global strategy of infant and young child feeding as a way of enhancing growth and development of infants and young children (WHO, 2003).

The need to increase the wellbeing and health of children has led to search for way in ensuring that that the child's nutritional needs are met during complementary feeding period, which is a global priority at the present. However, meeting nutritional needs of a child aged 6-24 months has become a challenge especially in the developing countries (Dewey, 2013). The quality of the diets used has been a major drawback, unlike the quantity of the diets available in the developing countries Lutter and Rivera, (2003). Therefore, efforts to increase food quality through techniques for combination of locally available food types in the developing countries to optimize on the dietary nutrients needed by children has been identified as a potential way to addressing the aforementioned challenges.

Complementary foods in developing countries are often nutritionally inadequate (Gibson *et al.*, 2010). The diets are mainly based on cereals and legumes with regard to the amount of bio

available iron and zinc provided by these foods (Dewey, 2013). In Kenya, complementary foods introduced to children are mainly low in energy and micronutrients (GOK; MPHS, 2007). This influences negatively on growth and development of these children. Furthermore, nutritional adequacy and infant and young child feeding practices suggest that there are low quality infant and young child diets in Kenya (Ferguson *et al.*, 2015).

Linear programming is a technique used to optimize diets when the nutrient composition, the prices and the nutrient requirements to be met of such foods are known (Dewey and Brown, 2013). This technique can perfectly be used in local food evaluation and combinations to increase nutrient supply to children. The programme has been used widely as a tool for nutritional recommendations, especially where combinations for optimization is considered (De Carvalho *et al.*, 2015). It has also been used as an approach to tailor make recommendations on appropriate foods for complementary feeding and supplementary foods for malnourished children (Fahmida *et al.*, 2015; Kunyanga *et al.*, 2012). A study in Indonesia using linear programming identified nutrients such as Niacin, thiamine, Calcium, Zinc and Iron were likely to remain low in local complementary diets (Santika *et al.*, 2009). The present study therefore seek to address the challenges of food diets optimization in Vihiga county, as a follow up on a study that showed the present local diets used by children do not meet their recommended dietary requirements. The findings seek to recommend appropriate diet combination that optimize on quality and quantity of locally used food fed to children in quest to reduce the malnutrition in Vihiga County.

## **6.3 Methodology**

### **6.3.1 Study Setting**

Vihiga County is located in the Western region of Kenya, in the Lake Victoria basin. The county is divided into four administrative Sub-counties namely; Hamisi, Emuhaya, Sabatia and Vihiga. It is further divided into nine divisions, 37 locations and 129 sub-locations. Vihiga County mainly lies in the Upper Midland (UM) agro-ecological zone (Jaetzold *et al.*, 2005). The main livelihood option is mixed farming with main crops being maize, beans, cassava; sweet potatoes, sugarcane, and livestock specie are cattle, sheep, goat and chicken. Agro forestry with most being fruit trees is also common among household farms, mainly papaya, avocado, loquats and bananas.

### **6.3.2 Sampling protocol and study population**

The study was a cross sectional study design with an analytical aspect. Purposive sampling was used to select Vihiga County, with five sub-locations namely; Essunza, Masana, Wanondi, Mambai and Itumbu being randomly selected. The next stage was random selection of households with children of the age groups (6-8 months, 9-11 months and 12-23 months) from the five sub locations. Thereafter, the selected households were grouped into three groups according to their children age groups as mentioned above. The households selected were later instructed to generate their normal food menus of the children's foods as done on routine basis at household level. They later prepared the food practically at central place per Sub County according to how they normally prepare at their homes. Moreover, the participants were asked to bring foods available from their kitchen gardens and if the foods were not available during the study time, they were to buy from the local market with the facilitation by the researchers.

### **6.3.3 Data collection Tools**

A semi structured recipe questionnaire was used to obtain information on the different food recipes used at household level when cooking for children of the three age groups. The researcher also used Focus Group Discussion, Key Informants from local women group leaders and personal observations during the food preparation process at the central cooking place during the study.

### **6.3.4 Data collection procedure**

The participants were engaged in formulation and preparation of food recipes based on commonly consumed dishes using local ingredients. The documented findings included names and raw weights of edible portions of all food ingredients used in the recipes; the cooking method used, cooking time and the final weight of the cooked dish. The ingredients of the foods were calculated per 100g of the cooked food and entered in an excel sheet. The specific ingredients were then entered in Lucille software, which then computed the specific nutrients of the different foods per 100g of cooked food. Nutri survey was used in the analysis of foods not available in the software that were included. The Kenya food composition table was also used to refer to specific foods not available in the nutri survey software.

A market survey was conducted in two local markets i.e., Majengo and Luanda markets with the help of field guides. Two enumerators bought two samples of food per market locally consumed by the children. The cost of the foods was the directly calculated. For the foods that were cooked, the raw ingredients were weighed individually and summed up to obtain the total cost of all the ingredients. The final cooked food was also weighed and the cost per 100g of the food obtained. The data obtained was used define parameters in the linear programming.

### 6.3.5 Sample size determination

Sample size was calculated using Fisher *et al.*, (1991) as follows:

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

Where:

n= Desired sample size

Z<sup>2</sup> 1- $\alpha$ /2 = Standard normal deviate set at 1.96 which corresponds to 95% of confidence interval

P=the prevalence of stunting in Vihiga County (23.5%)

d=Degree of accuracy desired set at 5%

Therefore:

$$\frac{1.96^2 (0.235) (0.765)}{(0.05)^2} = 276.24$$

Add 10% attrition= 303

Therefore, sample size of **303** respondents.

### 6.4 Data Analysis

Linear programming module for nutri survey was used in the analysis of the diets if they were meeting the recommended nutrient intakes for the different age groups (<http://www.nutrisurvey.de/lp/lp.htm>). Lucille software developed by university of Ghent, Belgium (<https://bw07srv4.ugent.be/foodintake/spring/intro>) was used to analyze the nutrients of the foods available locally in Vihiga. The foods not available in the two software's were added with the help of the Kenyan national food composition table.

The energy content of the diets formulated was determined using (WHO, 2003) recommendations for the breastfed child where the energy requirements of the different ages in the study were; 6-8 months (615 kcal), 9-11 months (686 kcal) and 12-23 months (894 kcal) as shown in appendix 6.

## **6.5 Results and Discussion**

### **6.5.2 Optimized diets for children aged 6-8 months**

Appendix 5 presents the nutrients incorporated in nutri survey software used in the analysis of the food types in this study. In Diet 1 in Table 6.2, the diet before optimization showed that there was high intake of carbohydrates (Ugali - 86g and rice-132g) (Table 6.2) which was analyzed for optimization of the diet and gave only Ugali at 82g without rice in the diet would be ideal. In addition, the optimized diets showed high intake of proteins when compared to the normal diets consumed at households across all the diets. The four different normal household's diets sufficient of key nutrients mainly: iron, zinc, energy, vitamin B<sub>12</sub>, vitamin B<sub>6</sub>, calcium and pantothenic acid (Table 6.2). These findings agree with those of (Dewey and Brown, 2003) where they reported Vitamin B<sub>6</sub>, zinc and iron are the problematic nutrients in complementary foods in developing countries. In addition, (Briend and Darmon, 2000; Allen, 2012) also noted that zinc and iron are the common problematic nutrients in the diets of children during complementary feeding. According to (Allen, 2012), complementary foods from low-income countries often do not meet micronutrient requirements, a statement that agrees to the findings of this study, since most of the micronutrients were not met from the foods taken by the children of the different age groups. (Dewey, 2013) also found out that most of the foods in low-income countries are often deficient of zinc and iron and in some cases, they are deficient of most

micronutrients. The findings of the present study collaborate with those of (Hlaing *et al.*, 2016) where they found out that calcium, iron, zinc, niacin and folate were seen to be the problem nutrients even after the foods had been optimized.

Maize porridge was mostly given to children of the age 6-8 months in the study region. From the analysis done on the recipes in (Chapter four), the nutrient and energy densities of selected nutrients of the maize porridge were; (0.68kcal/g for energy, 0.74mg/100kcal for iron, 0.41mg/100kcal for zinc) as compared to (WHO 1998) recommendations per 100kcal of the food. These nutrient densities were low and hence compromising growth and development of the children at this age within the study area. This finding agree with (Dewey, 2013) which highlighted that most diets of children in developing countries are dominated by cereal based porridges, which have low nutrient densities and often are of low bioavailability, thereby increasing the chances of malnutrition.

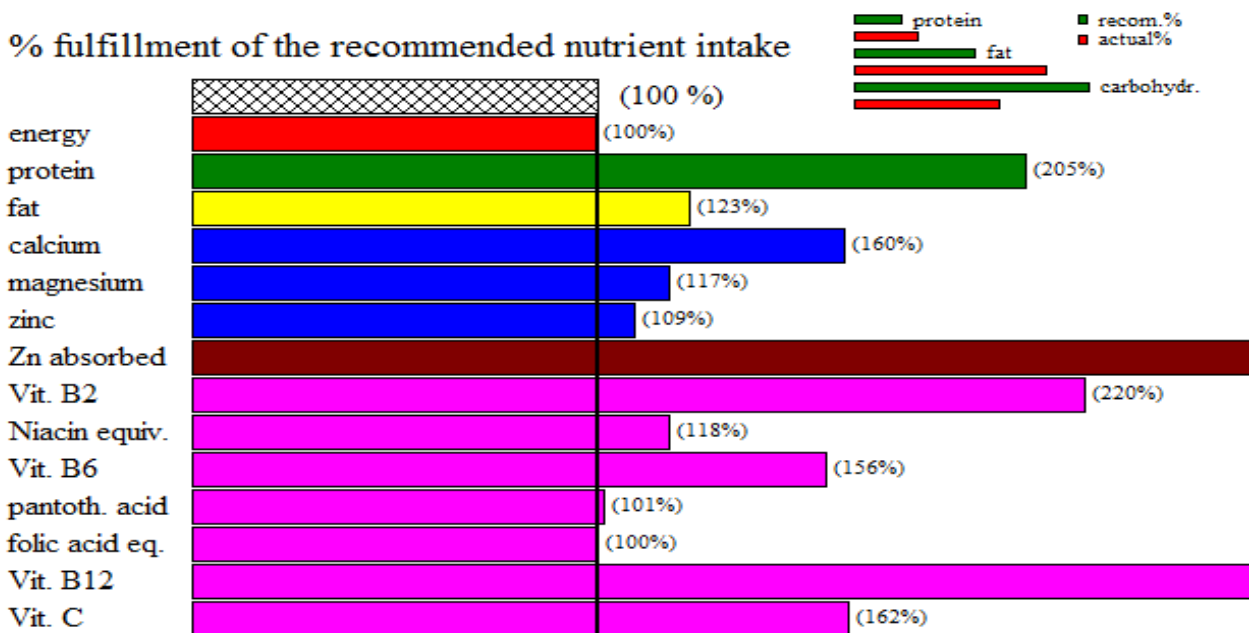
The foods cooked and eaten as combinations e.g. Jews mallow (local name-mrenda) +Amaranth (local name - zimboga) and Irish potatoes+ pumpkin leaves (local name-seveve) were seen to be deficient of most of the micronutrients. Nutrient losses during cooking could be the cause of nutrients deficient in these foods. It is well known that nutrient losses happen during different cooking processes and an understanding on when these nutrients are lost and why could be resourceful to the person preparing these foods (Fabbri and Crosby, 2016).



**Table 6. 1: Optimized and normal diets for a 6-8 month old child**

<b>Diets</b>	<b>Foods</b>	<b>Normal Diet amount</b>	<b>Optimized diet amount</b>
<b>Diet 1</b>	Jews mallow mixed with Cowpea leaves	78g	78g
	Ugali		
	Orange	86g	82g
	Cow's milk	120g	64g
	Ripe banana	290g	500g
	Boiled rice	29g	29g
		132g	0g
The limiting nutrients in the diet were: <b>iron, zinc, calcium and energy</b>			
<b>Diet 2</b>	Maize porridge	219g	0
	Jews mallow (Mrenda) and Amaranth (Zimboga)	55g	6g
	Ugali	86g	50g
	Ripe Banana	25g	29g
	Boiled Cow's milk	500g	76g
		Limiting nutrients: <b>vitamin B12, iron, calcium and zinc</b>	
<b>Diet 3</b>	Maize Porridge	409g	223g
	Irish potatoes and green bananas mixture	116g	116g
	Ugali	82g	282g
	Jews mallow (Mrenda) and Amaranth (Zimboga)	80g	82g
	Avocado	15g	15g
		Limiting nutrients are; <b>fat, calcium, zinc, vitamin B12, pantothenic acid and vitamin B6</b>	
<b>Diet 4</b>	Maize porridge	127g	111g
	Cow's milk	260g	408g
	Irish potatoes + pumpkin leaves(seveve)	112g	49g
	Ripe banana	8g	
	Maize porridge	127g	
<b>Zinc, calcium, niacin</b> nutrients requirements could not be met			

Figures 6.1, 6.2, 6.3 and 6.4 show the percentage fulfilment of the recommended nutrient intakes of the optimised diets designed by linear programming for the children aged 6-8 months after optimization of the diets. All the four diets after optimization met the recommended nutrient intakes as seen that they were all meeting the 100% of which other nutrient elements exceeded the recommendations Figure 6.1, show optimised diet 1 with Jews mallow (Mrenda) mixed with cowpea leaves(Kunde) 80g, Orange 64g, Boiled cows milk 500g, A ripe banana 29g; figure 6.2, presents optimised diet 2: Jews mallow(Mrenda) and Amaranth(Zimboga) 6g, Ugali 50g, Ripe Banana 29g, Boiled Cow's milk 76g; figure 6.3, optimised diet 3: Maize Porridge 223g, Irish potatoes and green bananas mixture 116g, Maize porridge 282g, Ugali 82g, Avocado 15g; and figure 6.4 optimised diet 4: Cow's milk 111g, Ripe banana 408g and Spinach 49g.



**Figure 6.1: Optimized diet 1, per cent fulfilment of the recommended nutrient intake for a 6-8 month old child**

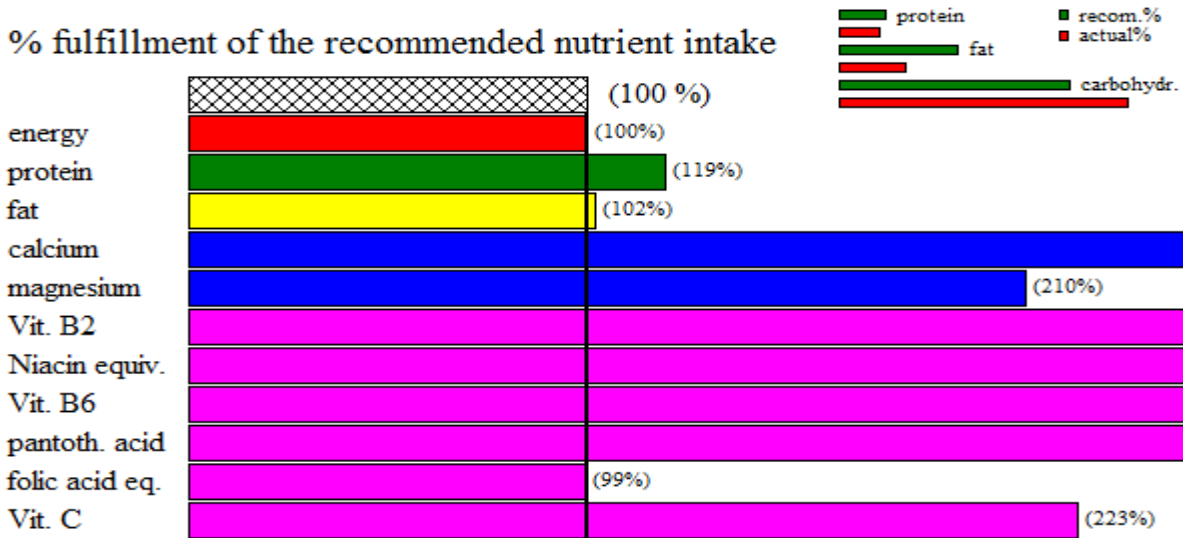


Figure 6.2: Optimized diet 2, per cent fulfillment of the recommended nutrient intake for a 6-8 month old child

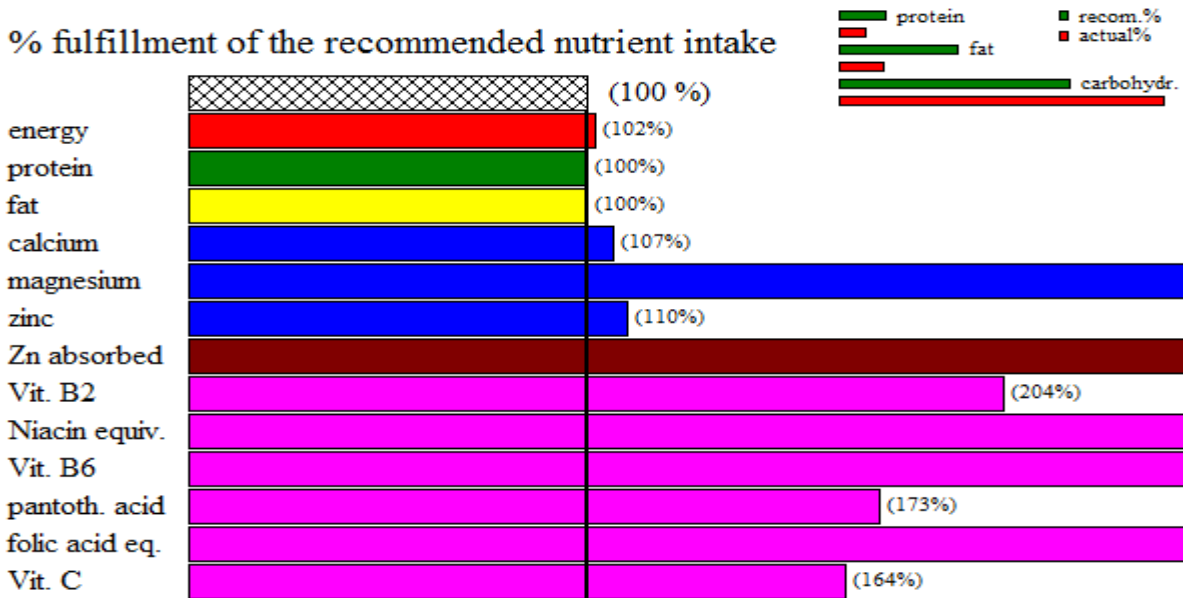
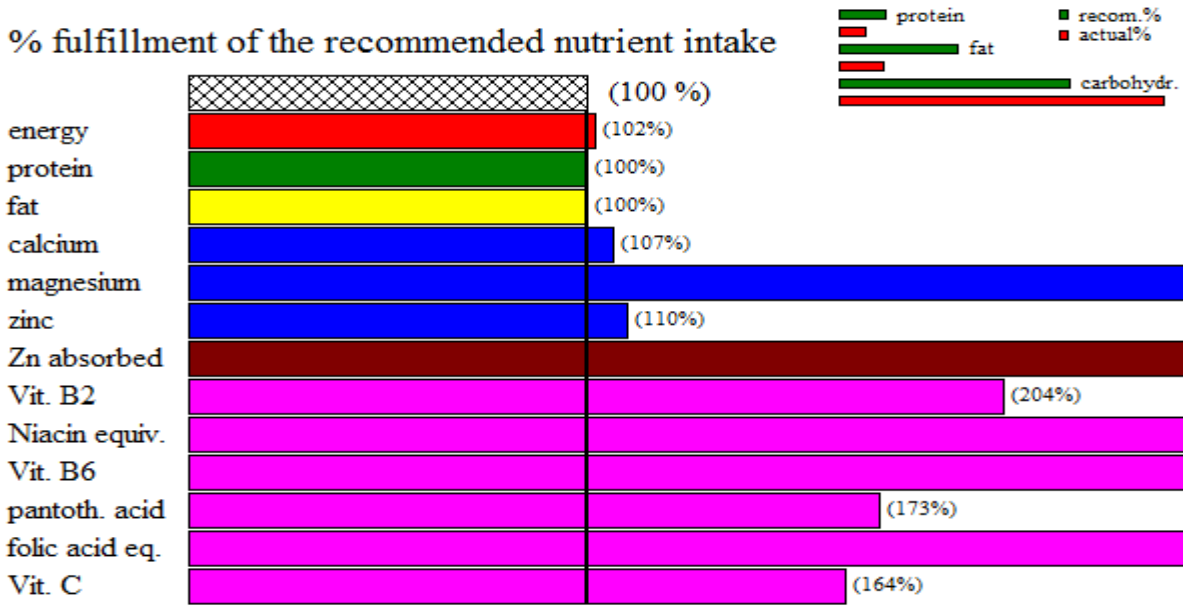


Figure 6.3: Optimized diet 3, per cent fulfillment of the recommended nutrient intake for a 6-8 month old child



**Figure 6.4: Optimized diet 4, per cent fulfillment of the recommended nutrient intake for a 6-8 month old child**

### 6.5.3 Optimized diets for children aged 9-11 months using linear programming

Table 6.3 , presents the optimised diets for children aged 9 - 11 months using linear programming. For the diets in age group 9-11, Diet 1 was deficient of fat, Iron, Pantothenic acid, Vitamin B12 and Vitamin C; Diet 2, Vitamin B6 and Vitamin B12 and Diet 3 Calcium, magnesium, zinc, iron (Table 6.3). Optimal solutions for the diets were found after adjusting the portions of the foods incorporated in the diets so as to meet the recommended nutrient intakes.

These findings were consistent with those of (Osendarp *et al.*, 2016) where they found out that in low and middle income countries; calcium, iron, zinc, energy, were among the nutrients that lacked in complementary diets of children aged 6-24 months. Findings of the current study are also in agreement with those of ((Briend and Darmon, 2000; Dewey and Brown, 2003; Alle,

2012; Dewey, 2013; Skau *et al.*, 2014; Hlaing *et al.*, 2016) where they found out there are of number of limiting nutrients in complementary foods of children aged 6-24 months.

The most common diet identified in these age groups was milk tea of which it was low nutrient dense in regards to the nutrients of interest to the age group. (Faber *et al.*, 2016) reported that it is difficult to meet the requirements of the children above 6 months with a complementary diet in the absence of fortified foods. Results of a study conducted in the same study area corroborate the ones of the present study where Zinc, calcium and iron were reported to be the limiting nutrients in complementary foods of the children in all the age group (Ferguson *et al.*, 2015).

When optimization of the diets for the two age groups as presented in figures 6.5, 6.6 and 6.7 using linear programming; all the nutrients had met the 100% threshold for the recommended nutrient intake for children of 9-11 months.

## Diets for children aged 9-11 months

**Table 6. 2: Optimized and normal diets for a 9-11month old child**

Diets	Food	Normal diet amounts	Optimised diet amounts
<b>Diet 1</b>	Maize porridge	260g	342g
	Boiled bananas	84g	69g
	Pumpkin leaves	77g	77g
	Ugali	98g	162g
	Omena	24g	30g
	Ugali	98g	98g
		Limiting Nutrients: <b>Fat, Iron, Pantothenic acid, Vitamin B<sub>12</sub> and Vitamin C</b>	
<b>Diet 2</b>	Milk tea	350g	0g
	Maize porridge	354g	0g
	Ugali	298g	98g
	Cooked spinach	77g	77g
	Omena	57g	56g
		Limiting Nutrients: <b>Vitamin B<sub>6</sub> and Vitamin B<sub>12</sub></b>	
<b>Diet 3</b>	Milk tea	269g	190g
	Maize porridge	404g	0g
	Rice	198g	76g
	+Pumpkin+Potato		
	Orange	90g	90g
	Ugali	169g	98g
	Water melon	20g	20g
	Cow's milk	340g	252g
	Chicken egg	20g	20g
	Chicken cooked	12g	67g
		Limiting nutrients: <b>Calcium, magnesium, zinc, iron</b>	

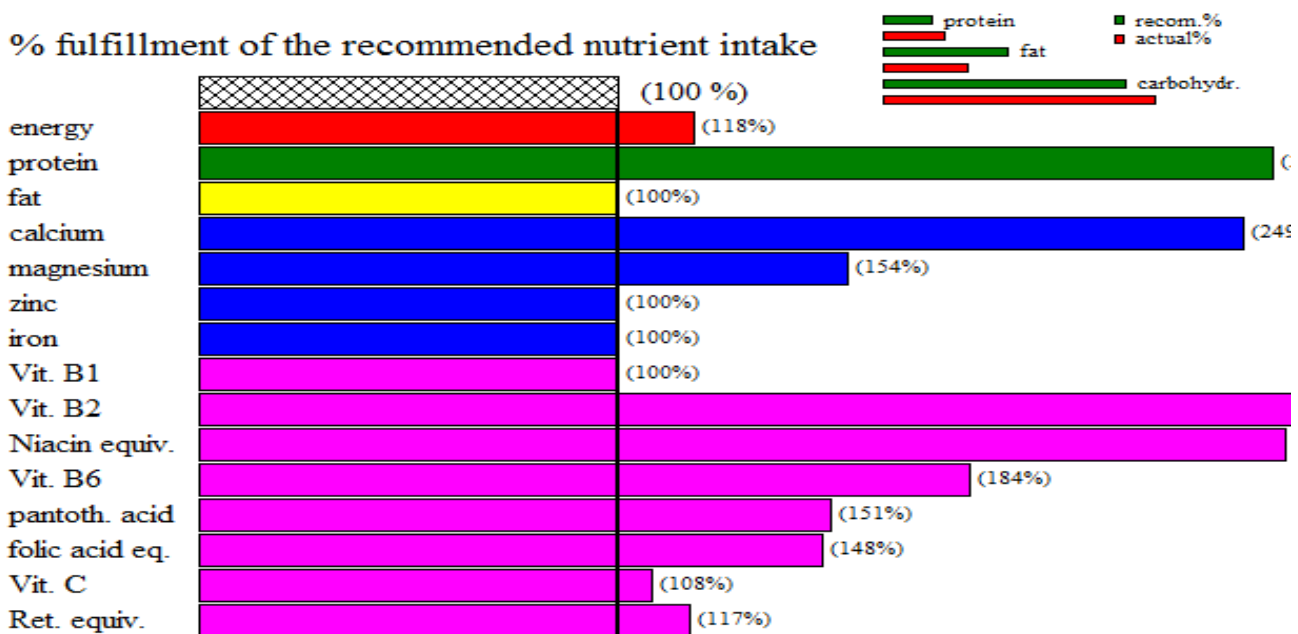


Figure 6.5: Optimized diet 1, per cent fulfilment of the recommended nutrient intake for a 9-11 month old child

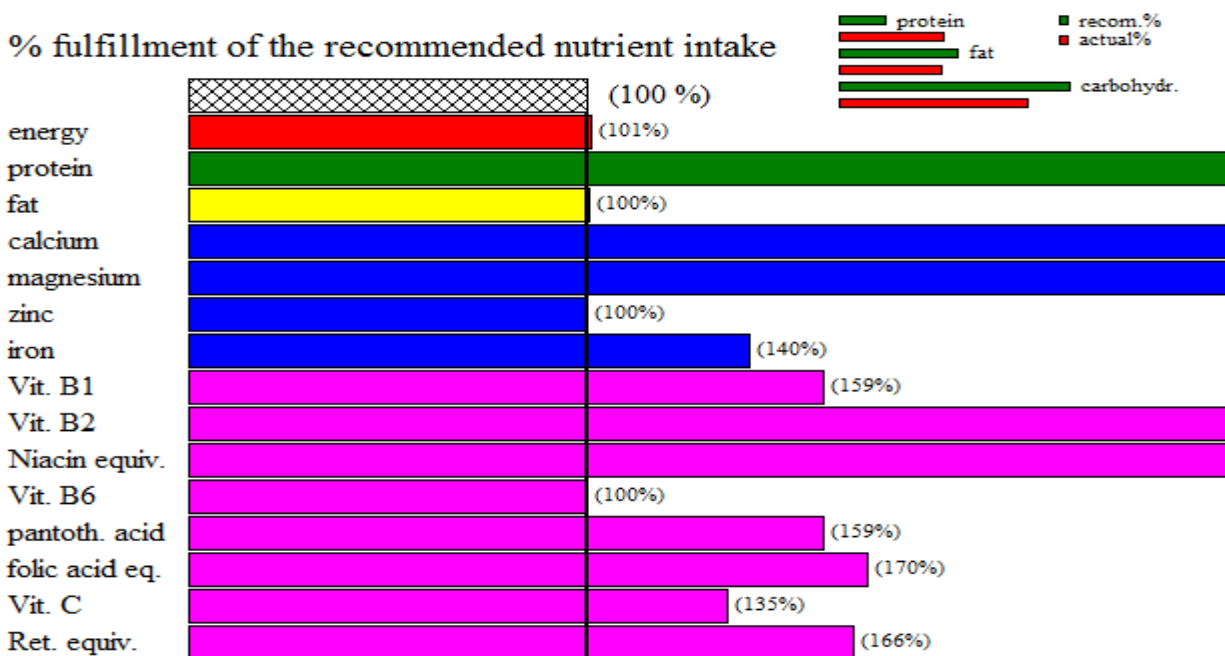
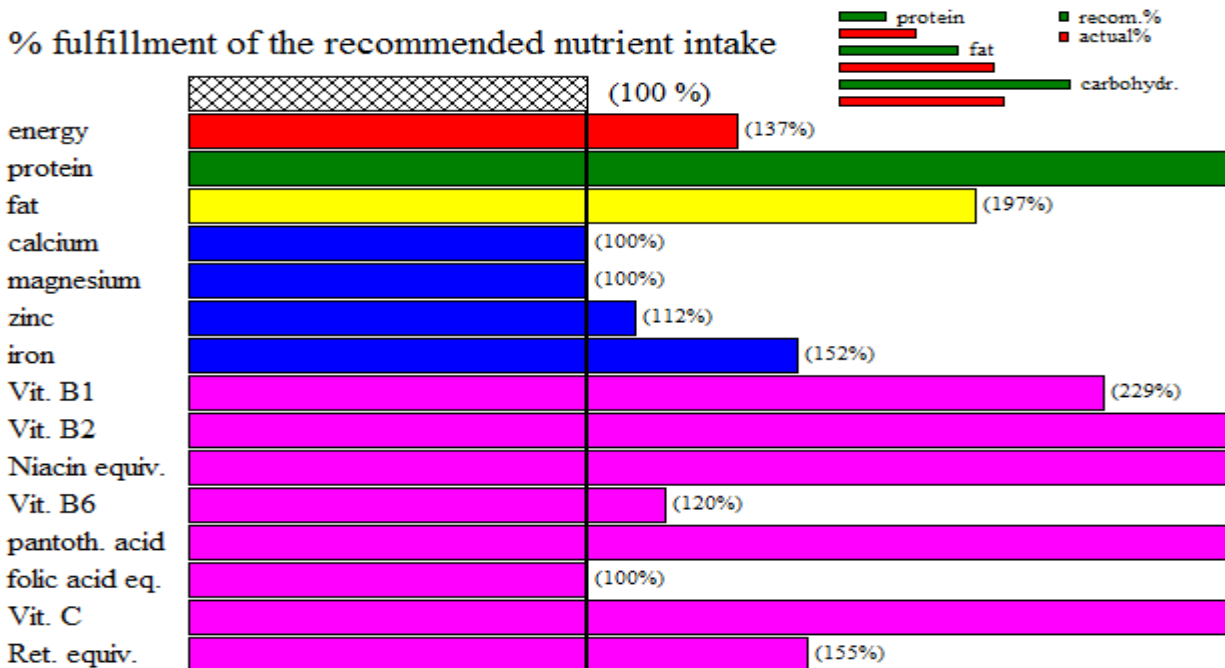


Figure 6.6: Optimized diet 2, per cent fulfilment of the recommended nutrient intake for a 9-11 month old child



**Figure 6.7: Optimized diet 3, per cent fulfilment of the recommended nutrient intake for a 9-11 month old child**

### 6.5.4 Optimized diets for children aged 12-23 months using linear programming

Table 6.4, presents normal and optimized diets for children aged 12-23 months. The common foods taken are milk tea, maize porridge, Ugali and kales (sukuma wiki). Interestingly after optimizing the diet combinations, milk tea, maize porridge and Ugali seem to be low nutrient density hence the program could not pick those foods. From the findings, diet 1 low in vitamin B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, energy and fat, diet 2 was low in energy, vitamin B<sub>1</sub> and Retinol equivalent; diet 4 on the other hand was low in energy, fat, zinc, iron, vitamin B<sub>1</sub>, Vitamin B<sub>2</sub>, Vitamin B<sub>6</sub>, Vitamin B<sub>12</sub> and Pantothenic acid. On the other hand, diet 3 met all the nutrient intake recommendations after adjusting the portions of the different foods in the diet. All the optimized diets were improved with the local ingredients and the foods that are locally available, for example, cow's milk was a key



food component that improved the nutrient content of the entire diet of children for this specific age group in improving the recommended nutrient intake. Different foods can be integrated together so as to meet the nutrient needs of the infants and young children as emphasized in the global strategy for infant and young child feeding (WHO, 2003). In the designed diets, fruits were also taken into great consideration in meeting micronutrient needs for children of this age. The fruits included Guavas, avocados, ripe bananas and mangoes collected from the bush.

The present study from the findings in diet 4 found out zinc and iron were limiting nutrients among others in that specific diet. This finding corroborate with that of a study done in Northern Kenya reported that zinc and Niacin were consistently found to be the problem nutrients in the modeled foods designed for complementary feeding (Vossenaar *et al.*, 2017; Santika *et al.*, 2009; Vossenaar and Solomons, 2012). Osendarp *et al.*, 2016 reported that nutrients such as energy, vitamin A, Thiamine, folate, Niacin, Riboflavin and vitamin C needs are not always met by the local foods.

Figures 6.8, 6.9, 6.10 and 6.11 show percentage fulfillment of recommended nutrient intake for 12-23 month old child. However, some of the nutrients in the diets exceeded the 100% mark after optimizing the diets for this age group. A study done on optimized diets for the 12 -23 months age group showed nutrients exceeded 100% (Fahmida and Santika, 2016). Findings of all the four diets optimized met the recommended nutrient intakes of the key nutrients after optimization by linear programming.

**Table 6. 3: Optimized and normal diets for children aged 12-23 months**

<b>Diets</b>	<b>Foods</b>	<b>Normal diet amounts</b>	<b>Optimized diet amounts</b>
<b>Diet 1</b>	Milk tea	951g	0g
	Maize Porridge	708g	0g
	Boiled maize	171g	145g
	Sukuma wiki(kales)	58g	60g
	Ugali	260g	76g
		The limiting nutrients in the diet were: <b>vitamin B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, and B<sub>12</sub>, energy and fat</b>	Cow's milk n 404g
<b>Diet 2</b>	Maize porridge	994g	497g
	Milk tea	350g	0g
	Avocado	112g	60g
	Omena	53g	42g
	Ugali	440g	0g
	Boiled egg	58g	58g
	Ripe Banana	103g	100g
	Limiting nutrients: <b>Energy, Vitamin B<sub>1</sub>, Retinol Equivalent</b>		Guava 41g Chicken egg(whole) local 60g
<b>Diet 3</b>	Milk tea	350g	0g
	Bread	42g	50g
	Boiled egg	58g	0g
	Maize porridge	350g	34g
	Rice	263g	0g
	Beans	165g	0g
	Mango	26g	30g
	Ugali	227g	19g
Sukuma wiki(kales)	77g	12g	
	Limiting nutrients are; <b>None</b> only modifying portions		Beans ,kidney, dried cooked 201g Guava 26g
<b>Diet 4</b>	Milk tea	700g	350g
	Bread	42g	50g
	Avocado	41g	60g
	Irish potatoes + green bananas	304g	0g
	Ripe banana	8g	20g
	Ugali	250g	250g
	Omena	64g	0g
	Mango	71g	30g
	Limiting nutrients: <b>Energy, fat, zinc, iron, Vitamin B<sub>1</sub>, B<sub>2</sub>,B<sub>6</sub>, B<sub>12</sub> And pantothenic acid</b>	87	Pumpkin leaves 80g Liver 74g Cow's milk 99g

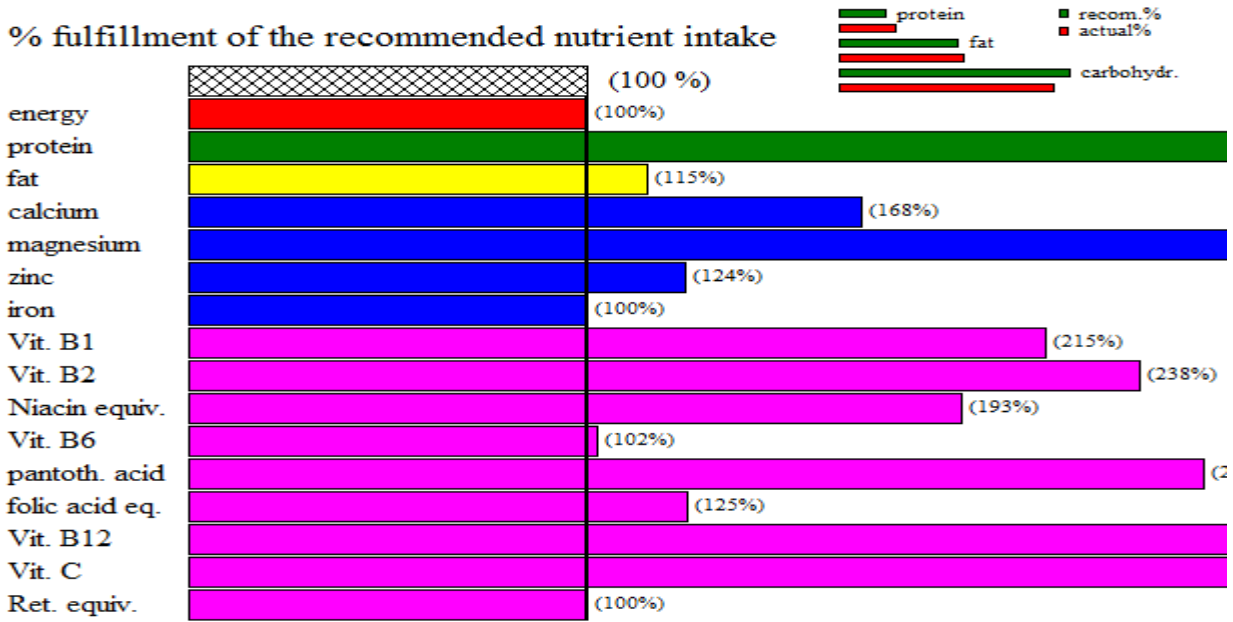


Figure 6.8: Optimized diet 1, per cent fulfillment of the recommended nutrient intake for a 12-23 month old child

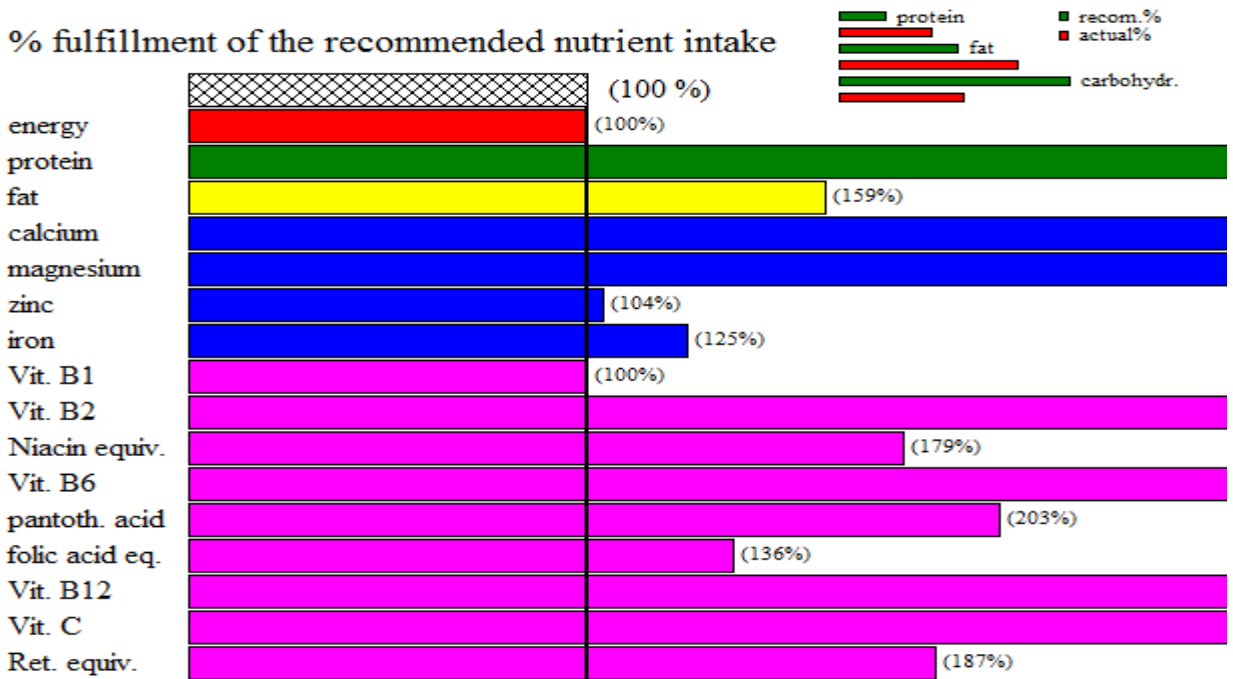
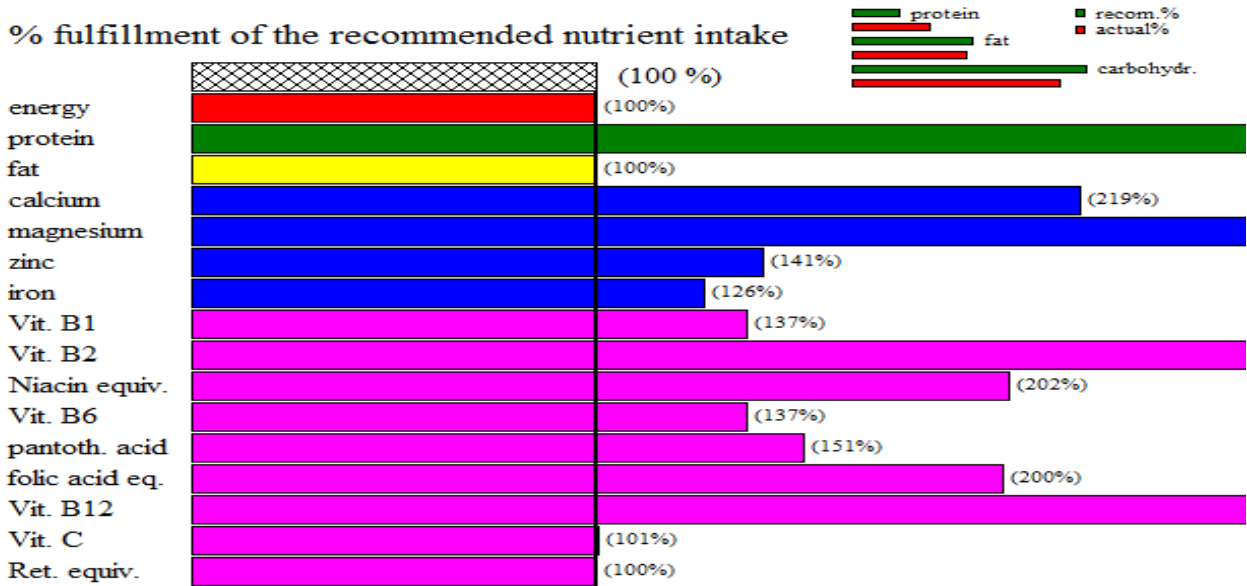
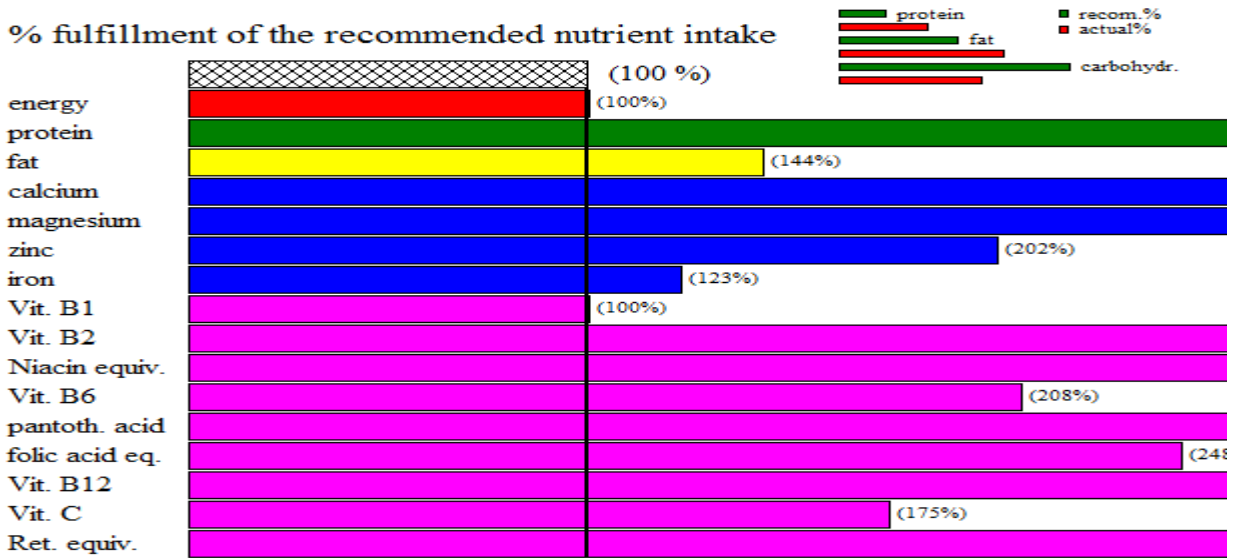


Figure 6.9: Optimized diet 2, per cent fulfillment of the recommended nutrient intake for a 12-23 month old child



**Figure 6.10: Optimized diet 3, per cent fulfillment of the recommended nutrient intake for a 12-23 month**



**Figure 6.11: Optimized diet 4, per cent fulfillment of the recommended nutrient intake for a 12-23 month old child**

## **6.6 Conclusion**

This study showed that the local diets made in Vihiga County are low in some critical nutrients, which are needed in high amounts during complementary feeding. The study also indicated that there are some low nutrient dense foods commonly consumed like tea with milk. This can be corrected with the replacement with enriched porridges that provide additional energy and nutrient rich ingredients such as groundnut flour, cooking oil, butter, 'omena' flour, sugar and milk to increase nutrient density. The findings also show that the locally available food types can be optimally used if the findings of the linear programming are adopted to correct for the identified deficiencies under the different diet types. This finding can be used as a useful tool in making recommendations for complementary foods for infants and young children in Vihiga County. The optimized diets met recommended nutrient intakes for infants and young children for the specific age groups.

## **6.7 Recommendations**

More focus needs to be put on diversifying the diets through integration of different ingredients to specific foods especially maize based porridges. This can be achieved through use of locally available foods e.g. Groundnuts, milk and sugar so as to increase nutritional content of those foods and improving nutrition status of children in Vihiga.

## CHAPTER SEVEN

### 7.1 GENERAL CONCLUSIONS AND RECOMMENDATIONS

#### 7.1.1 Conclusions

Given the study findings were line with the study objectives, the following conclusions were drawn from the study:

1. Most of the primary caregivers of children in Vihiga County were biological mothers of the children. Their educational level was often that of primary school level. Literacy level of the mothers was quite low as far childcare is concerned. This could be evidently seen in stunting that was positively associated with mother's educational level. Socioeconomic status of households is also a critical aspect in studying child development in any given set up. This is because it influences availability and accessibility of economic resources to be used in the household and hence overall child health.
2. There are diverse foods for complementary feeding in Vihiga County. This is because of the great agricultural potential in the region as lies in the humid tropics zone. However, most micronutrients are lost during food preparation and cultural influences.
3. Nutrition status of children was found to be influenced by different socio demographic factors i.e. marital status, number of children born to a mother and socioeconomic level of the study households and dietary diversity scores.
4. Local food diets consumed as complementary foods in Vihiga County are lacking in critical micronutrients for infant and young children's growth and development. Findings

show that there were some problematic nutrients in local foods used for complementary feeding in Vihiga.

### **7.1.2 Recommendations**

1. Maternal education level plays a crucial role in child development; more efforts need to be drawn to this influence. Other aspects can also be explored like the father's educational level to draw these inferences if any.
2. More research needs to be done to assess long-term effects of locally consumed foods and nutritional status of children through longitudinal studies. Additional nutrition education needs to be further explored in increasing more on dietary diversity of children in the region to improve nutrition status of children.
3. Further research needs to be done to explore other confounding factors that influence the nutritional status of children such as birth weight, nutrition status of the mother during pregnancy and overall household income.
4. Nutritional content of locally available foods used for complementary feeding in Vihiga can be improved through integration of different ingredients in some foods especially cereal based porridges. This can be achieved through more sensitization on importance of using different available ingredients to the caregivers taking part in food preparation for infants and young children.

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## APPENDICES

### APPENDIX 1: STUDY QUESTIONNAIRE

#### SECTION A: DEMOGRAPHIC AND SOCIO-ECONOMIC INFORMATION

Household No. ....: Location .....: Sub-location .....

Village.....: Date:.....:Day/month/Year.....

Name of interviewer.....

#### A 1. PARTICIPANT CHARACTERISTICS

No	Name	Age	Sex 1=Male 2=Female	Marital status 1=Married 2=Divorced 3=Separated 4=Windowed 5=Single 6=N/A	No. of Children 1=1 2=2 3=3 4=4 5=6 7=7 8=others	Education level (in years) 0=none 1=in primary 2=Completed primary 3=Primary drop out 4=insecondary school 5=Completed secondary 6=secondary drop out 7=college/university 8=NA (age <6yrs)	No. of years in education 1=6 2=8 3=12 4=14 5=16	Occupation 1=formal employment 2=Business 3=farming 4=casual labourer 5=unemployed 6=student 7=N/A(age<15 yrs) 8=others(specify)	Contribution to HH 1=Nothing 2=Money 3=Labour 4=Childcare 5=less than 15yrs 6=savings 7=pension 8=others specify)
1									
2									
3									
4									
5									
6									
7									

#### A2. What is the household's main source of income?

- 1=Animal and animal product sales
- 2=Casual/waged labor
- 3=Salaried or waged
- 4=Begging
- 5=Gifts
- 6=Petty Trade
- 7=crops sales
- 8=remittances
- 9=others(specify)



**A3.** What was your total expenditure for the previous month on:

Food.....Other expenses.....

**A4.** Do you have any savings? (1)Yes (2) No If Yes, how much?.....

**SECTION B**

**Dietary Intake-24 hour dietary recall**

Please describe the foods and drinks taken during the last 24 hours from morning to night time whether at home or outside the home.

*(Researcher to list all foods mentioned, where composite meals are mentioned probe for the ingredients, when respondent is through probe for any meal that might not have been mentioned.)*

*Match the meal according to time given by the respondent.*

<b>Time</b>	<b>Dish</b>	<b>Ingredients</b>	<b>Total volume of food prepared</b>	<b>Unit in Grams</b>	<b>Amount served to the child</b>	<b>Amount left over</b>	<b>Amount consumed</b>

## SECTION C: 24-Hour Individual Dietary Diversity Score

The interviewer should establish whether the previous day and night was usual or normal for the child. If unusual- feasts, funerals and most members absent, then another day is selected.

Question Number	Food Group	Examples	Yes = 1 No = 0	1= own 2= purchase 3= gift 4= other
1.	CEREALS	Bread, noodles, biscuits, cookies, or any other food made from millet, sorghum, maize, rice, wheat + <i>local foods e.g. Ugali, porridge</i>		
2.	VITAMIN A RICH VEGETABLES AND TUBERS	Pumpkins, carrots, squash, or sweet potatoes that are orange + <i>any other locally available vitamin A rich vegetables</i>		
3.	WHITE TUBES AND ROOTS	White potatoes, white yams, cassava, or foods from roots		
4.	DARK GREEN LEAFY VEGETABLES	Dark green/leafy vegetables		
5.	Other vegetables	Other vegetables, including wild one		
6.	VITAMIN A RICH FRUITS	Ripe mangoes, papayas + <i>any other locally available vitamin A-rich fruits</i>		
7.	OTHER FRUITS	Other fruits, including wild fruits		
8.	ORGAN MEAT (IRON RICH)	Liver, kidney, heart or other organ meats or blood-based foods		
9.	FLESH MEATS	Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds		
10.	EGGS			
11.	LEGUMES, NUTS AND SEEDS	Beans, peas, lentils, nuts, seeds or foods made from these		
12.	FISH	Fresh or dried fish		
13.	MILK AND MILK PRODUCTS	Milk, cheese, yogurt or other fermented milk products		
14.	OILS AND FATS	Oils, fats or butter added to food or used for cooking		
15.	SWEETS	Sugar, honey, sweetened soda or sugary foods e.g. chocolates, sweets or candies		
16.	SPICES, CONDIMENTS, BEVERAGES	Spices (salt, black pepper), condiments (soy sauce, hot sauce) coffee, tea, alcoholic beverages or local examples		
Did you eat anything (meal or snack) outside home yesterday?				

Adapted from FAO (2010)

## SECTION D: Anthropometry children (6-23 months) in the households

First Name	Sex	D.O.B	Age (months)	Weight (kg)			Height (cm)			Oedema	MUAC (cm)			W/A	W/H	H/A
				1 <sup>ST</sup>	2 <sup>ND</sup>	AVE	1 <sup>ST</sup>	2 <sup>ND</sup>	AVE		1 <sup>ST</sup>	2 <sup>ND</sup>	AVE			

**SECTION E: Recipe Questionnaire**

**Documenting recipes used in preparation of food for**

- 7-8 Month
- 9-11 Months
- 12-23 Months

**Name of Dish:**

**Meal/Time**.....

Description of dish

.....  
 .....

List of ingredients and their raw weights (g)

Weight of the cooking pot:.....

Name of Ingredient	Raw weight(g)	Edible portion(g)	Actual mount cooked (g)

Total weight (g) of final cooked food (before serving) +cooking pot

Actual weight of cooked food= Total weight (g) of final cooked food (before serving) +cooking pot -

Weight of the cooking pot

.....  
 .....  
 .....  
 .....

Procedure for cooking

.....  
 .....  
 .....  
 .....  
 .....

Amount served

(g).....  
 .....  
 .....

## APPENDIX 2: INFORMED CONSENT FORM

Introduction and consent form for a study on **Dietary Assessment and Nutritional Status of Children Consuming Local Food Recipes in Vihiga County, Western Kenya.**

### Introduction

Hello, my name is \_\_\_\_\_ and I am working in collaboration with Gladys Cherop from the University of Nairobi, Department of Food Science, Nutrition and Technology, Applied Human Nutrition Programme. I am conducting a research survey that seeks to determine **Dietary Assessment and Nutritional Status of Children Consuming Local Food Recipes in Vihiga County, Western Kenya**

### Purpose

The information you provide will be only used to asses' the diet and nutrition status of children consuming local foods in Vihiga County.

### Confidentiality

Information given will be kept confidential and used to prepare a dissertation which will not include any specific name. Reference numbers will be used to link you name and your answers without identifying you.

Your participation in this study is voluntarily, and if you have any issue concerning the study that you don't wish to raise with me, you can contact Egerton University Ethics Review Committee. However, I hope that you will participate in the survey since your views are very important.

### Benefits

The benefits of this study is that the information will be useful in knowing nutrition content of foods used for complementary feeding in Vihiga County.

By signing or approving this consent indicates that you understand what will be expected of you and you are willing to participate in the survey.

May I begin now?

Signature of respondent. \_\_\_\_\_

Signature of interviewer \_\_\_\_\_

Date \_\_\_\_\_

### APPENDIX 3: ENUMERATORS/RESEARCH ASSISTANTS TRAINING PACKAGE

DAY/TIME	TOPIC	TEACHING METHOD	TEACHING AIDS	MODERATOR
<b>DAY 1</b> <b>8:30-10:30 am</b>	Introduction Study objectives, aim and purpose, activity matrix for data collection, code of ethics and conduct Sampling	Discussion Brainstorming Lecture	Flip charts, markers	Principal Investigator
<b>10:30-11:00am</b>	<b>TEA BREAK</b>			
<b>11:00am-12:30pm</b>	Study tools(Questionnaire) Translation of questions	Discussion	Flip chart, markers, sample questionnaires, pencils, sharpeners, erasers, clip boards	Principal investigator
<b>1:00-2:00pm</b>	<b>LUNCH BREAK</b>			
<b>2:00-3:00pm</b>	Go through the questionnaire question by question, translation into Swahili or other language as appropriate	Discussion	Flip chart, markers, sample questionnaires, pencils, sharpeners, erasers, clip boards	Principal investigator
<b>3:00-4:00pm</b>	Practice taking measurements of height, weight, MUAC	Demonstrations Hand out	Height board, salter scales	Principal investigator
<b>DAY 2</b> <b>8:00-10:00am</b>	Final practice in accurate taking of measurements	Demonstrations, role play	Height board, salter scales	Principal investigator
<b>10:00-1:00pm</b>	Pre-test questionnaire	Field exercise at Kikuyu	Questionnaires, height boards, salter scales, stationery	Principal investigator
<b>1:00-2:00pm</b>	<b>LUNCH BREAK</b>			
<b>2:00-3:30pm</b>	Meeting with the team, debriefing, reviewing questionnaires and materials	Discussions, sharing of experiences	Flip charts, marker pens, pre-tested questionnaires	Principal investigator
<b>4:00pm</b>	<b>DEPARTURE</b>			

## APPENDIX 4: ETHICAL APPROVAL

**EGERTON**



**UNIVERSITY**

TEL: 051-2217808  
FAX: 051-2217942

P. O. BOX 536

**DIVISION OF RESEARCH & EXTENSION**

**RESEARCH ETHICS COMMITTEE**

**REF: EU/DVCRE/009**

22<sup>nd</sup> December, 2014

Dr.ir.Celine Temote  
Biodiversity Kenya  
C/O World Agroforestry Centre (ICRAF)  
P.O BOX 30677 - 00100  
Nairobi, Kenya

**RE: APPLICATION FOR ETHICAL APPROVAL OF RESEARCH PROJECT**

Reference is made to your application for Ethical clearance of your Research project entitled: *“Diagnostic Study on Agro biodiversity and Dietary Diversity in Vihiga County Humid Tropic Systems CRP- Western Kenya”*. The Egerton University Research Ethics Committee met on 18<sup>th</sup> December, 2014 and considered your application. The committee observed that participants are not exposed to risks as the information will be gathered by use of a questionnaire. It was also noted that participants are women of reproductive age (over 18 years). The committee therefore approved your research project for implementation.

You will however be required to get a research permit from the National Council of Science, Technology and Innovation (NACOSTI) before commencement of your study. Please also note that you are required to submit quarterly progress reports and a final project report to the Committee.

  
Dr. R.K. Sang

**For: CHAIRMAN RESEARCH ETHICS COMMITTEE**

RKS /pao

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“Transforming Lives Through Quality Education”  
Egerton University is ISO9001: 2008 Certified

## APPENDIX 5: FAO and WHO (2004) RECOMMENDED NUTRIENT INTAKES

<b>Nutrient</b>	<b>6-8 months</b>	<b>9-11 months</b>	<b>12-23 months</b>
Energy(kcal)	616	686	894
Protein(g)	9.2	9.6	10.9
Fat(g)	20.5	22.9	29.8
Retinol equivalent( $\mu$ g)	400	400	400
Vitamin B <sub>1</sub> (mg)	0.3	0.3	0.5
Vitamin B <sub>2</sub> (mg)	0.4	0.4	0.5
Niacin equivalent(mg)	4	4	6
Pantothenic acid(mg)	1.8	1.8	2
Vitamin B <sub>6</sub> (mg)	0.3	0.3	0.5
Folic acid( $\mu$ g)	80	80	160
Vitamin B <sub>12</sub> (mg)	0.5	0.5	0.5
Vitamin C(mg)	30	30	30
Calcium(mg)	400	400	400
Magnesium(mg)	54	54	60
Iron(mg)	9	9	6
Zinc(mg)	4.1	4.1	4.1

*Source:* [http://www.nutrisurvey.de/lp/background\\_info.htm](http://www.nutrisurvey.de/lp/background_info.htm) Accessed on 5th July 2017.



**APPENDIX 6: WHO 1998 NUTRIENT RECOMMENDATIONS PER 100kcal OF  
FOODS**

<b>Nutrient</b>	<b>Energy (kcal/g)</b>	<b>Proteins (g/100kcal)</b>	<b>Ca (mg/100kcal)</b>	<b>Fe (mg/100kcal)</b>	<b>Fo /100kcal)</b>	<b>Vit C (mg/100kcal)</b>	<b>Vit A (µgRE/100kcal)</b>	<b>Zn (mg/100kcal)</b>
<b>Age group</b>								
6-8 Months	0.36	0.7	125	7.7	0	0	5	1.6
9-11 months	0.42	0.7	78	4.6	0	0	9	1
12-23 months	0.56	0.7	26	1.6	0	1.1	17	0.8