DIETARY DIVERSITY AND PREVALENCE OF MATERNAL NIGHT BLINDNESS AMONG WOMEN IN RURAL KENYA: A COMPARATIVE STUDY OF SELECTED SUB-LOCATIONS IN MAKINDU, KILIFI AND KISUMU-EAST DISTRICTS

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DECLARATION

I hereby declare that this dissertation is my original work and has not been presented for a degree in any other University.

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God Bless you all!

DEDICATION

To GOD, for being my EBENEZER

To my FAMILY and my son ALVIN, for being my INSPIRATION

ABBREVIATIONS

24HR-VASQ	24 Hour - Vitamin A Semi-Qualitative
AIDS	Acquired Immune Deficiency Syndrome
ANOVA	Analysis of Variance
CI	Confidence Interval
CRBPII	Cellular Retinol Binding Protein II
DD	Dietary Diversity
DDS	Dietary Diversity Score
DR	Dihydroretinol (Vitamin A2)
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FFQ	Food Frequency Questionnaire
FGD	Focus Group Discussion
HIV	Human Immunodeficiency Virus
HKI	Helen Keller International
HPLC	High Pressure Liquid Chromatography
IDA	Iron Deficiency Aneamia
IDD	Individual Dietary Diversity
IDDS	Individual Dietary Diversity Score
INSTAPA	Improved Nutrition through Staple Foods in Africa Project
IVACG	International Vitamin A Consultative Group

KARI	Kenya Agricultural Research Institute
KEMRI	Kenya Medical Research Institute
KESREF	Kenya Sugar Research Foundation
KII	Key Informant Interview
LRAT	Lecithin Retinol Acyltransferase Enzyme
MoH	Ministry of Health
MRDR	Modified Retinol Dose Response
pXN	History of Maternal Night Blindness
RAE	Retinol Activity Equivalents
RBP	Retinol Binding Protein
RDR	Retinol Dose Response
RE	Retinol Equivalents
SWOT	Strengths, Weaknesses , Opportunities and Threats
UNICEF	United Nations Children's Emergency Fund
VAD	Vitamin A Deficiency
VADDs	Vitamin A Deficiency Disorders
WFP	World Food Programme
WHO	World Health Organisation
WP- 2	Work Package 2 of INSTAPA project
XN	Night Blindness

OPERATIONAL DEFINITION OF TERMS

Household	Group of people living together and eating from the same pot
Vitamin A rich food	Contains more than 130 Retinol Activity Equivalents per 100g of edible portion
Vitamin C rich food	Contains more than 18 mg of vitamin C per 100g of edible portion
Dietary diversity	A qualitative measure of food consumption segregated into the individual foods classified into various food groups.
Individual level	Unit of analysis is an individual (s) in the study
Overall	All the three study areas combined
Population level	Unit of analysis is the study areas

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ABSTRACT

Background: Although the prevalence of vitamin A deficiency in Kenya is estimated to be of sustained public health significance, information is scanty on the same among cassava reliant populations in Kenya who are targeted for the newly developed bio-fortified high beta-carotene (yellow) cassava. Therefore, the current study sought to provide information on food consumption and prevalence of vitamin A deficiency among selected cassava consuming populations in Kenya for selection of appropriate study site for the yellow cassava bio-efficacy feeding trial by the 'Improving Nutrition through Staple Foods in Africa' Project.

Materials and Methods: Three cross sectional surveys were conducted between July and October, 2009 among mothers in Kai, Junju and Wathorogo sub-locations purposively selected within Makindu, Kilifi and Kisumu –East Districts of Kenya respectively. Focus group discussions with mothers aged 17 to 85 years old, key informant interviews with administrative leaders, health workers and school head teachers, and case studies were used to establish local terms and descriptions for night blindness. Thereafter, a history of maternal night-blindness was elicited from mothers for their recent live birth within the previous three years to the survey. A total of 290 mothers consisting of 94, 83, and 113 women in Kai, Junju and Wathorego sub-locations respectively were interviewed. In addition, qualitative 24 hour recall individual dietary diversity questionnaire (21 food group) was administered to all the 290 mothers. Both the crude and adjusted prevalence rates of maternal night blindness were computed and populations with $\geq$ 5% crude prevalence of maternal night blindness were considered to have vitamin A deficiency problem of public health significance as recommend by the International Vitamin A Consultative Group. Comparison of study variables for significant differences across the sub-locations was done at both individual and population levels and a 0.05 level of significance was used. Relationships among dietary diversity, maternal night blindness and socio-economic characteristics were also analysed in SPSS 17.

Results: The mean age of mothers interviewed was 25.8 years with an average of three children per mother and a mean duration of 15 months since last birth. Majority of them were lactating (73.4%), had attained primary education (61.3%) and mainly housewives (39.0%). A total of 28 mothers (9.7%) reported to have experienced night blindness during their last pregnancy that ended in a live birth. About16% of these mothers were from Kai, 9.5% from Junju and 4.4% from Wathorego corresponding to the crude prevalence rates of maternal night blindness. On adjustment, the prevalence of maternal night blindness reduced to 12.2%, 6.5% and 1.9% for Kai, Junju and Wathorego respectively. Both the crude and adjusted prevalence rates of maternal night-blindness were significantly different across the sub-locations. The mean dietary diversity scores were highest in Wathorego at 5.43 ± 0.24; followed by Junju with 4.63 ±0.34 and least in Kai at 3.88 ± 0.36 at the 95% confidence interval. Likewise, the proportions of mothers who had consumed vitamin A rich foods within the previous 24 hrs were significantly different across the sub-locations with Wathorego leading at 95.6%; followed by Junju (80.7%) and least in Kai (57.4%). Both maternal night blindness and dietary diversity scores for mothers were significantly associated with age of the mother, number of children by mother and number of children attending primary school from the household.

Conclusions: Vitamin A deficiency is of public health significance in both Kai and Junju sub-locations (≥ 5% crude prevalence of maternal night blindness). Kai sub-location has the highest prevalence of vitamin A deficiency and least dietary diversity among mothers. Thus, this study recommends Kai sub-location as a suitable study site for the yellow cassava feeding trial.

CHAPTER 1: INTRODUCTION

1.1 Background

Night blindness which is the inability to see after dusk or in low levels of light is a common manifestation of moderate to severe Vitamin A deficiency (VAD). This condition has been commonly reported among young children but of late regarded as a public health problem in women of reproductive age (IVACG, 2002). There is biological evidence suggesting that vitamin A deficiency may increase mortality by increasing women's risk of pregnancy-related infections and other conditions that can lead to death (Faisel and Pittrof, 2000) hence eliminating vitamin A deficiency could prevent somewhere close to 100,000 maternal deaths each year (Rice, 2007). In addition, approximately, 10% of women world wide experience night blindness during pregnancy (West, 2002) and by extrapolation 6 million pregnant women become night blind yearly (West, 2002). Night blindness is strongly associated with other biochemical and functional indicators of VAD in women of reproductive age (15- 49 years old). Therefore, IVACG recommended the use of history of maternal night blindness as an indicator of VAD in communities where interventions are not in place since it is easy and simple to obtain (IVACG, 2002; Christian, 2002)

The main underlying cause of VAD as a public health problem is a less diversified diet that is chronically insufficient in Vitamin A that lead to lower blood stores and fail to meet physiologic needs of tissue growth, metabolism and resistance to infections (WHO, 2009).The average Kenyan diet mainly consists of staple cereals (especially maize) and dark green leafy vegetables with less animal based products and therefore is of poor diversity (Bwibo and Newmann, 2003). Thus, this diet is likely to have poorer micronutrient density (Arimond et al., 2008) and poor vitamin A bioavailability (dePee et al., 2006; de Pee et al, 1995) from widely consumed dark green leafy vegetables.

Assessment of Vitamin A status has traditionally been done using biochemical indicators; serum retinol concentrations are the golden standard of measuring vitamin A deficiency, but this method is invasive at population level and requires vast resources for sample collection and analysis. In addition, other clinical ocular manifestations of vitamin A deficiency like bitot spots, keratomalacia, corneal xerosis and scars have been used in VAD surveys but also require trained ophthalmologists to carry out eye examinations which likewise require massive financial and time resources. Due to these logistical and vast resource requirements, only a few population level surveys for vitamin A deficiency have been conducted in developing countries hence most countries lack current information on the status of vitamin A deficiency. Furthermore, these methods are less applicable for rapid screening of populations at risk of VAD in large scale surveys for quick decision making in the light of limited financial resources. For instance, the latest micronutrient survey in Kenya was conducted in 1999. As a result, current data on vitamin A status in Kenya is not available to inform implementation of interventions aimed at prevention of vitamin A deficiency among sub-populations where VAD is a public health problem.

The current study therefore, sought to identify cassava consuming populations with a public health prevalence of VAD ($\geq$ 5% prevalence of maternal night blindness) where food based intervention for VAD could be implemented. The present study is part of the Novel Staple foods for Improved Nutrition in Africa project (INSTAPA) dealing with bio-fortified high beta-carotene cassava for control of VAD.

1.2 Statement of the problem

Vitamin A Deficiency (VAD) is a major nutritional concern in poor societies, especially in lower income countries of Africa, South America and Asia. Globally, it is estimated that night blindness affects 7.8% of pregnant women and 6.4 % of pregnant women in Kenya annually (WHO, 2009). Kenya has been classified to have a sustained vitamin A deficiency prevalence of public health significance (≥5%) based on extrapolation from the 1999 micronutrient survey (WHO, 2009). The main strategy for controlling VAD in Kenya is high-dose supplementation of children under five years of age and postpartum mothers (MOH-Kenya and UNICEF, 2001) but the strategy is financially unsustainable in the long run. Other promoted strategies are industrial fortification of foods especially fats, oils and margarine combined with advocacy for diversification of diets but not affordable by the majority because 50% of Kenyans live below the poverty line (Index Mundi, 2010). Bio-fortification of staple foods with adequate levels of vitamin A is now globally acclaimed as an affordable and sustainable intervention for VAD in poor communities whose diets mainly comprises of starchy staples especially cassava and sweet potatoes.

Consequently, various genotypes of the bio-fortified cassava with high level of beta-carotene have been developed, and the bio-efficacy feeding trial had been scheduled for implementation in Kenya among cassava consuming populations by the INSTAPA project. The feeding trial hence required a cassava consuming population with a known public health problem of VAD. Though at national level VAD had been reported as a sustained public health problem, information was scanty on prevalence of vitamin A deficiency among the cassava consuming populations in Kenya. Thus, there was need to provide information on VAD among cassava consuming populations in Kenya for the feeding trial and potential introduction of yellow cassava in Kenya.

1.3 Aim of the study

To contribute towards improving the vitamin A status in Kenya

1.4 Purpose of the study

To provide information on dietary diversity and prevalence of maternal night blindness among three cassava consuming populations for selection of vitamin A deficient sub-population(s) for the INSTAPA bio efficacy feeding trial for the bio-fortified yellow cassava.

1.5 Justification for the study

Though no current representative data on prevalence of maternal night blindness in Kenya is available, WHO recently classified Kenya as having a sustained public health VAD problem with a maternal night blindness estimate > 5% based on projections from the 1999 survey (WHO, 2009). The prevalence of night blindness among pregnant women between 1995- 2005 was estimated to be 6.4% indicating a public health problem of VAD. This public health concern about Vitamin A deficiency calls for interventions to improve Vitamin A status of the population which rely on starchy staples and have limited access to vitamin A rich foods. Cassava is among the starchy staples widely consumed in rural Kenya especially in Coast, Eastern and Nyanza provinces of Kenya targeted in this study. Hence the beta-carotene bio-fortified cassava is a potentially sustainable intervention for VAD for such communities in Kenya once its bio-efficacy is established.

However, information on dietary diversity and vitamin A status of cassava consuming populations in Coast, Eastern and Nyanza provinces was not available for quick decision making on the study site for the bio-fortified yellow cassava. There was also lack data on dietary diversity and consumption of vitamin A rich foods. Therefore, there was need to provide information on prevalence of vitamin A deficiency and dietary diversity among selected communities in these potential study sites for selection of study site based on this needs assessment. Due to the wide coverage of potential study areas, financial constrains, and urgency to provide information these study opted to use prevalence of maternal night blindness for screening communities for public health problem of VAD (>5% prevalence rate). Thereafter, the prevalence of vitamin A deficiency in the identified communities was confirmed using serum retinol during the pilot study in August 2010 at a lower cost due to reduced sample size. The 1999 national survey sample only covered a few localized areas of Kenya due to resource constrains hence majority of the areas lack information on vitamin A status while information is now outdated for those covered.

1.6 Study objectives

The main objective of the study was to determine and compare dietary diversity and prevalence of maternal night blindness in Kai, Junju and Wathorego sub-locations respectively, within Eastern, Coast and Nyanza provinces of Kenya.

The sub-objectives for the study were:

1. To characterize demographic and socio-economic status of women in Kai, Junju and Wathorego sub-locations respectively in Kenya.
2. To establish the existence of local terms for night blindness and its description (s) in Kai, Junju and Wathorego sub-locations in Kenya.
3. To determine the prevalence of self reported history of maternal night blindness in population units in Kai, Junju and Wathorego sub-locations in Kenya and consequently identify sub-locations with VAD prevalence of public health significance.
4. To determine the level of dietary diversity among women of reproductive age in Kai, Junju

and Wathorego sub-locations in Kenya.

5. To determine associations among maternal night blindness, social-demographic characteristics dietary diversity and consumption of vitamin A rich foods among women of reproductive age in population units in Kai, Junju and Wathorego sub-locations in Kenya.

1.7 Study hypothesis

None of the three study populations has a public health prevalence of vitamin A deficiency (>5% prevalence of maternal night blindness).

1.8 Research questions

1. What are the social demographic characteristics of women of reproductive age in each of the sub-locations? Therefore, is there a significant difference in these characteristics?
2. Are there local terms and descriptions for maternal night blindness in the three sub-locations? If present what are they? Are they understood by most of the people?
3. What is the prevalence of maternal night blindness in the three sub-locations? Are there sub-locations with a public health prevalence of maternal night blindness (≥ 5%)?
4. What are the mean dietary diversity and consumption levels for vitamin A rich foods among women in the three sub-locations? Is there a significant difference across sub-locations
5. Are there significant associations among socio-economic status of women, mean dietary diversity, consumption levels for vitamin A rich foods and maternal night blindness at both individual level and population levels? If so, what is the nature of the identified relationships?

CHAPTER 2: LITERATURE REVIEW

This chapter reviews the existing relevant literature on vitamin A, its deficiency and functions as well as methods used in the assessment of vitamin A deficiency and in the identification of at risk populations. The aim of this review is to understand current research on vitamin A deficiency, various methods used for assessment at both individual and population level and identify research gaps to be addressed by the current study. As a result, this review forms the framework for study design and implementation, discussion and interpretation of study findings as well as conclusions and recommendations from the current study. The review is organized into the following sections: *Vitamin A and its food sources; Vitamin A digestion, absorption, metabolism and bioavailability; Main functions of vitamin A and vitamin A deficiency disorders (VADDs); Assessment of vitamin A deficiency; Prevalence of vitamin A deficiency disorders (VADDs); Treatment and control of VAD and Research gaps* to be addressed by the current study.

2.1 Vitamin A and its Food Sources

Vitamin A or retinol is a fat soluble substance found in liver (particularly fish liver) egg yolk and dairy products, which are the most common animal food sources for the vitamin. Generally, richest sources of preformed vitamin A (retinol) in nature are livers of some fish, most notably those of halibut, cod and shark. These animals are at the end of a long food chain in which first carotenoids and then vitamin A itself are progressively concentrated at each stage building up to the highest concentrations. Very high levels occur in polar bear and bearded seal without apparently harming the animal. Kidney, plasma, milk and those tissues where vitamin A is known to have its main functions, such as the eye and epithelial tissues, have very low concentrations in comparison with those found in the liver.

Carotenoids, which are potential pro-vitamin A precursors that can be converted to retinol in wall of the gut, are present in dark green leafy vegetables, red palm oil, yellow/orange fruits, yellow/orange vegetables and yellow/orange roots and tubers. Human communities rely on a very wide range of plant and animal foods to meet their dietary requirements for vitamin A. It has been noted that Asia and Africa, where the most serious problems of VADD occur, place the greatest reliance on vegetable sources (McLaren and Frigg, 2001). Carotenoids are the most widespread of all groups of naturally occurring pigments. They are red, orange or yellow in colour and are found in many plants and animals. They share common structural features, such as the polyisoprenoid structure and a series of centrally-located bonds (Olson, 1994). Most of the carotenoids are xanthophylls, which have one or more oxygen groups on the ring or in the chain (McLaren and Frigg, 2001).

Current conversion rates for beta-carotenes and other carotenoids are based on Retinol Activity Equivalents (RAE) unlike the old conversion rates which used Retinol Equivalents (RE). As per the current conversion rates, 1 RAE is equal to 26 μg of β-carotene from leafy vegetables and carrots (McLaren and Frigg, 2001); 12 μg of β-carotene from fruits and red/orange/yellow vegetables; 21 μg of β-carotene from a mixed diet (excluding palm oil and assuming a mix of vegetables to fruits of 4:1). However, most food composition tables list the vitamin A content of foods in retinol equivalents, which are based on the old conversion factors of 6:1 for ß-carotene and 12:1 for other provitamin A carotenoids. When these values are used, a correction for the new conversion factors can be made by dividing vitamin A intake by 2 for fruits and by 4.33 for green vegetables and carrots. For animal foods no corrections are necessary. For fortified foods it depends on the fortificant used (McLaren and Frigg, 2001). When retinol is used for fortification, correction is not necessary, but when ß-carotene has been used, the above mentioned conversion factors should be used, unless the food is an oil or fat spread. For the latter case, a conversion factor of 3 may be used hence the current consensus on vitamin A rich foods is that they are foods that contain > 130 RAE/100g (de Pee et al, 2006). Therefore, Table 2.1 below shows the RAE for some of the common foods in Kenya based on β-carotene and Retinol values reported in the Food Composition Tables for Kenya (Sehmi, 1993)

Table 2.1: Retinol and beta carotene content per 100g of edible portion of common foods

Food item	*β-carotene (μg)*	*Retinol (μg)*	***RAE***
Egg	-	139	**139**
Milk(cow)	-	55	**55**
Carrot (raw)	11652	-	**448**
Amaranthus (Terere-raw)	5520	-	**212**
Pumpkin leaves	3300	-	**126**
Sukuma wiki (kale)	4440	-	**170**
Apoth (Murenda)	6410		**246**
Cowpea leaves(mkunde)	7970		**306**
Pumpkin	1200		**100**

2.2 Vitamin A Digestion, Absorption, Metabolism and Bioavailability

Dietary preformed vitamin A and carotenoids are released from protein in the stomach by proteolysis. They then aggregate with lipids and pass into the upper part of the small intestine. Dietary fat and protein and their hydrolytic products stimulate, through the secretion of the hormone cholecystokinin, the secretion of bile. This emulsifies lipids and promotes the formation of micelles which have lipophilic groups on their inside and hydrophilic groups on their outside. In this way the absorption of fat is facilitated. (Olson, 1994; MacLarren and Frigg, 2001). Bile salts stimulate pancreatic lipase and other esterases that hydrolyze retinyl esters in intestinal mucosal cells (enterocytes). Retinol, the product of the hydrolysis, is well absorbed (70–90%) by intestinal mucosal cells. Provitamin A carotenoids pass into the mucosal cells unchanged. In terms of intake of vitamin A in the diet, about 10% is not absorbed, 20% appears in the faeces through the bile, 17% is excreted in the urine, 3% is released as carbondioxide and 50% is stored in the liver (Olson, 1994).

A proportion of retinol, along with non-provitamin carotenoids, passes through unchanged into the lymph and the blood. The remainder undergoes cleavage of the molecule by a specific enzyme 15,15'-dioxygenase within the intestinal mucosal cell. This process can also take place within the liver and some other tissues (Goodman et al, 1966). Symmetrical cleavage of the β-carotene molecule yields two molecules of retinal, which is mostly reduced and esterified to retinyl ester. Some cleavage is asymmetrical and less retinal is produced within the mucosal cells, retinol is esterified before incorporation into chylomicrons. In this process a specific cellular retinol-binding protein (CRBPII) carries the lipid-soluble retinol through the aqueous media and delivers it to the enzyme lecithin: retinol acyltransferase (LRAT). This enzyme appears to be the main intestinal enzyme that normally esterifies retinol and then delivers it to the chylomicrons.

Approximately, 50-90% of ingested retinol is absorbed in the small intestine and is transported, in association with chylomicra, to the liver, where it is stored primarily as retinyl palmitate. When needed it is released into the blood stream as retinol in combination with Retinol- Binding- Protein (RBP) from where it is removed from the serum and utilized by the target cells metabolic pathway. Availability of stored Vitamin A also depends on the individual's general nutritional status. Severely malnourished individuals who are protein deficient synthesize RBP at a much reduced rate; hence serum retinol levels may be sub-normal even if the liver stores are high. Furthermore, a diseased liver cannot store as much retinol or make much RBP, as a normal one.

Dietary components may influence the absorption of carotenoids in several ways. A minimum of 5 g fat daily is required for adequate micelle formation. This appears to be sufficient for optimal absorption of α -carotene, β -carotene and vitamin E, but lutein esters require more (Roodenburg, et al,, 2000). Adequate protein and zinc intake assists maintenance of vitamin A status. Vitamin E, as an antioxidant, protects vitamin A from being oxidized. Fibre, chlorophyll and non provitamin carotenoids, which are commonly present in the diet, tend to reduce bioavailability (MacLarren and Frigg, 2001).

Absorption of carotenoids is influenced by vitamin A status. If it is low, conversion of carotenoids to vitamin A is likely to be increased. There is evidence that zinc deficiency impairs the efficiency of β-carotene conversion to vitamin A. As clinical genetics advances it is likely that further cases of rare genetic defects as the cause of vitamin A deficiency will be reported. To date three types of defect are known: enzymatic failure to cleave β-carotene in the small intestinal mucosa (McLaren and Zekian, 1971); heterozygotic reduction of plasma RBP (Matsuo, et al., 1987), and mutations in the gene for retinol-binding protein (Biesalski et al., 1999). In addition, diseases that interfere with intestinal absorption, especially of lipids, are likely to impair carotenoid bioconversion. In terms of public health, especially in developing countries, intestinal parasites such as *Ascaris lumbricoides* and *Giardia lamblia* are of great importance.

2.3 Main Functions of Vitamin A and Vitamin A Deficiency Disorders (VADDs)

Vitamin A was first called the anti-infection vitamin in reference to its role in immune response. Many of the epithelial tissues are important barriers to infection and VAD impairs this function in a non specific way. In addition, vitamin A is known to be involved in maintaining immuno-competence in more specific ways. It helps to maintain the lymphocyte pool. Vitamin A also functions in T-cell-mediated responses. Consequently, pre-existing VAD appears to worsen infection (Scrimshaw et al., 1968) and increases the severity and complications associated with measles (Sommer, 1995), persistent diarrhea, and also accelerates progression of HIV infection into AIDS. Furthermore, vitamin A supplementation has been shown to reduce the risk of death in 6-59 months old children by 23-30% (Beaten et al., 1993; Glasziou and Mackerras, 1993; Fazwi et al., 1993). Three vitamin A supplementation trials from southern Asia reduced mortality by 21% in the first six months of life (Bhutta et al., 2008) while two other studies conducted in Africa showed no impact of supplementation (Malaba et al., 2005; Benn et al., 2008). A study by West et al. (1999) reported an approximate 40% reduction in maternal mortality following routine dietary supplementation with vitamin A during pregnancy.

Vitamin A is vital for normal vision through a series of biochemical reactions in the outer segment of rod cells in the retina of the eye. 11-cis retinal combines with the membrane bound protein, opsin to form rhodopsin which is involved in vision under conditions of low illumination. Similar complexes occur in the cone cells to give three specific iodopsins necessary for colour vision. The role played by retinol derivatives in vision is clearly illustrated in the visual cycle developed by Rando in 1994 (MacLarren and Frigg, 2001). Likewise, the vitamin is important in cell differentiation and in its deficiency state; the keratin-producing cells replace mucus-secreting cells in many epithelial tissues of the body. This pathological process is termed xerosis; it leads to drying of the conjunctiva and cornea of eyes affecting vision. However, the process can be reversed by vitamin A treatment. Xerophthalmia is the most specific Vitamin A Deficiency Disorder (VADD), and is the leading preventable cause of blindness in children throughout the world. Night blindness often appears during pregnancy, a likely consequence of pre-existing marginal maternal vitamin A status superimposed by nutritional demands of pregnancy and incurrent infections (Christian et al., 1998).

Retinoic acid is known to play its hormone like function in the control of growth and development of tissues in the musculo-skeletal system, just as it does elsewhere. In communities subject to widespread VAD the occurrence of many other adverse factors has made the demonstration of the retarding effect of VAD difficult (Sommer and West, 1996). One possible mechanism for the influence on growth is the demonstration that both vitamin A and retinoic acid produce rapid release of cyclic adenosine monophosphate (cAMP) and human growth hormone secretion (Djakoure, Guibourdeuche and Porquet, 1996).

VAD in man and in experimental animals is consistently associated with iron deficiency type of anaemia. It has been repeatedly shown that in these circumstances in addition to iron; vitamin A is required for a full haematologic response. The mechanism remains unclear. VAD might interfere with the absorption, transport or storage of iron. On the other hand it might act directly on haemopoiesis, although that seems less likely (Sommer and West, 1996). The demonstration that retinoic acid is necessary for erythrocyte differentiation implies that it controls the usage of iron (Pfahl and Chytil, 1996). Therefore, anaemia can result from VAD in children and women due to multiple apparent roles of vitamin A in supporting iron mobilization and transport, and heamatopoiesis (West et al., 2007).

Embryonic/fetal development is another vital role dependent on vitamin A. Several studies have shown that severe VAD on one hand, and excessive dosing with vitamin A/retinoic acid result in malformations of the embryo/foetus (Rando, 1994; Gerster, 1997; McLaren and Frigg, 1997). Another instance of acute hypervitaminosis A or vitamin A toxicity has long been reported among polar explorers and their sled dogs that have fallen sick after feeding on the liver of the polar bear and bearded seal (McLaren, 1993).

Vitamin A has also been identified to have functions in the human reproductive system. Both the male and the female reproductive organs are unable to maintain normal function when only retinoic acid is given. Dietary Retinoic acid appears to be taken up by testicular interstitial Leydig cells, as it supports testosterone production (Appling and Chytil, 1981).

Normal vitamin A status implies that an individual is free of physiological and pathological consequences of Vitamin A deficiency and has sufficient liver stores to provide protection against the increased metabolic demands in disease, reduced absorption or significant variations in dietary intake. As liver stores decline, serum vitamin A levels will fall as well and physiological consequences of vitamin A deficiency such as impaired dark adaptation or abnormal conjuctival epithelial differentiation (by impression cytology) generally begin to occur at levels below 1.0µmol/litre and especially below 0.7 µmol/liter (Natadisastra et al., 1987). Low Vitamin A intake during nutritionally demanding periods in life, such as infancy, childhood, pregnancy and lactation, greatly raises the risk of health consequences, or vitamin A deficiency disorders (WHO, 2009). VAD impairs numerous functions and as a result, can lead to many health consequences in infants, young children and pregnant women who appear to be at greatest risk.

A recent study in South –India reported that maternal night blindness during pregnancy is associated with low birth weights, morbidity and poor growth among infants because the mother's vitamin A status can affect her breastmilk vitamin A concentration and subsequently the status of her infant (Tielsch et al., 2008). These findings disagree with earlier investigators who reported that maternal vitamin A status in pregnancy does not have a major influence on the vitamin A stores of the newborn rat (Ross and Gardner, 1994) or infant (Gebre-Medhin and Vahlquist, 1984; Howells et al., 1986). Other earlier investigators also reported that maternal vitamin A supplementation during pregnancy does not appreciably affect the vitamin A status of her newborn, except perhaps when she is severely deficient. This was due to the fact that the fetus may be protected against maternal vitamin A deficiency by the low activity of the placental RBP receptor which enables efficient placental uptake of placental-retinol binding protein, even when maternal serum concentrations of retinol are below normal (Sivaprasadarao and Findlay, 1988; Dimenstein et al., 1996).

2.4 Assessment of Vitamin A Deficiency

2.4.1 Biochemical Methods

Several biochemical tests are available for assessment of vitamin A status and require blood samples for analysis. The most commonly used method for individuals and populations is serum retinol. Serum retinol levels below 0.7µmol/l indicate VAD and the percentage of population with <0.7µmol/l is used to classify the severity of VAD. Serum retinol is commonly quantified through

HPLC analysis but currently quick fluorescence methods are being developed for instant reading of blood samples in the field. These methods detect both clinical and sub-clinical deficiency levels (McLaren and Frigg, 1997; Sommer, 1995).

Other biochemical methods are Retinol Dose Response (RDR) level, Modified Retinol Dose Response (MRDR) level and Retinol Binding Protein (RBP). RDR measures fasting serum retinol where a 450–1000 mg retinyl ester in oily solution is given orally, then serum retinol is measured five hours after dosing. If the result of the calculation of serum retinol is greater than 20% then the test is considered to be positive, i.e. stores are deficient. It has been shown that a result of 20% in the test is approximately equivalent to a liver reserve of 0.07 μmol/g. On the other hand, MRDR employs a metabolite of vitamin A, 3, 4-didehydroretinyl acetate (DR, also known as dehydroretinol, vitamin A2). DR binds to RBP and appears in the serum after a test dose is given if liver reserves of vitamin A are low. A single oral dose of DR is given and only one blood test is required after 4–6 hours. The compound DR, used in the MRDR test, is costly and is not readily available (WHO, 1996), hence the test is rarely used. RBP is among a number of proteins involved in the acute phase reaction in infection and inflammation. The release of RBP from the liver is repressed by a number of factors beyond the scope of this review.

2.4.2. Deuterated-retinol-dilution Technique

This technique using the stable isotope of hydrogen, deuterium, measuring total body vitamin stores indirectly but quantitatively is being used increasingly in research projects. A dose of vitamin A labeled with the stable isotope deuterium is given by mouth and about three weeks allowed for equilibration with the reserves of the body. Blood is sampled at this point and extent of dilution of the labeled tracer relates to the amount of endogenous reserves (McLaren and Frigg, 2001).

2.4.3 Clinical Methods

Clinical manifestations of VAD are mostly pronounced on the eyes, hence a classification of eye lesions was agreed upon in 1976, as criteria for assessing VAD as shown in Table 2.2

Table 2.2: Classification of Xerophthalmia*	
Abbreviation	*Form of xeropthalmia*
XN	Night blindness in children
X1A	Conjuctival xerosis
X1B	Bitot's spots
X2	Corneal xerosis
X3A	Corneal ulceration/keratomalacia < 1/3 corneal surface
X3B	Corneal ulceration/keratomalacia ≥ 1/3 corneal surface
XS	Corneal Scar
XF	Xerophthalmic fundus
pXN	Maternal night blindness
* Adapted from Sommer Alfred, 1995	

Apart from night blindness, these assessments require a qualified ophthalmologist and the methods are time consuming and expensive to implement in the field (Sommer et al, 1980; Sommer, 1995; McLaren and Frigg, 1997).

Reported case of night blindness among pre-school children (XN) is usually the first observable clinical sign of VAD. This also often appears during pregnancy therefore, history of maternal night blindness (pXN) is used to assess population prevalence of VAD. Night blindness has been traditionally assessed in children but the method was found to be unreliable. This is because in most cases the children are unable to identify the condition themselves hence use observations by parents/guardians. Furthermore, children are used to playing games which makes it difficult to tell if they are telling the truth or lying. To overcome these limitations, maternal night blindness has been recommended as an indicator with a prevalence ≥ 5% being indicative of a public health concern for VAD in the population. Using this method, a history of night blindness is elicited from women who have had a live birth within the last three years for their last pregnancy that ended in a live birth (IVACG, 2002; Christian, 2002)

Conjuctival xerosis and bitot's spots are expressed as marked dryness or unwettability of the conjunctiva and affected area appears roughened with fine droplets or bubbles on the surface rather than smooth and glistening. This is due to the transformation of the epithelium of the conjunctiva from the normal columnar to the stratified squamous type, with a resultant loss of goblet cells, formation of a granular cell layer and keratinization of the surface. Bitot's spots are readily recognized and serve as a useful clinical criterion for assessing the vitamin A status of a population. They are characterized as an isolated oval or triangular patches with a foamy or cheesy appearance almost always present in both eyes. However, care should be taken not to confuse Bitot's spot with pinuecula (an elevated, fatty, yellowish lesion) or pterygium which is fleshy and invades the cornea. Conjunctival xerosis cannot be regarded as an acceptable criterion for determining whether vitamin A deficiency is a public health problem since the abnormality is often overlooked or, in apparent compensation, over-diagnosed (Sommer, 1995)

In corneal xerosis, the cornea develops classical xerosis, with a hazy, lusterless, dry appearance which might further progress to form thick keratinised plaques resembling Bitot's spots. However, occurrence of ulceration or keratinisation indicates permanent destruction of a part or all of the corneal stroma resulting in permanent structural alteration, hence administration of Vitamin A cannot reverse the condition as is the case in X3A and X3B. Healed sequele of prior corneal disease related to vitamin A deficiency is the corneal scar characterized by opacities or scars of varying density which are not specific for xerophthalmia and may arise from numerous other conditions, notably trauma and infection.

2.4.4. Biophysical Eye Tests of Vitamin A Status/Dark Adaptation Methods

In order to overcome the limitations of subjective assessment of night blindness, several objective functional tests have been developed but not commonly used at field level due to high cost of the equipment and logistics. These include the dark adaptation techniques which include contraction of visual fields, Rod spectrophotometry and pupillary threshold tests. Currently, John Hopkins University is conducting a validation study for the newly developed dark adaptation goggles for assessing functional manifestation of Vitamin A deficiency on vision (McLaren and Frigg, 2001).

2.4.5. Dietary Methods

Several dietary assessment methods have been developed as proxy assessment methods for VAD. Though these methods do not directly assess vitamin A status, they are important in identification of at risk individuals. The major constrain with these methods is the bioavailability of the foods consumed and conversion rates of pro-vitamin A in plant foods. The major dietary assessment methods are: The Helen Keller Food Frequency Questionnaire (HKI-FFQ), several types of Dietary Diversity (DD) Questionnaires and the 24 Hour Vitamin A Semi-Qualitative methods (24-hr VASQ). The first two methods are qualitative and give the types of foods and their frequency of consumption while the third method estimates the quantities of vitamin A intake.

The HKI-FFQ was the pioneer semi-structured qualitative dietary method used in assessment of vitamin A intake. The structure of the questionnaire is the same as the FANTA dietary diversity questionnaire which is an improvement on the HKI-FFQ though used differently. The HKI method was developed for assessing populations for vitamin A deficiency of public health concern based on weekly frequency of vitamin A rich food groups among 42 population clusters. However, scientific advances which refined the bio-conversion rates for carotenoid vitamin A precursors rendered the method obsolete as the rates used to develop consumption cut -offs became obsolete

Dietary diversity is a qualitative measure of food consumption that reflects household access to a wide variety of foods, and is also a proxy of the nutrient adequacy. The individual dietary diversity score (IDDS) aims to capture nutrient adequacy. Many studies in several different age groups have shown that an increase in individual dietary diversity score is related to increased nutrient adequacy of the diet. Dietary diversity scores have been positively correlated with increased mean micronutrient density adequacy of complementary foods (FAO, 2006) and micronutrient adequacy of the diet in non-breastfeeding children (Ruel et al., 2004; Steyn et al., 2006; Kennedy et al., 2007), adolescents (Mirmiran et al., 2004) and adults (Foote et al., 2004). Recently, dietary diversity was reported to be a good measure of women's diet quality in resource-poor areas of rural Bangladesh (Arimond et al., 2008). According to the study in Bangladesh, the 21 food group dietary diversity indicators have been recently reported to be consistent with the actual micronutrient intake among women of reproductive age. Currently, research is ongoing to better understand the strength of the association between dietary diversity and micronutrient intake in women of childbearing age.

From qualitative dietary diversity data, it is not possible to establish thresholds below which populations are not consuming sufficient vitamin A. In general, low percentages of individuals consuming food groups containing these micronutrients on a given day may be indicative of seriously inadequate diets that lead to morbidity related to micronutrient deficiencies. As with the dietary diversity mean score, percentages of those consuming micronutrient rich food groups can be used as one-time measure of a population or sub-populations, for on-going monitoring or to assess changes in diet such as before and after an intervention. Sub-groups can also be compared, for example communities undergoing a nutrition intervention compared to control communities.

The 24-VASQ method was developed in 2006 for estimating vitamin A intake of populations in a relatively quick and simple quantitative way. The method quantifies the vitamin A content in common serving amounts for various foods and uses coding data collection. The food codes correspond to a particular pre-calculated amount of vitamin A and the sum of all quantities is done. It can be used in large surveys and surveillance systems. The data can be used to quantify vitamin A intake of specific population groups, monitor changes in intake through time, compare intake among populations, identify the contribution of four different food groups - vegetables, fruits, animal foods and fortified foods - to vitamin A intake and identify populations at risk of vitamin A deficiency. However, data on vitamin A intake should not be interpreted at an individual level when using the 24-hr VASQ method (de Pee et al., 2006). , Using one 24 hour recall period does not provide an indication of an individual's habitual diet, however, it provides an assessment of the diet at population level, and can be useful to monitor progress or target interventions (Savy et al., 2005). The 24 hours recall period is less subject to recall error, less cumbersome for the respondent and also has been used in many other dietary diversity studies (Kennedy et al., 2007; Ruel et al., 2004; Steyn et al., 2006; Savy et al., 2005).

2.5 Prevalence of Vitamin A Deficiency Disorders (VADDs)

In 1987, WHO estimated that VAD was endemic in 39 countries based on ocular manifestations of Xerophthalmia or deficient serum (plasma) retinol (<0.35 μmol/l). In 1995, WHO updated theestimates and reported that VAD was of public health significance in 60 countries and was likely to be a problem in 13 additional countries. The current estimates released in 2009 by WHO reflect the time period between 1995 and 2005 (WHO, 2009)

It is estimated that, globally, night blindness affects 5.2 million preschool age children (95% CI: 2.0-8.4 million) and 9.8 million pregnant women (955 CI: 8.7-10.8 million), which corresponds to 0.9% and 7.8% of the population at risk of VAD, respectively (WHO, 2009). The prevalence of night blindness is of moderate to severe public health significance in 45 countries for preschool age children and 66 countries for pregnant women. Low serum retinol (<0.7μmol/l) affects an estimated 190 million preschool age children and 19.1 million pregnant women globally which corresponds to 33.3 % and 15.3% of the population at risk, respectively. Consequently, 122 and 88 countries are now classified as having a public health problem based on biochemical VAD in preschool children and pregnant women respectively (WHO, 2009)

The highest proportion (2.0%) of preschool age children affected by night blindness is in Africa, a value that is four times higher than estimated for South Asia (0.5%). This also means that Africa has the greatest number of preschool-age children affected with night blindness (2.25 million) and corresponds to almost half of the children affected globally. These estimates show that Africa and

South-East Asia regions also contain the highest proportion of preschool age children with biochemical VAD as indicated by a serum retinol concentration of < 0.7µmol/l, with South-East Asia having the greatest number of children and pregnant women affected (WHO, 2009).

Kenya is among the countries monitored in the WHO database for global prevalence of VADDs. Country current estimate of prevalence of night blindness in preschool-age children between 1995 and 2005 was classified as moderate public health problem at 1.4% but the prevalence of serum retinol < 0.70 µmol in the same group presents a severe public health problem as indicated at 84.4%. This could be due to the fact that estimation of night blindness among pre-school children is problematic and inaccurate due to reliance on parents/guardians observation of child's behavior at dusk. On the other hand, the prevalence of night blindness among pregnant women in the period 1995 - 2005 was estimated to be 6.4% indicating a public health problem of VAD, however the classification by low serum retinol < 0.70 µmol indicates a moderate public health problem at 17.3% (WHO, 2009).

Both the 1994 and the 1999 micronutrient surveys in Kenya indicated a vitamin A deficiency of public health significance (≥ 20% of serum retinol <0.070 µmol/l) among preschool age children, reporting a prevalence of approximately 20% and 40% respectively (MoH and UNICEF, 1994; MoH and UNICEF, 1999). However, in both surveys, night blindness was assessed among preschool age children and not among pregnant women. The 1999 survey data are probably outdated by now since so many changes in food security and social economic status have taken place within the previous 10 years. Therefore, Kenya currently lacks information on the status of vitamin A though WHO gives extrapolations from the 1999 figures which might not reflect the situation on the ground.

Vitamin A deficiency in Kenya was identified as early as 1928 by Phillip, who reported the deficiency among coastal people (Jansen et al., 1987). In 1938 Jansen found night blindness in varying degrees in 45% of school children in Nairobi, and 44% of the people surveyed in Githunguri, although he believed that the intake of vitamin A was high. Majority of families surveyed in Githunguri consumed 60% of the recommended daily allowance of vitamin (Bohdal et al., 1969). In 1974, Franken found xerophthalmia in patients with measles in East Africa (Franken, 1974). Sinabulya found cases of night or other blindness in the Machakos district in 1976, which he attributed to vitamin A deficiency (Sinabulya, 1976). Also in 1976, Sauter studied xerophthalmia and measles in Kenya and found that vitamin A deficiency was widespread (Sauter, 1976). This was doubted by various workers (Whitefield and Dekkers, 1978; Jansen and Alnwick, 1979; Kusin et al, 1980), which led Jansen and Horelli to review the evidence for vitamin A deficiency in Kenya and documented that VAD was common (Jansen and Horelli, 1982). The objectives of the surveys included determination of the prevalence, extent, magnitude and severity of vitamin A deficiency (VAD) in children aged 6–72 mo, its geographical distribution, risk groups and the identification of locally available resources that could be harnessed for its alleviation. The assessment of vitamin A status included serum retinol, night blindness, conjunctival xerosis, Bitot's spots and corneal xerosis. The survey showed that without exception, there was patchy geographical distribution of severe, moderate, and mild VAD in all the sampled districts. This disproved the previous assumption that VAD was not a significant public health problem in Kenya. Vitamin A deficiency was considered to be caused by a low consumption of vitamin A rich foods, early cessation of breastfeeding, low dietary fat and a high prevalence of intestinal parasites that could impair its absorption (MoH and UNICEF, 1994).

In 1994, Ngare and Kennedy reported a 13% prevalence of serum retinol < 0.35 mmol/L, and a 45% prevalence of values < 0.7 mmol/L among children below five years in South Nyanza. Thus vitamin A deficiency was a serious health problem among children in that part of the country. In another VAD survey, children aged 6–11 mo were the most affected by VAD, followed by those aged 12–24 mo, with serum retinol < 0.35 mmol/L in 11.2% and 9.6% respectively. Serum retinol < 0.7 mmol/L was found in 40.7% of children aged 6–11 months, followed by 34.9% of those aged 12–24 months. The lowest prevalence occurred at age 60–72 months, with 6.8% and 31.3% serum retinol values < 0.35 and < 0.7 mmol/L, respectively. All degrees of VAD occurred in all the surveyed districts, thus confirming the findings of the previous researchers that VAD deficiency was a serious public health problem in Kenya at that time. The severity of VAD was noted to be worst in the Lake Basin and the Western highlands, both malaria-endemic areas. In a sub sample of 926 children, those aged <6 months had the highest proportion (34.3%) of severe retinol deficiency (< 3.5 mmol/L). Malaria parasitaemia was associated with low serum retinol values (de Pee et al., 1995).

2.6 Treatment and Control of Vitamin A Deficiency

Immediate, substantial improvement in Vitamin A status is required in all instances in which deficiency poses an imminent threat to vision, health and survival. The most clinically apparent, urgent conditions are xerophthalmia, severe infectious episodes (particularly measles and dysentery or persistent diarrhea). The frequency of vitamin A dosage depends on the condition being treated (Sommer, 1995).

Three types of interventions can reduce VAD in affected populations. Improving the availability and intake of vitamin A through dietary diversification is viewed as an activity for all communities through nutritional education and encouraging home gardening. A second approach to increasing dietary intake of vitamin A is through fortification of a staple food or condiment with vitamin A. Industrial fortification has been done for several products in different countries e.g. sugar fortification in Central and South America; margarine, fats and oils in Kenya. (WHO, 2009). Bio-fortification of foods is now viewed as a long term solution to VAD. One of the successfully bio-fortified staple foods in Africa is the orange-fleshed sweet potato. Currently, bio-fortification of cassava with vitamin A is being explored in Africa though it has already taken off in South America. Thirdly, the most widely practiced approach is high dose supplementation with vitamin A for children under five years and postpartum mothers (WHO, 2009). The vitamin A supplementation programs are the widely promoted interventions for VAD in Kenya and coverage of these programs have gradually increased over time.

2.8 Research Gaps

This review concludes that there is no current information on prevalence of vitamin A deficiency among Kenyan population including the three study divisions. The 1999 micronutrient survey whose findings are likely to be outdated by now, did not segregate results to divisional and sub-locational levels to provide such information. Therefore, the specific gaps to be addressed in this study as outlined below:

1. No local terms and descriptions for night blindness have been investigated and documented among Kenyan communities. Even though the 1999 micronutrient survey documented local terms for anemia among women, it did not document the same for night blindness. Hence, in order to use maternal night blindness as indicator of vitamin A

deficiency among study populations, existence of local terms and descriptions for night blindness needs to be established, and documented.

2. Information is scanty on the socio-economic status of women of reproductive age in the three study areas. This information is important in identification of underlying causes of vitamin A deficiency among women and population as a whole.
3. The prevalence of maternal night blindness among women who delivered a live birth within the previous three years (as per IVACG recommendation) is not available. This is because no study has used this method in Kenya and also the Kenya Demographic and Health Survey has not adopted this method as some countries have done. Therefore, selection of populations with public health problem of vitamin A for implementation of interventions which need to be based on the current vitamin A status of populations is not possible.
4. Dietary diversity among women in different Kenyan populations is not known since most of the dietary diversity studies undertaken in Kenya focus on children below five years. Therefore, dietary intake of micronutrients especially vitamin A among women in Kenyan communities is unknown.
5. Currently, there is no clear understanding on the relationship between dietary diversity and prevalence of vitamin A deficiency at both individual and population levels. Though, prevalence of maternal night blindness has been advocated as a population indicator for identification of populations with public health prevalence of VAD, none of the studies have investigated its relationship with dietary diversity indicators at population level.

CHAPTER 3: STUDY SETTING AND METHODOLOGIES

3.1 Study Setting

This study was conducted among three rural populations in Kenya that were familiar with the cassava roots in Makindu, Kikambala and Winam divisions within Eastern, Coast and Nyanza provinces, respectively (see Appendix 1 for location of study areas in Kenya). The study districts were selected based on their food security situation, presence of Kenya Agricultural Research Institute (KARI) station with capacity to grow the bio-fortified yellow cassava roots and proximity/accessibility to other collaborating institutions that have capacity to provide laboratory services for blood sample analysis for retinol. The location of the KARI station with reference to primary schools was a major deciding factor in the selection of study populations for logistical reasons during the proposed feeding trial to be conducted at primary schools. Based on these requirements, three possible areas for the mother study were selected which needed to be assessed for prevalence of vitamin A deficiency for decision making on study site. The identified areas were as listed below with their corresponding rationale for selection:

1. Makindu District- Eastern province:
   - KARI- Kiboko station had excellent irrigation facilities for growing the cassava.
   - Kenya Medical Reasearch Institute (KEMRI) in Nairobi could manage the required laboratory work
   - Chronically food insecure hence likely to encounter high prevalence of vitamin A deficiency
   - The population grew and consumed cassava roots
2. Kilifi District- Coast province:
   - KARI- Mtwapa station had excellent facilities for growing the yellow cassava

- KEMRI-Kilifi manage the required laboratory work
- Chronically food insecure especially in Bamba and Ganze areas hence likely to encounter high prevalence of vitamin A deficiency
- The population grew and consumed cassava roots

3. Kisumu-East district- Nyanza province:
   - KARI-Kibos had adequate land to grow the cassava though lacked irrigation facilities.
   - Kenya Sugar Research Foundtion (KESREF) -Kibos station could provide irrigation services for the growing of cassava.
   - KEMRI-Kisumu could manage the required laboratory work
   - Food insecure due to high population of casual laborers working in sugar plantations
   - The population grew and consumed cassava though the Mosaic virus was a problem.

In Makindu district, Makindu division was selected as the study division since it was more food insecure compared to Kibwezi. The main source of livelihood in both Kibwezi and Makindu districts is marginal mixed farming but with persistent droughts, no farming activities were ongoing except under irrigation (see Appendix 2 for map showing livelihood zones). Though Kibwezi was food insecure, it had substantial food supplies form KARI-Kibwezi and the University of Nairobi farm hence the populations had access to food at local markets. In contrast, the population in Makindu division had been depending on World Food Program (WFP relief food programs for the past 10 years and consequently, pellagra (Niacin deficiency) outbreak had been reported in the area due to overreliance on relief maize as the staple (Gatonye, 2009). Furthermore, the area had experienced drought for the past 3 years, agricultural activities had halted and people depended on relief food. At the time of the survey, Red Cross was distributing monthly food rations comprising of maize, pulses, vitamin A fortified cooking oil and iodised salt. However, the school feeding programs had stopped awaiting the government to implement its decision to start giving money directly to schools for purchase of food from local markets. Consequently, Kai sub-location was selected within Makindu division as the study area based on its proximity to KARI-Kiboko. Furthermore, Syengoni primary school was selected within Kai sub location as a possible study site for the cassava feeding trial and therefore 6 villages bordering this school (Likoni, Kawelu, Muthingitho, Kyeni, Syengoni and Ngiluni) were assessed for maternal night blindness.

In Kilifi district, most of the divisions were food insecure due to persistent droughts though it has varied livelihood zones as shown in the map (Appendix 3). Ganze, Bamba and Kikambala divisions had chronic food insecurity and all had school feeding programs. The food insecurity situation was worst in Bamba and Ganze which were on both relief food and school feeding programs compared to Kikambala. Though from Appendix 3, the map shows that Junju subl-ocation is mainly a cash cropping area, land is majorly owned by Vipingo industry which grows sisal. Therefore, most of the local people are squatters without access to farming land and experience chronic food shortages due to droughts. As a result, most households are severely food insecure and the area is under the Government of Kenya and WFP school feeding program. Kikambala was selected as the study area because Ganze and Bamba were located far from the KARI Mtation in Mtwapa and also had poor road accessibility which posed potential logistical problems for the cassava feeding trial. Within Kikambala division, Junju sub-location within Junju location was selected as the study area after Bodoi primary school was selected as a possible site for the cassava feeding trial. Therefore, one large village (Bodoi) was assessed surrounding Bodoi primary school and also majority of pupils at the school hailed from this village.

In Kisumu–East District, Winam division was the focus area for this study. The main form of livelihood in this division is mixed farming and small scale trade as shown in the map (Appendix 4). However, the division experiences chronic food shortage due to destruction of crops by floods because the division is among the zones prone to flooding in the lake region (see Appendix 5 for a map of flooding zones). Though, the division has been known to grow a lot of cassava, the area had been affected by cassava mosaic virus at the time of the survey, increasing food insecurity among households as cassava is a food security crop. Wathorego sub-location was selected as the study area since it was the host to KARI-Kibos and KESREF. This sub-location location was dominated by sugarcane farming with most of the local people working as casual laborers in the sugar plantations and Kibos Sugar Factory. Limited land is available for food crop farming and a large proportion of the population are immigrants who came to search for employment in the area. Therefore, the area is multilingual and Kiswahili is the common language. Two villages (Riwa and Kotunga) within Wathorego were home to majority of the children at school and therefore were assessed for maternal night blindness. These two villages had more stable populations who had lived in the area for a longer time period as opposed to the Nubian village and Kibos town which had mobile populations seeking employment in the area.

3.2 Study Design

A cross sectional survey was carried out among women who had delivered a live birth within the 3 year duration prior to the study in the identified locations. Qualitative data was collected through focus group discussions, key informant interviews and questionnaires.

3.3 Sampling

3.3.2 Sample Size Calculation

Selection of key informants in the district was purposive based on the information sought and the technical ability of the key-informant to provide accurate information on the topic of interest. At community level, selection of key informants for local terms and descriptions for night blindness was based on the age. Three old women aged > 70years were interviewed to seek clarification on local terms and descriptions for night blindness raised in the focus group discussions due to their excellent command in use of local language.

Likewise, selection of participants for the focus group discussions was purposive based on their age, area of residence, occupation, marital status as well as social economic status of household. The basic criterion was that all must have gone through full term of pregnancy and had at least one live birth and fit within the following age categories: below 20yrs, 20-30 yrs, 30-40, 50-70yrs and > 70yrs old. Two participants were selected in each of the age categories. The village leaders assisted in selection of the participants based on these variables in order to have a representative group of mothers in the community.

A total of 290 mothers consisting of 94, 83, and 113 women in Kai, Junju and Wathorego sub-locations respectively were interviewed. In administration of individual questionnaires, exhaustive sampling (census) of all the mothers who met the inclusion criteria within selected villages was done. The villages assessed were home to majority of the children attending each of the primary schools selected in the study areas. The census method was used because the condition of night blindness is a rare occurrence in communities (with >5% prevalence being a public health concern) hence requires a large sample size which the project time frames and resources could not facilitate. Therefore, there was need to assess manageable number of respondents within an intact population (combined villages) so that the results obtained were indicative of the prevalence of maternal night blindness as a proxy indicator for population prevalence of VAD in the assesed areas.

3.3.3 Sampling Procedure

The administrative boundaries for the sub locations where the KARI stations were located were established. A list of all primary schools in each study district was obtained from the District Education Officer (DEO) and with his help, the public primary day schools, near the identified KARI station, with an enrollment of at least 400 pupils and located in food insecure areas of the District were identified. Key informant interviews were held with the DEO concerning the schools and the information was used to select primary schools that were potentially eligible for the cassava feeding trial. Schools which were located more than 80 km radius from KARI station or had a high fraction of boarders were not eligible. In addition, schools located close to or along a river with a lot of horticultural irrigation farming activities were not considered since the population had considerable access to fruits and vegetables. Furthermore schools that were located inside KARI research stations were not selected because majority of the population were KARI employees with regular income to buy food, better access to fruits and vegetables, improved farming methods and food crop varieties.

A comprehensive comparison (SWOT analysis) of the three study areas was undertaken by an intern student who was attached to this survey. The report by Zijlstra (2009) was submitted to Wageningen University for examination. The SWOT analysis results were used in selection of focal primary schools for the study. In general the following criteria were used in selection of schools for identification of populations to be surveyed:

1. Enrollment numbers of greater than 400 pupils in school in a public-day primary school
2. Proximity to collaborating KARI station (at most 80 kms / 1 hr drive radius from KARI station)
3. Accessibility by a car/truck (transport system-nature of roads, location from main road)
4. Access to water by the school/community in selected sub-location
5. Availability of toilets and other sanitation facilities at the school which can facilitate proper hygiene standards during on-site preparation and feeding with the yellow cassava
6. Presence of a health facility near the school/ in the community
7. Population density of greater than 1000 people in selected sub-location (proxy indicator of possible number of women who meet the inclusion criteria in the population).
8. Food security situation in the area (Populations reported to experience chronic food shortages were preferred since it was likely to encounter VAD in such populations).
9. Friendliness/hostility by the administrative leaders/community and school head-teachers to facilitate community mobilsation and offer security to the research team.

After triangulation of the above and other factors, one primary school was chosen in each of the identified sub-locations in Makindu, Kilifi and Kisumu-East districts. Using admission records from the selected school, the villages from where the pupils hailed were identified and ranked based on the number of children from each village. These villages were then assessed starting with the one with highest number of children. A census of mothers who met the inclusion criteria was was conducted in the villages host to majority of the children attending the index primary school.

See sampling schema in Appendix 5 for the procedures used in the field).

3.3.3 The Inclusion and Exclusion Criteria for Mothers

All the mothers included in this survey had delivered a live birth within three years prior to survey (calculated as from the date of interview) regardless of whether the child was alive or dead at the time of the survey. In addition, they must have lived in the village for the last at least six months of their pregnancy and also delivered while living in the same village.

Those excluded from the survey included women who refused to participate, had not lived in the community during both second and third trimester of their pregnancy, were mentally ill and were absent during the survey period.

3.4 Research Instruments

The research instruments used included semi-structured questionnaires on respondent profile and maternal night blindness; Focus Group Discussion (FGD) and Key Informant Interview (KII) guides and Individual Dietary Diversity (IDD) questionnaire with 21 food groups (see appendices 7, 8,10, 11 and 12 for the questionnaires used for data collection in this study).

3.5 Ethical and Human Rights Considerations in Research

Research permit was obtained for the the PhD study " Bioefficacy feeding trial for biofortifed cassava among children aged 6-12 years in Kenya" was sought from the ministry of Education, Science and Technology by the INSTAPA project WP2). This survey was a baseline for the PhD study and therefore was covered by the research permit. In addition, the study objectives were clearly explained to the community leaders, community members and selected study participants. Verbal informed consent was sought from study participants before the interviews were conducted and confidentiality of information collected was assured and maintained throughout the study. The mothers were interviewed alone away from other household members except for children below 5yrs (see Appendix 9 for consent note). The names of participants were recorded for helping in maintaining quality of data while in the field to facilitate revisits and to guard against missing details. However, these names were not used in reporting of the findings.

3.6 Training of Field Work Personnel

All questionnaires were administered by the principal investigator who was trained in questionnaire administration through interviews for the various sections. No field assistants were used in this study to ensure consistency in the interviewing process for minimization of inter-interviewer errors. The field guide was trained before the beginning of the survey on translations for the questionnaire in order to assist in interviewing mothers where a language barrier was encountered (interviewing done through a translator).

3.7 Pre-Testing the Questionnaire

The questionnaires were pre-tested in Kai village, within Kai sub-location in Makindu District which had not been selected for the main study. Based on the findings of the pretest, appropriate modification of the questionnaires was done to ensure objectivity and clarity of the questions, but the data was not analyzed. The modified questionnaires were then used for data collected in the three study areas.

3.8 Data Collection Methods

3.8.1 Key Informant Interviews (KIIs)

These were conducted with key stakeholders at district and village levels in order to gather information on issues of relevance to the survey and INSTAPA WP-2 project. The interviews broadly covered the following areas as per the key informant interview guide in Appendix 7:

3.8.1.1 Administrative systems in the area

The main aim of the interviews was to understand the administrative levels and boundaries within the area and after being granted permission to conduct research in the area. The Office of the president officials at different levels were targeted for these interviews and village elders.

3.8.1.2 Education system

The aim of the interviews was to find out the names and numbers of primary schools within 80km radius from KARI station, with their enrollment numbers, presence of school feeding and health programs, and accessibility to the school by car/truck in each of the study districts. The information was to guide in selection of a school around which the population was to be surveyed for maternal night blindness. Ministry of education officials at different levels in the district, head teachers and teachers at various primary schools in the district were interviewed.

3.8.1.3. Healthcare system and night blindness

The aim was to understand the health structure in the district, common health illnesses in the area, vitamin A deficiency and existence of maternal night blindness. In addition, information on postpartum vitamin A supplementation programs, health seeking practices of pregnant women, antenatal and post natal care and prevalence of malnutrition both in hospital and community was ought. District medical officers, District public health officers, doctors, nurses, nutritionists, eye specialists and local leaders in the area were interviewed.

In addition, elderly women were interviewed for clarification of the meaning of local terms and descriptions for maternal night blindness in the area identified from the FGDs. These elderly people were interviewed after focus group discussions in order to differentiate the local terms/descriptions whose meaning was not agreed on during FGDS. In Kai and Junju sub-locations, eye specialists were consulted for clarification on unfamiliar eye conditions reported by mothers during the administration of maternal night blindness questionnaire. Clarification was sought on 4 cases in Kai and 1 case in Junju and weren't cases of nightblindness. All the cases in Kai were conjunctivitis, while the Junju case was pterigium. Such cases were not encountered in Wathorego.

3.8.1.4 Agriculture and food security

The main aim of the interviews was to gain information on agricultural activities in the area and food security situation. Further interest was on cassava production and consumption in the area and/or willingness to consume the bio-fortified yellow cassava. The Ministry of Agriculture officials, administrative leaders and local leaders were interviewed to gather this information.

3.8.2 Focus Group Discussions

Two focus group discussions (FGDs) were conducted in each study area in order to establish local terms for night blindness (if any existed) and to capture the various descriptions of night blindness in the community. Each of FGD consisted of women who had at least experienced a full pregnancy. The women were aged between 15 and 49 years old with at least one woman from each of the age categories: < 20; 20-30; 30-40, 40-50, 50-60, 60-70 and >70 years old. Short notes were taken during the FGD session and then expanded later to capture all the various terms and descriptions mentioned for night blindness.

A total of five FGDs were conducted for this study in Kai, Junju and Wathorego sub-locations within Makindu, Kilifi and Kisumu East districts of Kenya, respectively. Two focus group discussions were conducted within Kai sub-location in Likoni and Kawelu villages with 13 and 10 participants respectively); two discussions within Wathorego for combined Riwa and Kotunga Villages and for combined Kabonyo villages with 12 and 6 participants respectively. One FGD was conducted in Bodoi village with 12 participants within Junju. The second focus group discussion was done only if the participants in the first discussion did not give convincing information especially on local terms and descriptions for night blindness. The FGD participants consisted of mothers aged 17 years and above with at least two women from each of the following age groups: below 20yrs, 20-30 yrs,30-40, 50-70yrs and > 70yrs old. However, the FGD for the combined Kabonyo villages consisted of only six women because of the heavy rains which made other participants not to attend. Therefore, this group consisted of two women aged above 60years, and one mother in each of the following age categories 50 -60 yrs, 30-40 yrs, 20-30 yrs and below 20 years.

The FGD findings on local terms and descriptions were used to modify the night blindness questionnaire for each of the study areas. Furthermore, the FGDs were used to identify the various types of foods available in the community and their local names in order to adapt the dietary diversity questionnaire for each of the study areas

3.8.3. Individual Interviews

A total of 290 mothers who had delivered a live birth within the previous three years were interviewed for maternal night blindness during their last pregnancy that ended in a live birth.This number consisted of 94, 83, and 113 women in Kai, Junju and Wathorego sub-locations respectively. The questionnaire was administered through interviews in Swahili with mothers who had delivered a live birth within the last three years. Where language barrier was encountered, the field guide with at least form four level of education was trained to objectively translate the questions and answers during the interviews in the local language but this happened less often. Revisits were done for those not at home; however those who were not found during the survey period were not interviewed. The interviews covered various study topics based on several rationales as explained below.

3.8.3.1 Respondent characteristics

The profile of the women who had delivered a live birth within the last three years was established in order to estimate denominators for calculation of population statistics and to form a framework for interpretation of results. Information was gathered on date of last live birth which was used to screen out women who did not meet the inclusion criteria and identify the target respondents. In addition, information on year of birth/age of respondent, literacy level of the respondent, literacy level of husband (if currently married), main source of household income, post-partum vitamin A supplementation and the number of children in the household who were in primary school was established.

3.8.3.2 History of maternal night blindness

The questionnaire for assessing history of maternal night blindness was administered to mothers who had delivered a live birth within the last three years in order to estimate the population prevalence of maternal night blindness as an indicator of population prevalence of vitamin A deficiency. The mothers were asked if they had any visual problems either at daytime or dusk and/ or low levels of light during their last pregnancy that ended in a live birth. Those who reported only daytime visual problems were considered not night-blind. However, those who experienced visual problems at dusk or in low levels of light were asked to elaborate on the nature of their visual problems. If these visual problems were experienced in the evening /low levels of light especially during the last trimester and disappeared after birth, they were classified as night blind. Short notes were made on the questionnaire for the given descriptions for night blindness, difficulties encountered and coping strategies used as mentioned by the mother. A lot of probing and listening to mothers' explanations was used in order to identify history of maternal night blindness. Where known local terms or descriptions had been identified in the FGDs, these terms were used to ask about night blindness at the end of the interview. Descriptions for night blindness in the local language i.e "*Kwoona Mbindu*" in Kamba and "*kuona wiriri*" in Chonyi were used in Kai and Junju, respectively, based on the findings of the ethnographic study which was done before the survey. However, the local descriptions for night blindness in Luo could not be used for maternal night blindness in Wathorego because the area was highly multi-lingual without common local terms and descriptions in local languages.

A history of maternal night blindness was only accepted where the response was definite and positive using a modified algorithm suggested by WHO (1996) and also that used by Wedner et al (2004). Mothers who reported poor vision at dusk caused by known medical eye condition/injury/allergy during pregnancy and were either treated by eye medications (other than vitamin A capsules) or had pre-existing visual problems (long and short sightedness, photosensitivity) which persisted during pregnancy were not classified as being night blind. Eye conditions, which were unclear to the interviewer, were noted down and clarification sought from ophthalmologists at the District hospital. Classification of maternal night blindness cases encountered was as indicated in figure 1 shown below that was developed for this study.

Figure 3. 1: Decision tree for classification of night blindness cases.

Algorithm used	**Scenarios for classification of maternal night blindness cases based on algorithm questions used**					
	1	**2**	**3**	**4**	**5**	**6**
Daytime visual problems	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Visual problem in low levels of light	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**No**
Visual problem different from others in community	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**
Reported p roblem during pregnancy	Reported poor vision at dusk/low levels of light that developed during pregnancy but disappeared within the first month postpartum or persistent up to time of survey				Didn't report poor vision at dusk/low levels of light during last pregnancy that ended in a live birth	
Night blindness asked using local description	Yes		Didn't know local description for pXN/ no local description exist		No or didn't know terms	No or didn't know terms
Night blindness case classification	**Adjusted case**	**Crude case**	**Adjusted case**	**Crude case**	**No case**	**No case**

Definition of maternal night-blindness cases as per the classification above:

1. Adjusted case – Mother reported visual problems only at dusk or in low levels on light which developed during pregnancy. They also had no prior visual problems during daytime

or at dusk. This is a classic case of night blindness

2. Crude case- Mother reported visual problems both during daytime and at dusk during pregnancy. They could have experienced night blindness in addition to pre-existing visual problems during their pregnancy hence we couldn't rule it out.
3. No case- Mother did not experience night blindness during pregnancy

3.8.3.3 Individual Dietary Diversity

The qualitative dietary diversity questionnaire was administered at individual level for women on food consumption for the previous day (24 hrs). The respondent was asked to recall all the foods they ate the previous day from the time they woke up to the time they slept. As the respondent listed the foods, the interviewer noted them on the questionnaire without interrupting. After the respondent had finished narrating, the interviewer then prodded on any snacks (especially fruits, nuts and drinks) and food eaten outside the home on the previous day and made notes. When all the foods had been listed, the interviewer prodded on the preparation methods and ingredients used for mixed meals and the individual ingredients were listed alongside the dish name.

Scoring of the questionnaires was done off the field in the evening of the same day. The foods were classified into 21 food groups based on the questionnaire guidelines and food composition tables (see Appendix 13 on classification of foods into food groups). For mixed dishes, the individual ingredients were classified into appropriate food groups and scored on the questionnaire. Each food group consumed was scored as 1 and a food group not consumed was scored as 0. Individual Dietary Diversity Score (IDDS) was calculated by summing up all the food groups consumed the previous day. Though information on consumption of sugars, oil, spices, alcohol and other beverages was collected, these foods were not scored on the questionnaire and therefore did not contribute to the IDDS.

3.8.4 Case Studies

Women who reported a history of maternal night blindness were further interviewed for further information on experienced symptoms of night blindness, when condition started, when condition disappeared, difficulties encountered as a result of the condition and coping strategies used. This was noted in a separate notebook.

3.9. Data Quality Assurance

In order to ensure data quality, a standardized questionnaire was used for all respondents and only under special circumstances, the interview was done through a translator. The inclusion and exclusion criteria were adhered to for the mothers interviewed. In addition, probing was done for night blindness and food groups not mentioned in the 24 hr dietary intake to facilitate memory of events and allow adequate time for response. Finally, the questionnaire was checked before leaving the household to ensure it was completely and appropriately filled.

3.10 Data Management and Analysis Procedures

The data was entered, cleaned and analyzed in SPPS version 17. However, graphs showing comparison of variables by study area were done in EXCEL using the results obtained in SPSS. A significance level of 0.05 was used in all analysis.

Exploratory data analysis was conducted to establish data structure and distribution before statistical analysis was carried out. Normality of the data was tested using Q-Q plots while the explore command in SPPS was used to calculate frequencies and proportions for various variables by study areas. The results for various demographic and socio-economic characteristics of mothers were presented using box-plots, error-bars, tables and graphs as appropriate for the information.

The prevalence of night blindness in the study area(s) was calculated in SPPSS for each of the three study sites using frequencies as shown in Table 3. The mothers (cases) with reported visual problems during both daytime and dusk were filtered out in SPPS 17during calculation of adjusted prevalence as per the table 3.1.

Table 3.1: Calculation of prevalence rates for maternal night blindness in study area	
Crude prevalence of pXN%	Total count of crude cases of night blindness reported by mothers in the study area ________________________________ **x 100** Total number of mothers interviewed
Adjusted prevalence of pXN%	Total count of adjusted cases of night blindness reported by mothers in the study area ________________________________ **x 100** Total number of mothers interviewed - Total number reporting poor vision both during the day and at dusk

Study areas found to have ≥ 5% crude prevalence of maternal night blindness or an adjusted prevalence of ≥ 2% was considered to have a vitamin A problem of public health significance based on IVACG, 2002 recommendations.

Comparison of prevalence rates in the three study areas was done using direct standardization based on age distribution for mothers. The overall age distribution for all the study sites combined was used as the standard for comparison of the prevalence rates following the methodology outlined by Mausner and Krammer (1994). As per this procedure, the age specific prevalence rates for maternal night blindness were obtained from the SPPS and the standardized prevalence rates were calculated in EXCEL (see Appendix 4).

Calculation of dietary diversity indicators was done as per the FAO (2008) guidelines on measurement of individual dietary diversity indicators as presented in table 3.2.

Dietary diversity indicators were calculated as follows:

Table 3.2: Calculation of dietary diversity indicators for consumption of vitamin A rich foods in study areas

Percent of mothers consuming plant foods rich in vitamin A	(Sum of mothers who consumed vitamin A rich vegetables and tubers **OR** vitamin A rich fruits) / (Total number of mothers interviewed) **x 100**
Percent of mothers consuming animal foods rich in vitamin A	(Sum of mothers who consumed organ meat **OR** eggs **OR** milk and milk products) / (Total number of mothers interviewed) **x 100**
Percent of mothers consuming either plant or animal foods rich in vitamin A	(Sum of mothers who consumed vitamin A rich vegetables and tubers **OR** vitamin A rich fruits **OR** organ meat **OR** eggs **OR** milk and milk products) / (Total number of mothers interviewed) **x 100**

One way independent measures Analysis of Variance (ANOVA) and Kruskal-wallis tests were respectively used for comparison of parametric and non-parametric variables among the three study areas. A 0.05 level of significance was used for test of difference for variables investigate in this study. Variables whose values had a significant difference among study areas were not analyzed further because post hoc tests for Kruskal-Wallis Test are not available in SPPS. However, the mean ranks for the study areas generated by the Kruskal-Wallis Test were used to rank the study areas based on their "mean study area deviation for the overall mean rank".

Associations between parametric variables were investigated using correlations while cross tabulations where used to investigate associations among non-parametric variables. Correlations were accepted to be significant at 0.05 level and partial correlations were also done for some of the variables. For cross tabulations, Pearson Chi–square Test (χ^{2}) was used but where the χ^2 was violated (i.e had cells with count less than 5 in analysis), Fisher's Exact Test was used to investigate associations. *Scatter graphs* were used in EXCEL preliminary to give trends of maternal night blindness and dietary diversity indicators across the three study areas. Binary logistic regression was used to build a model for predicting maternal night blindness.

CHAPTER 4: RESULTS

4.1 Demographic and Socio-Economic Characteristics

4.1.1 Demographic Characteristics

307 mothers who had delivered a live birth within the previous 3 years were eligible for the study in the three sub-locations accounting for approximately 10.39% of the total population. Out of these, 290 (94.5%) consisting of 94, 83, and 113 mothers were interviewed in Kai, Junju and Wathorego sub-locations respectively. Table 4.1 shows a comparison of selected population characteristics by sub-location assessed.

Table 4.1: Selected population characteristics by sub-location

Sub-location	Kai	Junju	Wathorego	Overall
Number of households in the area	178	107	199	475
Mean household size*	6.05	7.53	5.39	6.22
Estimated population of area	1077	806	1070	2954
Number of eligible mothers	100 (9.2%)	89 (11.04%)	118 (11.03%)	307 (10.39%)
Number of mothers interviewed	94 (94%)	83 (93.3%)	113 (95.8%)	290 (94.5%)
Eligible mothers who:				
• Didn't participate	6	6	5	17
• Refused to participate	1	2	1	4
• Incapacitated (mental problems)	2	0	1	3
• Away during survey period	3	4	3	10
Number of mothers with husbands	85	72	100	257

* Mean household size was significantly different between study areas ($F = 16.07$, $p<0.05$)

** Estimated population = Number of households*mean household size

4.1.2 Socio-economic Characteristics of Mothers

Table 4.2 indicates the distribution of selected demographic characteristics of mothers interviewed in the study areas. Generally, the characteristics of mothers interviewed were significantly different ($p < 0.05$) in the three sub-locations with the exception of physiological status.

Overall, the mean age for women interviewed was approximately 25.8 years, with an average of three children per mother. The mean duration since last live birth was 15 months and majority of

Table 4.2: Selected demographic characteristics of study mothers by study area

	Kai n=94	Junju n=83	Wathorego n=113	Total n=290	χ^2 Test p-value
Mean age of mothers (17-40 yrs)	27.35	26.66	23.90	25.81	0.00
Mean duration since last live birth (months)	17.74	14.99	12.88	15.06	0.03
Mean number of children per mother	3.16	3.53	2.59	3.04	0.03
Physiological status (% within study area)					0.519
Lactating	70.2	72.3	77.0	73.4	
Neither pregnant nor lactating	24.5	19.3	18.6	20.7	
Pregnant	4.5	8.4	4.4	5.5	
Both pregnant and lactating	1.1	0	0	0.3	
Literacy level of mothers (% within study area)					0.00
Not attended school	1.1	1.1	1.8	8.6	
Lower primary (1-4 dropout)	9.6	9.6	3.5	7.9	
Upper primary (class 5-8)	58.5	58.5	54.0	53.4	
Technical training post primary school	10.6	10.6	14.2	11.4	
Secondary (form 1-4 dropout)	11.7	11.7	20.4	12.8	
Completed secondary	4.3	4.3	0	1.7	
Tertiary education	4.3	4.3	6.2	4.1	
Occupation of mothers (% within study area)					0.00
Housewife					
Casual labor	53.2	16.9	43.4	39.0	
Small scale trader	14.9	7.2	4.4	8.6	
Farmer	20.2	31.3	34.5	29.0	
Formal employment	5.3	41.0	13.3	18.6	
Others	1.1	3.6	1.8	2.1	
Postpartum Vit. A supplementation (%)	11.7	68.7	49.61	42.8[2]	0.00

[2] Three mothers were still eligible for supplementation at time of survey though were classified as not received post partum vitamin A supplementation,

these mothers were still lactating. In addition, a high proportion of the mothers had attained primary education and their main occupations were housewife (39.0%) and small scale trading (29.0%).

4.1.3 Socio-economic Characteristics of Husbands

Out of the 290 women interviewed, 88.6% were married. Generally fewer husbands (2.7%) compared to wives 8.6% (in table 8) had not attended school and Junju sub-location had the highest proportion of illiterate persons compared to other sub-locations accounting for 88% and 71.4% of illiterate mothers and husbands respectively. Majority of the husbands had attained primary school education though more husbands compared to wives had attained education beyond primary school as indicated in Table 4.3.

Table 4.3: Selected socio-economic characteristics of husbands to the women interviewed by study area

Characteristic	Kai H[3]=85	Junju H=72	Wathorego H=100	Overall H=257	χ2- Test p-value
Literacy level of husbands (% within study area)				2.7	0.00
Not attended school	1.2	6.9	1.0	4.7	
Lower primary (class 1-4)	9.4	2.8	2.0	39.7	
Upper primary (class 5-8)	37.6	50.0	34.0	11.7	
Technical training post primary school	10.6	15.3	10.0	12.1	
Secondary (form 1-4 dropout)	8.2	9.7	17.0	14.0	
Completed secondary	22.4	4.2	14.0	15.2	
Tertiary education	10.6	11.1	22.0		
Occupation of husbands (% within study area)					0.00
Casual labour	69.4	2	61.0	54.1	
Formal employment(salaried)	27.1	6.4	16.0	23.0	
Small scale trader	0	27.8	18.0	16.0	
Unemployed	2.4	31.9	1.0	2.3	
Farmer	1.2	4.2	1.0	1.9	
Student/pupil	0	4.2	2.0	1.6	
Businessman	0	2.8	1.0	1.2	

The main occupation of husbands was casual labour (54.1%) followed by formal employment (23%) and small scale trading (16.0%) in that order. It was noted that while 18.6% of women reported themselves as farmers, only 2.3% of their husbands were farmers. However, more husbands were formally employed (23.0%) compared to their wives (2.1%). A significant difference ($\chi 2$, $p<0.05$) was observed in both literacy levels and occupation of husbands among the three sub-locations assessed.

4.1.4 Main Source of Household Income

The main source of income was casual labour (44.8%) followed by trade (23.1) and salaried employment (21.4%) in that order. The trend was however, not similar in individual study areas as indicated in Table 4.4. Junju had two main sources of income, trade (34.9%) and salaried employment (28.9%) which were not significantly different ($\chi 2$- $p<0.05$) while Kai and Wathorego mainly depended on casual labour for household income.

Table 4.4: Distribution of study households by main source of income and study area

	Kai	Junju	Wathorego	Overall
Main source of HH income (% within study area):				
Casual labor	56.4	22.9	51.3	44.8
Trade	10.6	34.9	24.8	23.1
Formal employment (salaried)	19.1	28.9	17.7	21.4
Crop sales	1.1	12.0	0.9	4.0
Animal and animal product sales	3.2	0	0	1.0
Remittances	8.5	0	1.8	3.4
Destitute/gifts/begging	1.1	1.2	3.5	2.1

4.2 Local Terms, Descriptions and Perceptions on Maternal Night blindness

Maternal night blindness existed in all the three areas assessed though it was not on the spontaneous list of common health problems during pregnancy as expectant women mostly assumed it to be dizziness. The populations used different local descriptions for the condition and no specific local term existed in all the three areas assessed. However, proxy terms for night blindness were identified and when used with further probing on the type of visual problems encountered; it was possible to distinguish night blindness cases from other visual problems.

The proxy local terms identified were:

- *kwona mbindu e mawiyo* (Akamba language) in Makindu
- *kuona wiriwiri jioni* (Chonyi language) in Junju

No specific local term was identified in Wathorego because the area was multilingual and Kiswahili was the common language. Therefore, the questionnaire was asked in Kiswahili without modifications to include local terms and descriptions for night blindness.

The various descriptions given by mothers for maternal night blindness were:

- Good vision during daytime but poor vision at dusk or low levels of light; often disappeared within one month postpartum after delivery due to nutritionally adequate diets consumed in the postpartum period
- Inability to see well when moving into house from outside/lit area (reduced eye adaptation to reduced light)
- Seeing shadows at dusk- inability to identify people or things well
- Foggy/ misty vision at dusk (like a spider web over the eyes)
- Knocking on objects at dusk- falls and sometimes injuries
- Inability to cook at dusk (onions/food got burnt); hence cooked early (before 7pm)

- Lighting the lamps early from 6 pm and sometimes daytime

ı total of 226 mothers (77.9%) interviewed reported at least one problem during their last regnancy which had ended in a live birth. Table 4.5 shows percent distribution of study articipants by problems encountered during their last pregnancy and study area.

)izziness was the most common problem reported during pregnancy followed by lower bdominal pain, night blindness, malaria, nausea and vomiting in that order. Maternal night ılindness ranked third among the health problems encountered during pregnancy by the study ›articipants and this trend was the same in Junju. In Kai, night blindness ranked second to lizziness accounting for 20% of the problems reported while it ranked fourth in Wathorego. All he mothers who reported to have been night-blind also recognized that their condition was lifferent from others in all the three study areas.Of the mothers who reported night blindness, the most common accompaniment was dizziness which was reported by 66.7%, 20% and 40% of night blind women in Kai, Junju and Wathorego, respectively.

Table 4.5: Percent Distribution of mothers by problems encountered during last pregnancy & study area.

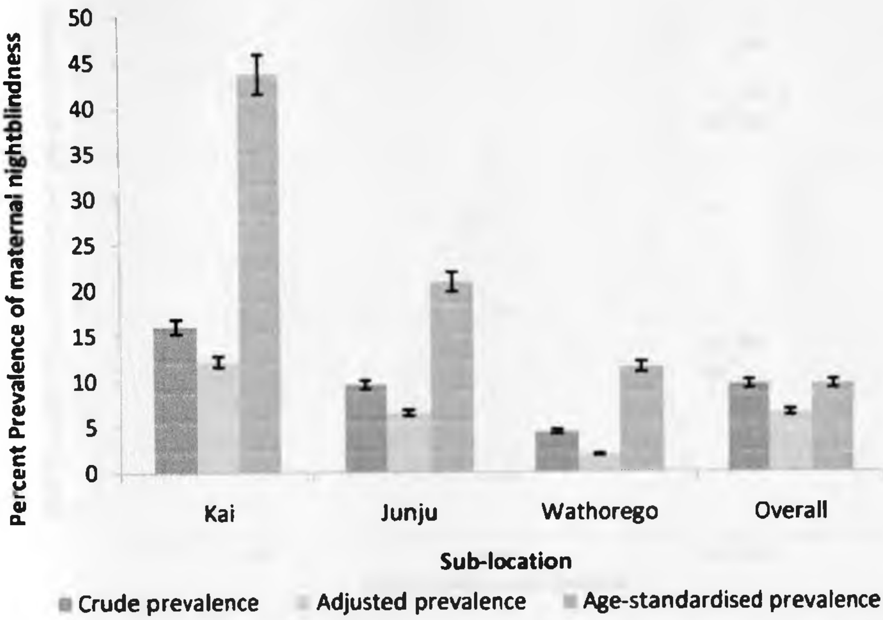
	Kai (n=75)	Junju (n=64)	Wathorego (n=87)	Overall (n=226)
Dizziness	33.3	31.3	31.0	31.9
Lower abdominal pain	14.7	18.8	16.1	16.4
Night blindness	20.0	12.5	5.7	12.4
Malaria	10.7	0	11.5	8.0
Nausea and vomiting	6.7	3.1	4.6	4.9
Oedema in legs	1.3	3.1	3.4	2.7
Iron deficiency anaemia	0	4.7	2.3	2.2
Fatigue	2.7	1.6	2.3	2.2
Other visual problems	0	1.6	4.6	2.2
Poor appetite	0	3.1	2.3	1.8

*calculated as a percentage of women who reported at least one problem (n)

.3 Prevalence of Maternal Night Blindness as a Proxy Indicator of Vitamin A Deficiency

'he crude prevalence rates of self reported history of maternal night blindness was highest in Kai 16%), followed by Junju (9.6%) and least in Wathorego (4.4%). On adjustment, the prevalence ated reduced to 12.2%, 6.5% and 1.9% for Kai, Junju and Wathorego respectively as shown in igure 4.1.

3oth the crude and adjusted prevalence rates for maternal night blindness were significantly lifferent (χ^2 p<0.05) for the three sub-locations The crude prevalence rate included mothers who eported to have experienced visual problems both during daytime and at dusk/low levels of light while the adjusted prevalence rate excluded these mothers



When comparison of the prevalence rates using the direct (age) standardization method was performed, Kai still had the highest prevalence of maternal night blindness followed by Junju while Wathorego had the lowest prevalence. Standardization used the combined age distribution for all the three study sites (overall) as the standard population distribution against which omparison was made for individual study areas as indicated in Appendix 7. The age-standardized revalence rates for maternal night blindness were also significantly different for the three ivisions. ($\chi^2_{(2\ d.f,\ 0.05)} = 29.63$, p=0.000).

.4 Dietary Diversity

.4.1 Individual Dietary Diversity Scores (IDDS)

'or all the study sites, the distribution of IDDS was normal for mothers interviewed with kewness and kurtosis statistics within -1 to 1 and -0.8 to 0.8 respectively for individual areas. However, Wathorego had nine mothers with extreme individual dietary diversity score as presented in Figure 4.2.

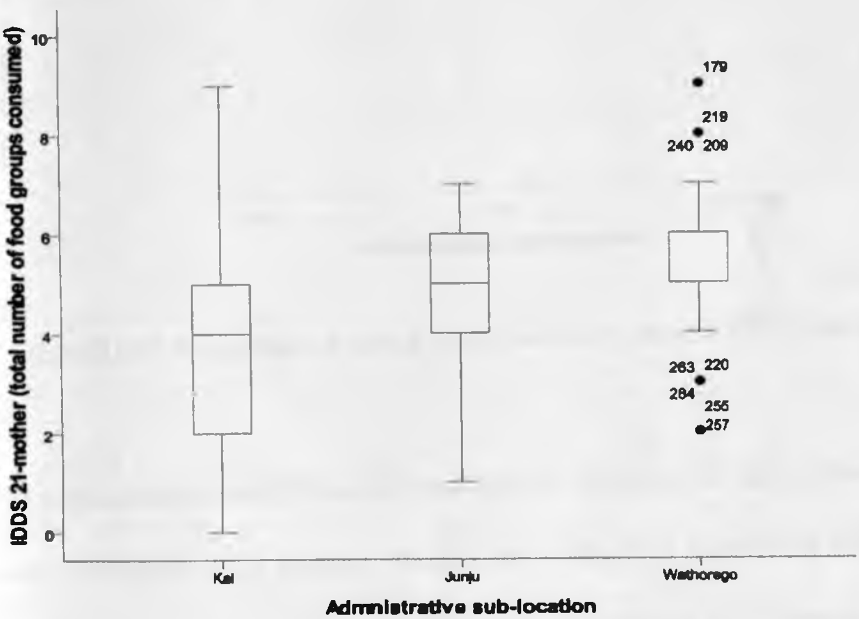


Figure 4.2: Distribution of individual dietary diversity scores among mothers by study area

Overall, 1.4 % of mothers reported unusual food consumption patterns within the previous 24 hours. Kai had the highest proportion of mothers who reported unusual food consumption at 2.1 % followed by Junju (1.2 %) and Wathorego (0.9%) in that order. Exclusion of mothers who ported having unusual food consumption within the previous 24 hrs did not have a significant fect ($p > 0.05$) on the mean IDDS hence all mothers were used in analysis. Therefore, the mean umber of food groups consumed (IDDS) by mothers was highest in Wathorego at 5.43 ± 0.24; llowed by Junju with 4.63 ±0.34 and Kai trailed at 3.88 ± 0.36 at the 95% confidence interval as resented in figure 4.3.

Figure 4.3: Mean IDDS for mothers by study area and error bars at 95% confidence interval.

Kruskal – Willis test indicated that IDDS was significantly different for the mothers when the three study areas were compared ($\chi^2_{(2\ d.f,\ 0.05)} = 48.499$; p= 0.00).This significant difference persisted even when comparison was done excluding the outliers observed in Wathorego ($\chi^2_{(2\ d.f,\ 0.05)} = 52.089$; p= 0.00). However, in SPSS, there are no post-hoc options available for Kruskal Wallis hence the mean rank coefficients from analysis output were used to generate a mean rank deviation of the mean IDDS in order to investigate the magnitude of difference in IDDS among hence the mean rank coefficients from analysis output were used to generate a mean rank deviation of the mean IDDS in order to investigate the magnitude of difference in IDDS among individual study areas as indicated in Table 4.6. Wathorego ranked first based on the Kruskal Wallis Test mean rank statistic, followed by Junju and Kai in that order. The magnitude of deviation from the overall mean rank was greatest in Kai and lowest in Junju while Wathorego ranked in between with a positive mean deviation. On the other hand, Junju ranked in between Kai and Wathorego and was closest to the overall mean rank deviation.

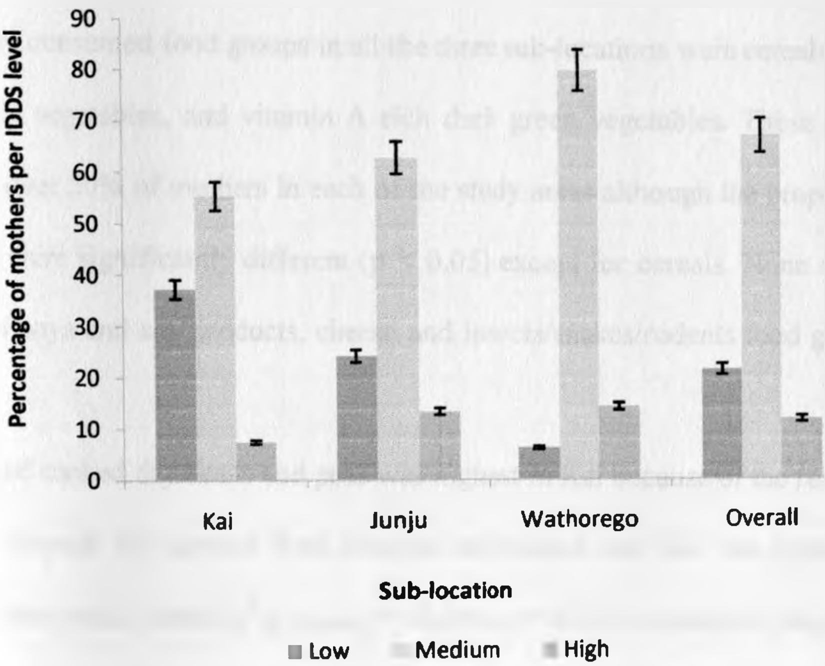
Table 4.6: Mean rank deviations of dietary diversity scores of study areas from the overall

Sub-location	Number of Mothers (N) [A]	Kruskal Wallis Test- Mean Rank statistic [B]	Deviation from Mean overall rank {145.50 - [B]}= [C]
Kai	94	103.37	-42.134
Junju	83	141.86	-3.64397
Wathorego	113	183.23	37.72603
Overall	290	145.503966	0

When the individual dietary diversity scores were categorized into dietary diversity levels: Low (0- 3 food groups), Medium (4-6 food groups) and High (7-9 food groups), the trend was as shown in figure 4.4.

Two-thirds (66.9%) of the mothers had medium dietary diversity level, while less than one-quarter (21.4%) and 11.7% had low and high respectively. This trend was the same in Kai and Junju. In contrast, Wathorego had a higher proportion of mothers with high dietary diversity compared to low dietary diversity hence the proportion of mothers with high diversity ranked second. The dietary diversity levels for mothers were also significantly different between the three study areas ($\chi^2_{(2\ d.f.\ 0.05)}$ p= 0.00)

Figure 4.4: Distribution of study mothers by dietary diversity levels and study area and error bars at 5% value



Few mothers (1.4%) reported to have eaten outside home within the interview period (previous 24 hrs). The proportion of mothers who had eaten outside the home was 11.7%, 8.4% and 8.8%, respectively for Kai, Junju and Wathorego sub-locations. Eating outside of the home was associated with IDDS only in Wathorego ($\chi^2_{(2\,d.f,\,0.05)} = 6.706$; $p= 0.00$). All the mothers who had eaten outside home in Wathorego had IDDS ≥ 5 food groups and 50% of them were small scale traders.

4.4.2 Consumption Levels for Individual Food Groups

The consumption levels for almost all food groups were highest in Wathorego and least in Kai sub-location. All the respondents had consumed at least one food group (cereal grain product) within the last twenty four hours except one mother in Kai who had drunk black tea without sugar and therefore had an IDDS of zero. This reflects the severity of hunger which existed in Kai during the survey period where over 90% of the population had been dependant on relief food for the previous 10 years.

The commonly consumed food groups in all the three sub-locations were cereals, other vegetables, vitamin C rich vegetables, and vitamin A rich dark green vegetables. These food groups were consumed by over 50% of mothers in each of the study areas although the proportions consuming each of them were significantly different ($p < 0.05$) except for cereals. None of the respondents had consumed soya and soy products, cheese and insects/snakes/rodents food groups as indicated in Table 4.7.

Consumption of cooked dry beans and peas was highest in Kai because of the relief food programs implemented through the general food distribution rations and this was significantly different compared to other study areas ($\chi^2_{(2\ d.f,\ 0.05)} = 43.104$; p= 0.02). In contrast, Junju had the highest consumption of vitamin A rich fruits because the survey was carried out towards the end of the mango season ($\chi^2_{(2\ d.f,\ 0.05)} = 20.301$; p= 0.00). Equally, consumption of Vitamin C rich fruits was highest in Wathorego because the survey was conducted during the guava season ($\chi^2_{(2\ d.f,\ 0.05)} = 24.108$; p= 0.00).

Consumption of eggs and vitamin A rich deep yellow, orange and red vegetables was only observed in Wathorego. Other food groups whose consumption was significantly different in the three study areas were: starch staples ($\chi^2_{(2\ d.f,\ 0.05)} = 9.003$; p= 0.011), milk and milk products ($\chi^2_{(2\ d.f,\ 0.05)} = 22.018$; p= 0.00), small fish eaten with bones ($\chi^2_{(2\ d.f,\ 0.05)} = 37.258$; p= 0.00) and large fish and seafood($\chi^2_{(2\ d.f,\ 0.05)} = 29.966$; p= 0.00). It was also noted that none of the mothers in Kai had consumed either small or large fish as opposed to Junju and Wathorego where consumption was reported.

Table 4.7: Distribution of study mothers by food groups consumed and study area						
	Food group on 21 dietary diversity questionnaire	Kai (%)	Junju (%)	Wathorego (%)	Overall (%)	Asymp. Sig (2-sided)
1.	Cereal grains and cereal products	**98.9**	**100**	**100**	**99.7**	**0.351**
2.	All other starchy staples	2.1	13.3	13.3	9.7	0.011
3.	Cooked dry beans and peas	**58.5**	32.5	15.0	34.1	**0.00**
4.	Soy beans and soy products	0	0	0	0	-
5.	Nuts and seeds	0	2.4	0.9	1.0	0.28
6.	Milk and yoghurt	12.8	24.1	**41.6**	**27.2**	**0.00**
7.	Cheese	0	0	0	0	-
8.	Organ meats	0	1.2	0	0.3	0.286
9.	Eggs	1.1	0	8.0	3.4	0.03
10.	Small fish eaten whole with bones	0	18.1	**32.7**	17.9	**0.00**
11.	Large whole fish and seafood	0	**28.9**	15.9	14.5	**0.00**
12.	Flesh meats and game meats	5.3	4.8	11.5	7.6	0.131
13.	Poultry, birds and game birds	0	2.4	0.9	1.0	0.281
14.	Insects, snakes, rodents	0	0	0	0	-
15.	Vit. A rich dark green leaf vegetables [a]	53.2	**62.7**	**86.7**	**69.0**	**0.00**
16	Vit. A rich deep yellow/orange/red vegetables [a]	0	0	3.5	1.4	0.042
17.	Vitamin A rich fruits [a]	1.1	22.9	12.4	11.7	0.00
18.	Vitamin C rich vegetables [b]	**70.2**	**62.7**	**91.2**	**76.2**	**0.00**
19.	Vitamin C rich fruits [b]	5.3	3.6	8.8	6.2	0.295
20.	All other vegetables	**71.3**	**78.3**	**92.9**	**81.7**	**0.00**
21.	All other fruits	8.5	4.8	8.0	7.2	0.595
	Mean IDDS-21	**3.88**	**4.63**	**5.43**	**4.70**	**0.00**

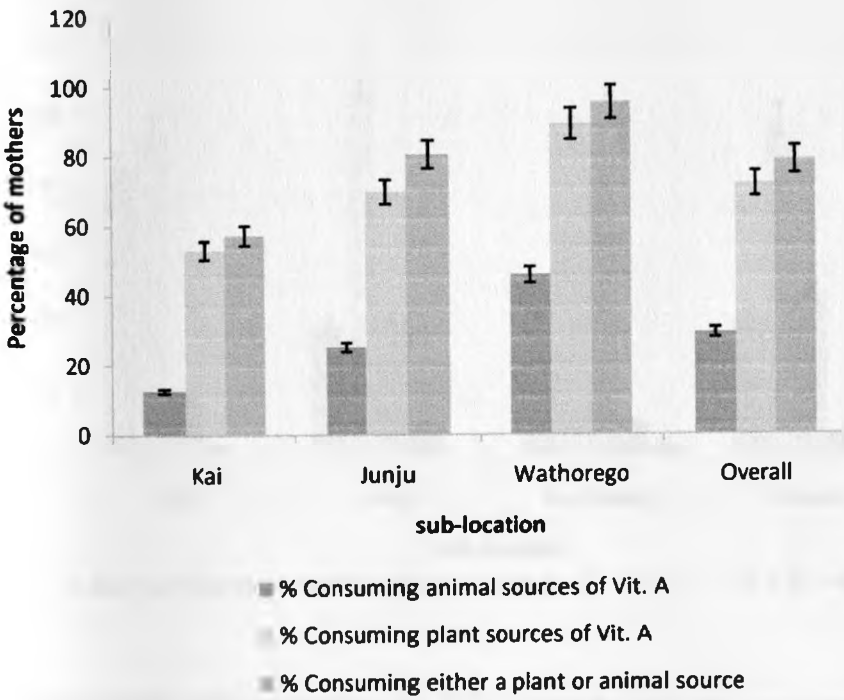
[a] "Vitamin A rich" is defined as> 130 RAE/100g

[b] "Vitamin C rich" defined as > 18mg/100g

4.4.3 Consumption of Vitamin A Rich Foods.

Consumption of vitamin A rich foods was highest in Wathorego followed by Junju and least in Kai.. Overall, 79% of the mothers had consumed either an animal or plant source of vitamin A within the previous 24 hours. Generally, consumption of animal sources of vitamin A was lower than for plant sources and the trend was the same in all study areas. However, Wathorego had the highest consumption level for animal sources (46%) as shown in figure 4.5.

Figure 4.5: Distribution of study mothers by Vitamin A food sources consumed and study area with error at 5% value

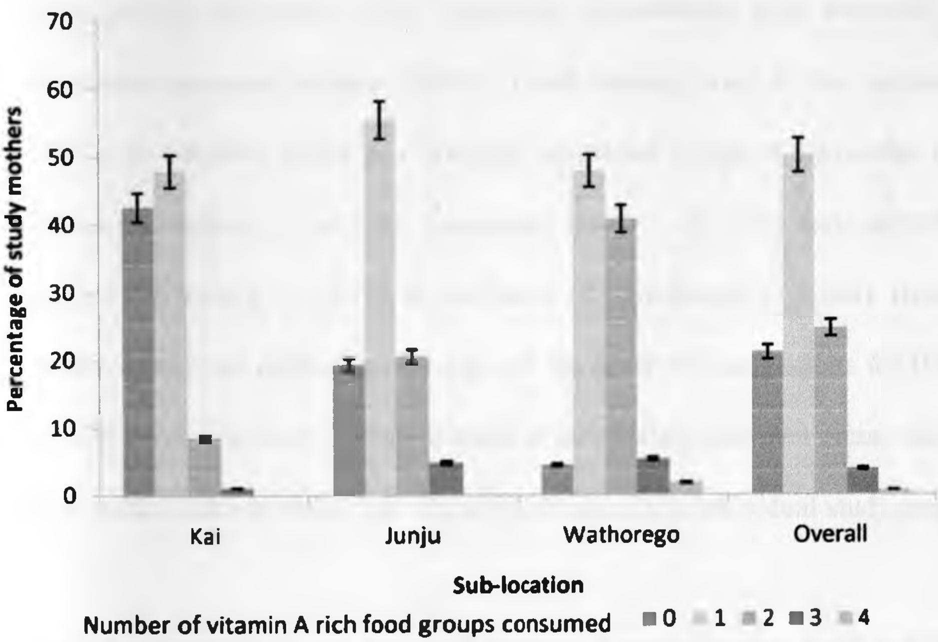


In contrast, almost three quarters (72.1%) of the mothers in all the three study areas had consumed a plant source of vitamin A especially the dark green leafy vegatables. The most commonly consumed dark green leafy vegetables in all the three areas were kales (*sukuma wiki*), amaranthus leaves (*terere*) and cowpea leves (*mukunde*). Consumption of vitamin A rich fruits was highest in

Junju because of the mango season as mentioned earlier. Orange, yellow and red vegatables were only consumed in Wathorego mainly orange fleshed sweet potatoes though by a small proportion of the mothers.

Half of the mothers interviewed had consumed at least one vitamin A rich food group within the previous 24 hours and the same trend was observed for individual study areas as indicated in Figure 4.6.

Figure 4.6: Distribution of study mothers by number of vitamin A rich food groups consumed and study area with error bars at 5% value



Wathorego had an equally high proportion (40.7%) of mothers who had consumed two vitamin A rich food groups. In addition, it was the only study area with mothers who had consumedfour vitamin A rich food groups. Kruskall-Wallis test indicated that the distribution of mothers by number of vitamin A rich food groups consumed was significantly different in the three study areas ($\chi^2_{(2\ d.f,\ 0.05)} = 14.527$; p= 0.00).

4.5. Associations among Socio-demographic Characteristics, Maternal Night Blindness and Dietary Diversity

4.5.1 Social Demographic Characteristics and Dietary Diversity

Generally, the dietary diversity level (low, medium or high) was positively associated with the literacy category of husbands ($\chi^2_{(6\ d.f,\ 0.05)}$ = 44.418; p= 0.00) and the main source of household income ($\chi^2_{(8\ d.f,\ 0.05)}$= 17.619; p= 0.024).

However, when the diversity levels were disaggregated into individual dietary diversity scores (number of food groups consumed), other significant associations were observed. Overall, a significant association emerged between IDDS 21 and literacy level of the husband (Fisher's Exact Test p=0.00). In addition, IDDS was inversely correlated to age of the mother (r = -0.145), number of children by mother (r = -0.172)   household size (r = -0.5153), and number of primary school children in household (r = -0.219), at 0.05 level of significance (2-tailed). However, when partial correlations were done controlling for age, all the observed correlations for IDDS became insignificant at 0.05 level (2-tailed). The same trend of associations between dietary diversity level and social demographic characteristics was inconsistent across the individual study areas.

In Kai sub-location, associations were observed between dietary diversity level and literacy level of mothers ($\chi^2_{(6\ d.f,\ 0.05)}$= 14.134.589; p= 0.028), and main source of household income ($\chi^2_{(8\ d.f,\ 0.05)}$ = 28.697; p= 0.00). On the other hand, Wathorego had significant associations between dietary diversity level and literacy level of husbands ($\chi^2_{(6\ d.f,\ 0.05)}$ = 38.200; p= 0.00), and vitamin A supplementation within 6 weeks postpartum ($\chi^2_{(4\ d.f,\ 0.05)}$ = 28.19.939; p= 0.001). Similarly additional associations emerged when the dietary diversity levels were disaggregated into total number of food groups consumed. Significant associations were observed between IDDS and age of mothers in Kai ($\chi^2_{(207\ d.f,\ 0.05)}$ = 279.083; p= 0.01) and between IDDS and occupation of mothers in Wathorego ($\chi^2_{(21\ d.f,\ 0.05)}$ = 34.447; p= 0.032).

Consumption of animal sources of vitamin A was significantly associated with literacy level of the husband (Fisher's Exact test; p=0.031) and main source of household income (Fisher's Exact test; p=0.017). This was not the case for individual study areas where no significant associations were observed except in Kai where consumption of vitamin A rich foods from animal sources was significantly associated with literacy level of the mother (Fisher's Exact test; p=0.010)
In addition, consumption of plant sources of vitamin A was significantly associated with the age of the mother ($\chi^2_{(56\ d.f,\ 0.05)}$ = 89.787; p= 0.003) and number of vitamin A rich food groups consumed (Fisher's Exact test; p=0.000 for each of the study areas). For individual study areas, the association between consumption of plant sources and number of vitamin A rich foods consumed persisted in all the three study areas (Fisher's Exact test; p=0.000 for each of the study areas). In Kai consumption of plant sources of vitamin A was significantly associated with the main source of household income (Fisher's Exact test= 9.45; p=0.026). However, no significant associations were observed in Junju and Wathorego.

Consumption of either plant or animal sources of vitamin A was significantly associated with the occupation of the mother ($\chi^2_{(56\ d.f,\ 0.05)}$ = 12.941; p= 0.005) and number of vitamin A rich food groups consumed (Fisher's Exact test; p=0.000 for each of the study areas). In Wathorego, consumption of either plant or animal sources of vitamin A also had a significant association with the number of children by the mother (Fisher's Exact test= 116.922; p=0.000).

4.5.2 *Socio-demographic Characteristics and Maternal Night Blindness*

Overall, maternal night blindness (pXN) was significantly associated with the number of children by mother (Fisher's Exact test= 116.922; p=0.000) and number of children attending primary school in household (Fisher's Exact test= 116.922; p=0.000). Pearson Chi-square test also indicated significant association between pXN and age of mother ($\chi^2_{(28\ d.f,\ 0.05)}$ = 45.783; p= 0.018). For individual study areas, a significant association between maternal night blindness and number of children attending primary school was observed (Fisher's Exact test= 13.386; p=0.007). No associations were observed between maternal night blindness and social demographic characteristics of study mothers in Junju and Wathorego.

4.5.3 *Dietary Diversity Indicators and Maternal Night-blindness*

Generally the prevalence of maternal nightblindness (both crude and adjusted) decreases with increasing consumption of vitamin A rich foods from various sources.Wathorego had the lowest crude prevalece of maternal nightblindness (4.4%) with also the highest consumption of vitamin A rich foods from animal and plant sources. On the other hand, Kai which had the highest prevalence of maternal nightblindness (16%) had the lowest consumption levels for vitamin A rich foods among study mothers.

However, the sample size for this study was insufficient for building predictive models for prevalance of history of maternal night blindness using consumption levels for vitamin A rich foods. On the other hand, no significant associations were observed between maternal night blindness and dietary diversity indicators at individual level for mothers interviewed in all study areas.

CHAPTER 5: DISCUSSION

5.1. Demographic and Social Economic Characteristics of women

Regional and gender disparities were observed in this study. Junju sub-location has the highest proportion of mothers (26.5%) and husbands (6.9%) who had never attended school compared to Kai and Wathorego. In all sub-locations, the literacy level of women was lower than for their husbands. A survey by Kebathi (2008) also revealed both regional and gender disparities in literacy levels in Kenya in that women performed worse in reading and numeracy than men, at 64.2 % and 67.9 % and 58.9 % and 61.4 % respectively.

Subsistence farming activities were largely carried out by women in all the three sub-locations while majority of the men provided casual labour to earn a living. While 18.6% of women reported themselves as farmers, only 2.3% of their husbands were reported to be farmers. In Junju, it was cropping season but still 31.9% of the husbands were reported to be unemployed and not involved in crop production.

Coverage for post-partum vitamin A supplementation was low in all the three sub-locations being highest in Junju and lowest in Kai. This was a main concern for health workers who participated in the Key informant interviews in all the three study areas. One of the Key Informants had this to say (quoted verbatim):

> *"Vitamin A supplementation is given within six weeks postpartum as per the [Kenyan] national guidelines. However, most mothers deliver at home and are not aware of this service and by the time they come at 6 weeks for child immunization their eligibility time has elapsed. Therefore, they are not supplemented because they may have conceived again and as we all know, vitamin A has a teratogenic effect during pregnancy. We can't test every mother [for pregnancy] before supplementation therefore we just follow the guidelines. May be we need to inform mothers about postpartum vitamin A supplementation during antenatal visits"* (Health worker, Antenatal Clinic)

5.2. Local Terms Descriptions and Perceptions on Maternal Night Blindness

Maternal night blindness exists in all the three study areas though it is not on the spontaneous list of common problems reported during pregnancy because its occurrence is rare. The local populations use different local descriptions for the condition but no specific local term exists in the three study areas assessed. Night blindness is just described as poor vision at dusk using different terms in local language, hence further probing on the type of visual problems helps to distinguish a night blindness case from other visual problems. L local terms "*kwona mbindu*" and "*kuona wiriri*" at dusk during the last pregnancy are the most appropriate descriptions for night blindness in Kai and Junju respectively. In contrast, a specific local term for night blindness "*rataunı*" in Terai language was documented in Nepal (Christian et al., 1997). The participants in Kenya are aware of the condition and link it to poor nutrition status. Further, consecutive pregnancies and number of births had a great influence on its occurrence since the body nutrient stores get depleted over time. In contrast, participants in Junju associate the condition with witchcraft *(kutupiwa* or *kurogwa)* without any nutritional aspects just as in Nepal, where women attributed the condition to "pregnancy weakness or hotness" (Christian et al,, 1997). The finding of this study that night blindness increases reliance on family members to perform various domestic chores since it adversely affects the activity patterns of affected women, especially food preparation were also documented in Nepal. In addition, personal injury and accidents were common in Nepal. There are no treatment alternatives to the condition among the assessed communities in Kenya as documented in Nepal. Women who experience maternal night blindness consider it part of pregnancy because it mostly disappears a few months after delivering.

5.3. Prevalence of Maternal Night Blindness as a Proxy Indicator for Vitamin A Deficiency

Results indicate that prevalence of vitamin A deficiency is of public health significance in both Kai and Junju sub-locations at ≥5% prevalence of maternal night blindness among women who delivered a live birth within the last three years (IVACG, 2002). Though Wathorego has a crude prevalence rate of below this cut-off (4.4%), the population prevalence of vitamin A deficiency might still be of public health significance as available data suggests that a prevalence ≥4% is nearly as reliable (Christian, 2002). The last live birth was used because estimates for prevalence of night blindness for the current pregnancy or a pregnancy that ended in a stillbirth/miscarriage has been found to underestimate the prevalence among Nepalese women presumably because they had not experienced the full highest-risk third trimester (Christian, 2002). Even though this study elicited a history of maternal night blindness for the recent live birth within the previous three years, some studies have used the previous five years (WHO, 2009) while others have used the last two pregnancies. Although these longer recall durations are likely to yield slightly higher prevalence rates; they still give the same classification for public health significance of vitamin A deficiency in a population when compared to using recent live birth within the previous three years. However, longer recall periods are prone to recall bias due to memory issues and may overburden the respondent.

Several studies have also assessed maternal night blindness under various time periods in relation to the pregnancy period. Cross-sectional surveys in three provinces in southern Vietnam in 1999, reported the prevalence of night blindness among women aged 15 to 49 years during their most recent pregnancy within the three year period prior to the interview as 1.5% in Ben Tre Province, 5.6% in Long An Province, and 10% in Quang Ngai Province (Dibley et al, 1999). The study used the same duration as the current study and these findings are closely comparable to the adjusted prevalence rates observed in Kai (12.2%), Junju (6.5%) and Wathorego (1.9%). In Central Java-Indonesia, 4.8% of the women in the placebo group of a trial of vitamin A and zinc supplements in pregnancy reported night-blindness during the second or third trimester of pregnancy (West and Roodenburg, 1992). In the rural Terai region of Nepal, a cross-sectional study of pregnant and lactating women found that 8.1% of pregnant women were night blind at the time of interview, although 16.2% of the lactating women reported being night blind at some time during their preceding pregnancy (Katz et al,, 1995). In another study, a very high prevalence (52%) of any night blindness during their previous pregnancy was reported by women in Jumla, Nepal, a remote community with a documented very high prevalence of vitamin A deficiency in children and a very high infant mortality rate (Katz et al,, 1995). In Nepal during the large scale maternal vitamin A supplementation trial, a trained village fieldworker, using a local term, asked women if they were night-blind. Reports of night-blindness were verified within a week by specially trained interviewers who asked more detailed questions about the symptoms and their effects on the women's activity. Seventy-nine percent of the histories of current night-blindness were verified by this method. Thus, it is likely that some of the variation in estimates of the prevalence of night-blindness between studies is related to the method used to collect the information.

The use of maternal night blindness as an indicator of population prevalence of VAD was reported as a poor indicator of the same in a Tanzanian population without specific local terms (Wedner et al., 2004). However, this validation study used current cases of night blindness among mixed population groups (children and women) as opposed to women who had delivered a live birth within the last three years as per the IVACG (2002) recommendation used in this study. The use of serum retinol and pupilllary threshold measurements used as the standard methods in Tanzanian study, are only recommended for assessment of vitamin A status of populations, not individuals (Wedner et al., 2004). This is on the basis that night blindness can occur in individuals with high serum retinol concentrations of 0.7 mmol/l or higher (Sommer & West, 1996) and conversely, some individuals with low serum retinol concentrations do not have night blindness. Hence, the findings of Wedner et al. (2004) have no effect on the current study which assessed maternal night blindness for the recent live birth within the last three years.

It also emerges that using the crude prevalence without adjusting for daytime visual problems may actually overestimate the true prevalence of night blindness especially if there are a high proportion of women who experienced visual problems both at dusk and daytime. In the current study, both the crude and the adjusted prevalence rates have been calculated and the prevalence rates reduced for all the three areas by approximately 3%. This is in agreement with the existing data that suggest that misclassification of self-reported night blindness may account for a prevalence of $\leq$ 3%. Therefore, the higher cut-off of 5% includes this potential false positive prevalence thereby improving specificity of maternal night blindness as an indicator of Vitamin A deficiency (Christian, 2002). Consequently, adjustment of rates in the current study was done as per the IVACG (2002) recommendation, women with visual problems both during the day and at dusk have been excluded from both the numerator and denominator. Though this gets rid of doubtful cases, it also assumes that women with other visual problems cannot be night blind at the same time so the adjusted prevalence rate is likely to underreport.

The current study findings also indicate that mothers who experience maternal night blindness report having dizziness, lower abdominal pain; fatigue and poor appetite. This has also been reported in Nepal where night blind women were at two to three times more likely than controls to report symptoms of urinary tract infections (lower abdominal pain) and three times more likely to be severely anaemic with [Hb] < 70g/L (Christian et al., 1998). These could be due to the fact that Zinc deficiency and iron deficiency also interfere with the transport and utilization of stored retinol (Amine et al., 1970; Huber and Gershoff, 1975; Staab et al., 1984); hence in food insecure populations like the ones assessed in the current study, a mix of micronutrient deficiencies is likely to be present. It is evident that Kai sub-location has the highest number of mothers who reported both maternal night blindness and dizziness during pregnancy. It is likely that the prevalence of iron deficiency anemia (IDA) is equally high among pregnant women in Kai. This is because dizziness and fatigue are the common symptoms of IDA among pregnant women. The sub-location is also highly food insecure (compared to Junju and Wathorego) with over 90% of the population depending on relief food (mainly maize) for the last 10 years. As a consequence, cases have been reported in the community (Gatonye, 2009). Junju as well is food insecure; with majority of primary schools in the area receiving relief food through the school feeding program though the area is not prioritized for general food distributions.

5.4. Dietary diversity and Consumption of Vitamin A Rich Foods in Relation to Maternal Night Blindness

Dietary diversity and consumption of vitamin A rich foods is highest in Wathorego followed by Junju and least in Kai. This was consistent with the prevalence of maternal night blindness across the three study areas (i.e prevalence of maternal night blindness is highest in Kai, followed by Junju and least in wathorego). This differenece in prevalence of maternal night blinndess across study areas may be due to the observed differences in dietary diversity indicators (IDDS and consumption of vitamin A rich foods from various sources). This finding is supported by a recent study which reported that dietary diversity is a good indicator of micronutrient adequancy among women of reproductive age (Arimond et al, 2008). In addition, consumption of eggs has also been associated with nutrient adequacy among women (Torheim et al., 2004) and in populations where fish, meat, milk or eggs, dark green leafy vegetables and yellow fruits are consumed in comparatively larger quantities, the prevalence of night blindness is significantly lower (Hussain et al., 1993).Vitamin A deficiency is probably not a public health problem in Wathorego due to low prevalence of maternal night blindness which may be explained by a combination of findings from studies under review. Astudy by Mirmiran et al. (2006) also reported that dietary diversity within food groups is an indicator of specific nutrient adequacy in Tehranian Women in Iraq although the current study did not cover this aspect.

With the exception of Wathorego, the average diets of mothers in this study are of poor diversity, mainly consisting of staple cereals (especially maize) and dark green leafy vegetables with less animal based products. Similar findings were also reported by Bwibo and Newmann (2003) when investigating consumption of animal food sources in Kenya. WHO identifies the main underlying cause of VAD as a public health problem to be less diversified diets that are chronically insufficient in Vitamin A that lead to lower blood stores and fail to meet physiologic needs of tissue growth, metabolism and resistance to infections (WHO, 2009). Even though, consumption of plant sources of vitamin A was above 50% in Kai and Junju, the diets are less diversified with low consumption of animal foods.

In addition, consumption of fats/oils which are vital for bioavailability of vitamin A in diet was also least among mothers in Kai and highest in Wathorego at 95.6% .In Junju, 89.2% of mother had consumed fats/olis and this was consistent with consistent with the trends for food consumption among the study areas. Thus, these diets are likely to have poorer micronutrient density (Arimond et al., 2008) and poor vitamin A bioavailability (de Pee et al., 1995; de Pee et al, 2006) from the dark green leafy vegetables that were widely consumed in these study areas. Therefore, the less diversified diets in addition to documented low bioavailability of vitamin A from plant sources probably explain the vitamin A deficiency of public health problem observed in Kai and Junju.

Though the nature of association between prevalence of maternal night blindness and consumption of vitamin A rich foods at population level could not be statistically established due to limited sample size); results of the current study suggest that consumption of vitamin A rich foods inversely associated with prevalence of maternal night blindness at population level . However, other studies on this subject are not available to enhance our understanding on the nature of this relationship.

The current study did not observe significant ($p > 0.05$) associations between maternal night blindness and dietary diversity or consumption of vitamin A rich food at individual level. This is because dietary intake was assesed within the previuos 24 hours while maternal night blinndess was assessed within the previous 3 years. Therefore, these methods can only be compared at population level. Furthermore, there is high likelihood that the individuals who report consumption (or no consumption) of vitamin A rich foods on the recall day usually consume (or do not consume) or vice versa (Ashima et al., 1993). Nonetheless, percentages of those consuming vitamin A rich food groups gives a one-time measures of dietary intake of vitamin A among populations or sub-populations (FAO, 2008). Therefore, both dietary diversity and prevalence of history of maternal nightblindness are recommended for assessement of vitamin A deficiency at population level and not individual level.

5.5. Associations among Socio-demographic Characteristics, Maternal Night Blindness and Dietary Diversity

Results indicate that maternal night blindness is significantly associated with study area, age of the mother, the number of children by the mother and number of children attending primary school within the household. Other studies have also documented association between occurrence of night blindness and socio-economic characteristics among affected women. Higher family income, higher mother's literacy level, and smaller family size were associated with lower prevalence of night blindness in Bangladesh (Hussain et al., 1993). Area of residence has been reported to be a strong and statistically significant determinant factor for occurrence of maternal night blindness (Hussain et al., 1993) and also prevalence of maternal night blindness at population level (Santos et al., 2010). These associations could be indirectly due to the association between socio-economic and dietary intake among mothers and populations which result from area of residence. In Most cases, the area of residence is a proxy indicator for economic status and consequently household food security. However, a recent study reports that prevalence of maternal night blindness is not significantly associated with socioeconomic or obstetric variables of women (Santos et al., 2010). This was not explored in the current study which only investigated associations at individual level because the data was not sufficient for such investigations.

IDDS is inversely correlated with age of the mother, number of children by the mother, household size and number of children attending primary school within the household. In addition, literacy level of husband and main source of household income are significantly associated with IDDS. These results can be explained by factors that affect food demand, access and food availability at household level. Households with younger mothers are more likely to be married to young men who have not yet attained financial stability as is common in rural settings. The school drop-out rates are high in rural areas for both boys and girls as evident in this study that majority of mothers and their husbands had only attained primary school education. Consequently, majority of young people marry at a young age and majority of mothers become housewives while husbands become the main bread winners through non-formal employment activities (e.g casual labor, small scale trade and farming).

The results indicate that consumption of vitamin A rich foods from animal sources is significantly associated with literacy level of the husband and main source of household income, while consumption of vitamin A rich foods from plant sources is associated with age of mother and number of vitamin A rich food groups consumed. These results agree with the findings of Torheim et al. (2004) that high DDS is positively associated with male sex, education and residence. The association between dietary diversity and socio- economic characteristics has also been reported at household level where the households' socioeconomic status was compared with dietary diversity at household level, not at individual level as in the current study (Gittelsohn et al., 1998; Hatloy et al., 1998; Hoddinott and Yohannes, 2002).

5.6. Study Limitations

It is evident that the findings of the current study had some limitations especially in regard to generalization, and investigation of relationships between dietary intake and prevalence of maternal night blindness. Being a cross sectional study, prevalence of maternal night blindness was assessed over the previous three year period while the dietary diversity was assessed within the previous 24 hours. Hence, the two can only be compared at community level. In addition, causal relationships cannot be identified hence where necessary it is better to evaluate the effect of varied diets on maternal night blindness through longitudinal studies. Furthermore, the prevalence of maternal night blindness and dietary diversity findings only apply to assessed sub-locations because the study areas were purposively selected for this study based on several non statistical variables which were of interest to the INSTAPA WP-2 project.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion from the study

This study concludes that:

1. Socio- economic characteristics of mothers are significantly different among the study areas with the exception of physiological status. Mainly, age of the mother, the number of children by the mother and number of children attending primary school within the household have a significant association with both dietary diversity and occurrence of maternal night blindness among mothers in Kai, Junju and Wathorego.
2. Different populations use different local descriptions for the night blindness but no specific local term exists in all the three areas assessed. However, proxy terms for night blindness can be identified and when used with further probing on the type of visual problems encountered it is possible to distinguish night blindness cases from other visual problems.
3. Prevalence of maternal night blindness is highest in Kai, followed by Junju and Wathorego in that order. Consequently, prevalence of maternal night blindness is of public health concern in Kai and Junju sub-locations.
4. Diets of mothers in Kai and Junju are of poor diversity compared to Wathorego; mainly consisting of cereals and dark green vegetables with little animal source foods Consequently, percentage of mothers consuming vitamin A rich foods is highest in Wathorego, followed by Junju and Kai in that order. This trend is the same across the study areas when vitamin A rich foods are subdivided into plant and animal sources.
5. An inverse relationship exists between prevalence of maternal night blindness and consumption of vitamin A rich foods at population level although data. Generally, the

higher the prevalence of maternal night blindness, the lower the percentage of mothers consuming vitamin A foods in the study area. In contrast, there is no association between maternal night blindness and consumption of vitamin A rich foods among mothers at individual level.

6.2 Recommendations from the study

Based on the findings of the current study, the following recommendations are made:

1. Kai sub-location should be prioritized for the bio-efficacy yellow cassava feeding trial due to the observed high prevalence of VAD and low dietary intake of vitamin A rich foods. Thereafter, the yellow cassava should be introduced in all the three sub-locations once proved to be efficacious in improving the vitamin A status of individuals.
2. Larger studies are needed to understand the following: (1) association of women's socio economic status and prevalence of maternal night blindness at population level (2) demographic and social-demographic factors that predispose women to maternal night blindness in Kenya; (3 relationship between prevalence of maternal night blindness and dietary diversity indicators at population level and possible develop predictive models for maternal night blindness.

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DRAFT MANUSCRIPT

...ary Intake of Vitamin 'A' and Prevalence of Maternal Night Blindness among Women in ...al Kenya: A comparative Study of Selected Sub-Locations in Makindu, Kilifi and Kisumu-... Districts.

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...BSTRACT

...ckground: This study assessed dietary intake ...vitamin A and prevalence of maternal night ...indness as proxy indicators for vitamin A ...ficiency among selected cassava consuming ...pulations in Kenya.

...aterials and Methods: Three cross sectional ...rveys were conducted between July and ...ctober, 2009 in Kai, Junju and Wathorogo ...b-locations purposively selected within ...akindu, Kilifi and Kisumu –East Districts of ...enya respectively. History of maternal night-...lindness was elicited from 290 mothers for ...heir recent live birth within the previous three ...ears and qualitative 24 hour recall individual ...ietary diversity questionnaire was ...dministered. The prevalence rates of maternal ...ight blindness were computed and populations ...with ≥ 5% crude prevalence of maternal night blindness were considered to have a public health of vitamin A deficiency. Proportions of mothers consuming vitamin A rich foods were also calculated for the study areas.

Results: The crude prevalence of maternal night blindness was 16% in Kai, 9.5% for Junju and ...4.4% in Wathorego sub-locations and respectively reduced to 12.2%, 6.5% and 1.9% on adjustment. Dietary intake of vitamin A within the previous 24 hours was highest in Wathorego (95.6%) followed by Junju (80.7%) and least in Kai (57.4%) and this was mainly from plant sources. Both prevalence rates of maternal night-blindness and proportion of mothers consuming vitamin A rich foods were significantly different across the sub-locations ($\chi 2$, $p<0.05$).

Conclusions: Vitamin A deficiency is of public health significance in both Kai and Junju sub-locations. The bio-fortified high beta-carotene cassava should be introduced in Kenya if found efficacious in improving vitamin A status.

INTRODUCTION

Night blindness which is the inability to see after dusk or in low levels of light is a common manifestation of moderate to severe Vitamin A deficiency (VAD). Approximately, 10% of women world wide experience night blindness during pregnancy (West, 2002) hence the condition is regarded as a public health problem in women of reproductive age (IVACG, 2002). Night blindness is strongly associated with other biochemical and functional indicators of VAD in women of reproductive age (15- 49 years old). Therefore, IVACG recommended the use of history of maternal night blindness as an indicator of VAD in communities where interventions are not in place since it is easy and simple to obtain compared to biochemical and clinical methods (IVACG, 2002; Christian, 2002). Populations with ≥ 5% prevalence of maternal night blindness are considered to have

) of public health significance.

main underlying cause of VAD as a public th problem is a less diversified diet that is nically insufficient in Vitamin A that lead lower blood stores and fail to meet siologic needs of tissue growth, metabolism resistance to infections (WHO, 2009). The rage Kenyan diet mainly consists of staple als (especially maize) and dark green leafy etables with less animal based products and refore is of poor diversity (Bwibo and mann, 2003). Thus, this diet is likely to e poorer micronutrient density (Arimond et 2008) and poor vitamin A bioavailability Pee et al., 2006; de Pee et al, 1995) from dely consumed dark green leafy vegetables. roduction of bio-fortified staple foods like ssava is a sustainable intervention for control VAD especially among cassava consuming pulations in Kenya. However, current formation on prevalence of vitamin A ficiency among cassava consuming pulation in Kenya was not available for lection of appropriate study for the bio-rtified cassava feeding trial in Kenya by the ovel Staple foods for Improved Nutrition in frica (INSTAPA) project. The objective of this tudy was to assess and compare dietary intake f vitamin A and prevalence of maternal night lindness among three selected sub-locations in Kenya.

STUDY DESIGN AND METHODOLOGY

Three cross sectional surveys were conducted between July and October, 2009 among mothers in Kai, Junju and Wathorogo sub-locations purposively selected within Makindu, Kilifi and Kisumu –East Districts of Kenya respectively. Focus group discussions with mothers aged 17 to 85 years old, key informant interviews with administrative leaders, health workers and school head teachers, and case studies were used to establish local terms and descriptions for night blindness. Thereafter, a history of maternal night-blindness was elicited from mothers for their recent live birth within the previous three years to the survey. A total of 290 mothers consisting of 94, 83, and 113 women in Kai, Junju and Wathorego sub-locations respectively were interviewed. In addition, qualitative 24 hour recall individual dietary diversity questionnaire (21 food group) was administered to all the 290 mothers. Both the crude and adjusted prevalence rates of maternal night blindness were computed as per the method outlined by IVACG. Consequently, populations with ≥ 5% crude prevalence of maternal night blindness were considered to have vitamin A deficiency problem of public health significance as recommend by the International Vitamin A Consultative Group. Comparison of study variables for significant differences across the sub-locations was done at both individual and population levels and a 0.05 level of significance was used. Relationships among dietary diversity, maternal night blindness and socio-economic characteristics were also analysed in SPSS 17.

RESULTS

Demographic and Social economic characteristics

The mean age for women interviewed was approximately 25.8 years, with an average of three children per mother and mean duration 15 months since last live birth. Majority of these mothers were still lactating. In addition, a high proportion of the mothers had attained primary education and their main occupations were housewife (39.0%) and small scale trading (29.0%). The main occupation of husbands was casual labour (54.1%) followed by formal employment (23%) and small scale trading (16.0%) in that order. It was noted that while 18.6% of women reported themselves as farmers, only 2.3% of their husbands were farmers. However, more husbands were formally employed (23.0%) compared to their wives (2.1%). A significant difference (χ^2, $p<0.05$) was observed in both literacy levels and occupation of husbands among the three subions assessed. The main source of income casual labour (44.8%) followed by trade) and salaried employment (21.4%) in that . The trend was however, not similar in idual study areas as indicated in Table 4.4. a had two main sources of income, trade %) and salaried employment (28.9%) h were not significantly different (χ2- .05) while Kai and Wathorego mainly nded on casual labour for household me.

al Terms, Descriptions and Perceptions Maternal Night blindness

ernal night blindness existed in all the three s assessed though it was not on the ntaneous list of common health problems ing pregnancy as expectant women mostly umed it to be dizziness. The populations used ferent local descriptions for the condition and specific local term existed in all the three as assessed. However, proxy terms for night ndness were identified and when used with ther probing on the type of visual problems countered; it was possible to distinguish night ndness cases from other visual problems.

e proxy local terms identified were:

- *kwona mbindu e mawiyo* (Akamba language) in Makindu
- *kuona wiriwiri jioni* (Chonyi language) in Junju

o specific local term was identified in athorego because the area was multilingual nd Kiswahili was the common language. herefore, the questionnaire was asked in iswahili without modifications to include local rms and descriptions for night blindness.

he various descriptions given by mothers for aternal night blindness were:

- Good vision during daytime but poor vision at dusk or low levels of light; often disappeared within one month postpartum after delivery due to nutritionally adequate diets consumed in the postpartum period
- Inability to see well when moving into house from outside/lit area (reduced eye adaptation to reduced light)
- Seeing shadows at dusk- inability to identify people or things well
- Foggy/ misty vision at dusk (like a spider web over the eyes)
- Knocking on objects at dusk- falls and sometimes injuries
- Inability to cook at dusk (onions/food got burnt); hence cooked early (before 7pm)
- Lighting the lamps early from 6 pm and sometimes daytime

Prevalence of Maternal Night Blindness as a Proxy Indicator of Vitamin A Deficiency

The crude prevalence rates of self reported history of maternal night blindness was highest in Kai (16%), followed by Junju (9.6%) and least in Wathorego (4.4%). On adjustment, the prevalence rated reduced to 12.2%, 6.5% and 1.9% for Kai, Junju and Wathorego respectively as shown in figure 4.1.

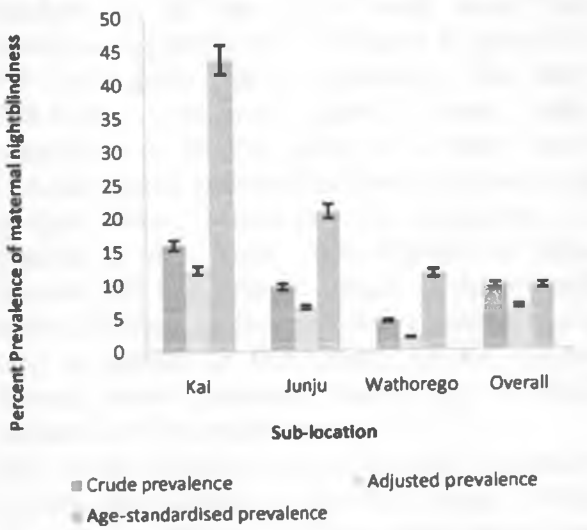


Figure 4.1: Prevalence of maternal night blindness among study mothers by study area and error bars at 5% value

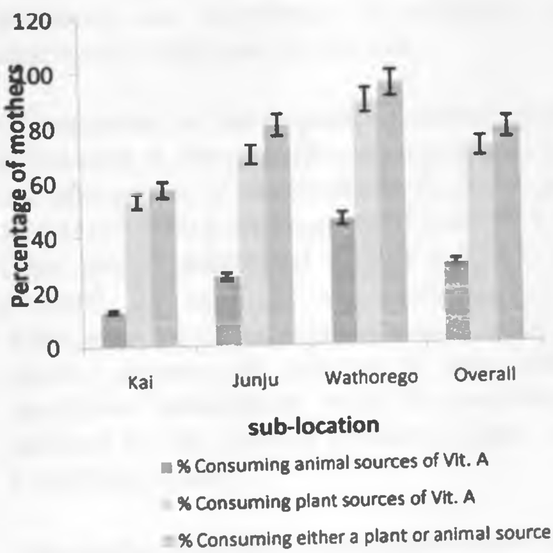
Both the crude and adjusted prevalence rates for maternal night blindness were significantly different (χ^2 $p<0.05$) for the three sub-locations The crude prevalence rate included mothers who ned to have experienced visual problems during daytime and at dusk/low levels of while the adjusted prevalence rate uded these mothers

n comparison of the prevalence rates using direct (age) standardization method was ormed, Kai still had the highest prevalence aternal night blindness followed by Junju le Wathorego had the lowest prevalence. dardization used the combined age ibution for all the three study sites (overall) he standard population distribution against ch comparison was made for individual ly areas as indicated in Appendix 7. The age-dardized prevalence rates for maternal night dness were also significantly different for three divisions. ($\chi^2_{(2\ d.f,\ 0.05)}$ = 29.63,).000).

zziness was the most common problem orted during pregnancy followed by lower dominal pain, night blindness, malaria, nausea d vomiting in that order. Maternal night indness ranked third among the health oblems encountered during pregnancy by the idy participants and this trend was the same in nju. In Kai, night blindness ranked second to zziness accounting for 20% of the problems ported while it ranked fourth in Wathorego. ll the mothers who reported to have been ght-blind also recognized that their condition as different from others in all the three study reas.Of the mothers who reported night lindness, the most common accompaniment as dizziness which was reported by 66.7%, 0% and 40% of night blind women in Kai, unju and Wathorego, respectively

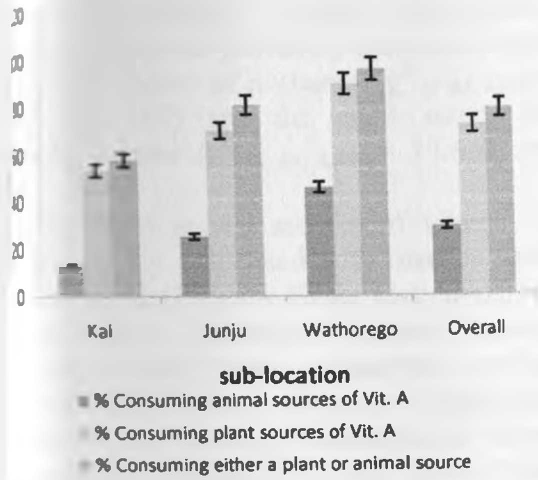
Dietary intake of vitamin A

Consumption of vitamin A rich foods was highest in Wathorego followed by Junju and least in Kai.. Overall, 79% of the mothers had consumed either an animal or plant source of vitamin A within the previous 24 hours. Generally, consumption of animal sources of vitamin A was lower than for plant sources and the trend was the same in all study areas. However, Wathorego had the highest consumption level for animal sources (46%) as shown in figure 4.5.



In contrast, almost three quarters (72.1%) of the mothers in all the three study areas had consumed a plant source of vitamin A especially the dark green leafy vegatables. The most commonly consumed dark green leafy vegetables in all the three areas were kales (*sukuma wiki*), amaranthus leaves (*terere*) and cowpea leves (*mukunde*). Consumption of vitamin A rich fruits was highest in Junju because of the mango season as mentioned earlier. Orange, yellow and red vegatables were only consumed in Wathorego mainly orange fleshed sweet potatoes though by a small proportion of the mothers.

Half of the mothers interviewed had consumed at least one vitamin A rich food group within the previous 24 hours and the same trend was observed for individual study areas as indicated in Figure below.



athorego had an equally high proportion 0.7%) of mothers who had consumed two amin A rich food groups. In addition, it was e only study area with mothers who had nsumedfour vitamin A rich food groups. uskall-Wallis test indicated that the stribution of mothers by number of vitamin A ch food groups consumed was significantly ifferent in the three study areas ($\chi^2_{(2\ d.f,\ 0.05)}$ = 4.527; p= 0.00).

onsumption of animal sources of vitamin A as significantly associated with literacy level f the husband (Fisher's Exact test; p=0.031) nd main source of household income (Fisher's Exact test; p=0.017). This was not the case for ndividual study areas where no significant ssociations were observed except in Kai where onsumption of vitamin A rich foods from nimal sources was significantly associated with iteracy level of the mother (Fisher's Exact test; p=0.010)

In addition, consumption of plant sources of itamin A was significantly associated with the age of the mother ($\chi^2_{(56\ d.f,\ 0.05)}$ = 89.787; p= 0.003) and number of vitamin A rich food groups consumed (Fisher's Exact test; p=0.000 for each of the study areas). For individual study areas, the association between consumption of plant sources and number of vitamin A rich foods consumed persisted in all the three study areas (Fisher's Exact test; p=0.000 for each of the study areas). In Kai consumption of plant sources of vitamin A was significantly associated with the main source of household income (Fisher's Exact test= 9.45; p=0.026). However, no significant associations were observed in Junju and Wathorego.

Consumption of either plant or animal sources of vitamin A was significantly associated with the occupation of the mother ($\chi^2_{(56\ d.f,\ 0.05)}$ = 12.941; p= 0.005) and number of vitamin A rich food groups consumed (Fisher's Exact test; p=0.000 for each of the study areas). In Wathorego, consumption of either plant or animal sources of vitamin A also had a significant association with the number of children by the mother (Fisher's Exact test= 116.922; p=0.000).

Association between, demographic and socio economic characteristics of mothers, dietary intake of Vitamin A and Maternal night blindness

Overall, maternal night blindness (pXN) was significantly associated with the number of children by mother (Fisher's Exact test= 116.922; p=0.000) and number of children attending primary school in household (Fisher's Exact test= 116.922; p=0.000). Pearson Chi-square test also indicated significant association between pXN and age of mother ($\chi^2_{(28\ d.f,\ 0.05)}$ = 45.783; p= 0.018). For individual study areas, a significant association between maternal night blindness and number of children attending primary school was observed (Fisher's Exact test= 13.386; p=0.007). No associations were observed between maternal night blindness and social demographic characteristics of study mothers in Junju and Wathorego.

Generally the prevalence of maternal nightblindness (both crude and adjusted) decreases with increasing consumption of vitamin A rich foods from various sources as indicated in figure 4.7.

erally, the dietary diversity level (low, dium or high) was positively associated with literacy category of husbands ($\chi^2_{(6\ d.f,\ 0.05)}$ = 418; p= 0.00) and the main source of sehold income ($\chi^2_{(8\ d.f,\ 0.05)}$ = 17.619; p= 24).

sumption of animal sources of vitamin A s significantly associated with literacy level the husband (Fisher's Exact test; p=0.031) d main source of household income (Fisher's act test; p=0.017). This was not the case for ividual study areas where no significant ociations were observed except in Kai where sumption of vitamin A rich foods from imal sources was significantly associated with eracy level of the mother (Fisher's Exact test; =0.010)

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Wathorego had the lowest crude prevalece of maternal nightblindness (4.4%) with also the highest consumption of vitamin A rich foods from animal and plant sources. On the other hand, Kai which had the highest prevalence of maternal nightblindness (16%) had the lowest consumption levels for vitamin A rich foods among study mothers.

However, the sample size for this study was insufficient for building predictive models for prevalance of history of maternal night blindness using consumption levels for vitamin A rich foods. On the other hand, no significant associations were observed between maternal night blindness and dietary diversity indicators at individual level for mothers interviewed in all study areas.

DISCUSSION

Demographic and Social economic characteristics

Coverage for post-partum vitamin A supplementation was low in all the three sub-locations being highest in Junju and lowest in Kai. This was a main concern for health workers who participated in the Key informant interviews in all the three study areas. Vitamin A supplementation is given within six weeks postpartum as per the [Kenyan] national guidelines. However, most mothers deliver at home and are not aware of this service and by the time they come at 6 weeks for child immunization their eligibility time has elapsed. Therefore, they are not supplemented becuse they may have conceived again and as we all know, vitamin A has a teratogenic effect during pregnancy. We can't test every mother [for pregnancy] before supplementation therefore we just follow the guidelines. May be we need to inform mothers about postpartum vitamin A supplementation during antenatal visits

Local Terms Descriptions and Perceptions on Maternal Night Blindness

Maternal night blindness exists in all the three study areas though it is not on the spontaneous list of common problems reported during nancy because its occurrence is rare. The populations use different local descriptions the condition but no specific local term s in the three study areas assessed. Night ness is just described as poor vision at dusk g different terms in local language, hence er probing on the type of visual problems s to distinguish a night blindness case from r visual problems. Local terms "*kwona ndi*" and "*kuona wiriri*" at dusk during the pregnancy are the most appropriate riptions for night blindness in Kai and Junju ectively. In contrast, a specific local term night blindness "*ratauni*" in Terai language s documented in Nepal (Christian et al., 97). The participants in Kenya are aware of condition and link it to poor nutrition status. ther, consecutive pregnancies and number of ths had a great influence on its occurrence ce the body nutrient stores get depleted over e. In contrast, participants in Junju associate condition with witchcraft *(kutupiwa* or *rogwa)* without any nutritional aspects just as Nepal, where women attributed the condition "pregnancy weakness or hotness" (Christian al., 1997). Night blindness increases reliance family members to perform various domestic ores since it adversely affects the activity atterns of affected women, especially food reparation were also documented in Nepal. In ddition, personal injury and accidents were ommon in Nepal. There are no treatment ternatives to the condition among the assessed ommunities in Kenya as documented in Nepal. Women who experience maternal night blindness consider it part of pregnancy because t mostly disappears a few months after delivering.

Prevalence of Maternal Night Blindness as a Proxy Indicator for Vitamin A Deficiency

Results indicate that prevalence of vitamin A deficiency is of public health significance in both Kai and Junju sub-locations at ≥5% prevalence of maternal night blindness among women who delivered a live birth within the last three years (IVACG, 2002). Though Wathorego has a crude prevalence rate of below this cut-off (4.4%), the population prevalence of vitamin A deficiency might still be of public health significance as available data suggests that a prevalence ≥4% is nearly as reliable (Christian, 2002). Even though this study elicited a history of maternal night blindness for the recent live birth within the previous three years, some studies have used the previous five years (WHO, 2009) while others have used the last two pregnancies. Although these longer recall durations are likely to yield slightly higher prevalence rates; they still give the same classification for public health significance of vitamin A deficiency in a population when compared to using recent live birth within the previous three years. However, longer recall periods are prone to recall bias due to memory issues and may overburden the respondent.

Several studies have also assessed maternal night blindness under various time periods in relation to the pregnancy period. Cross-sectional surveys in three provinces in southern Vietnam in 1999, reported the prevalence of night blindness among women aged 15 to 49 years during their most recent pregnancy within the three year period prior to the interview as 1.5% in Ben Tre Province, 5.6% in Long An

Province, and 10% in Quang Ngai Province (Dibley et al, 1999). The study used the same duration as the current study and these findings are closely comparable to the adjusted prevalence rates observed in Kai (12.2%), Junju (6.5%) and Wathorego (1.9%). Thus, it is likely that some of the variation in estimates of the prevalence of night-blindness between studies is related to the method used to collect the information.

The use of maternal night blindness as an indicator of population prevalence of VAD was reported as a poor indicator of the same in a Tanzanian population without specific local s (Wedner et al., 2004). However, this ation study used current cases of night ness among mixed population groups dren and women) as opposed to women had delivered a live birth within the last years as per the IVACG (2002) mmendation used in this study. The use of m retinol and pupilllary threshold surements used as the standard methods in zanian study, are only recommended for ssment of vitamin A status of populations, individuals (Wedner et al., 2004). This is on basis that night blindness can occur in viduals with high serum retinol centrations of 0.7 mmol/l or higher (Sommer West, 1996) and conversely, some individuals h low serum retinol concentrations do not e night blindness. Hence, the findings of dner et al. (2004) have no effect on the rent study which assessed maternal night ndness for the recent live birth within the last ee years.

also emerges that using the crude prevalence thout adjusting for daytime visual problems ay actually overestimate the true prevalence of ght blindness especially if there are a high oportion of women who experienced visual oblems both at dusk and daytime. In the rrent study, both the crude and the adjusted evalence rates have been calculated and the evalence rates reduced for all the three areas y approximately 3%. This is in agreement ith the existing data that suggest that isclassification of self-reported night blindness ay account for a prevalence of ≤ 3%. herefore, the higher cut-off of 5% includes this otential false positive prevalence thereby mproving specificity of maternal night lindness as an indicator of Vitamin A eficiency (Christian, 2002). Consequently, djustment of rates in the current study was done as per the IVACG (2002) recommendation, women with visual problems both during the day and at dusk have been excluded from both the numerator and denominator. Though this gets rid of doubtful cases, it also assumes that women with other visual problems cannot be night blind at the same time so the adjusted prevalence rate is likely to underreport.

The current study findings also indicate that mothers who experience maternal night blindness report having dizziness, lower abdominal pain; fatigue and poor appetite. This has also been reported in Nepal where night blind women were at two to three times more likely than controls to report symptoms of urinary tract infections (lower abdominal pain) and three times more likely to be severely anaemic with [Hb] < 70g/L (Christian et al., 1998). These could be due to the fact that Zinc deficiency and iron deficiency also interfere with the transport and utilization of stored retinol (Amine et al., 1970; Huber and Gershoff, 1975; Staab et al., 1984); hence in food insecure populations like the ones assessed in the current study, a mix of micronutrient deficiencies is likely to be present. It is evident that Kai sub-location has the highest number of mothers who reported both maternal night blindness and dizziness during pregnancy. It is likely that the prevalence of iron deficiency anemia (IDA) is equally high among pregnant women in Kai. This is because dizziness and fatigue are the common symptoms of IDA among pregnant women. The sub-location is also highly food insecure (compared to Junju and Wathorego) with over 90% of the population depending on relief food (mainly maize) for the last 10 years. As a consequence, cases have been reported in the community (Gatonye, 2009). Junju as well is food insecure; with majority of primary schools in the area receiving relief food through the school feeding program though the area is not prioritized for general food distributions.

Dietary intake of vitamin A

Consumption of vitamin A rich foods is highest in Wathorego followed by Junju and least in Kai. This was consistent with the prevalence of rnal night blindness across the three study (i.e prevalence of maternal night blindness ghest in Kai, followed by Junju and least in orego). In addition, consumption of eggs also been associated with nutrient adequacy ng women (Torheim et al., 2004) and in lations where fish, meat, milk or eggs, dark n leafy vegetables and yellow fruits are umed in comparatively larger quantities, the alence of night blindness is significantly er (Hussain et al., 1993).

ddition, consumption of fats/oils which are l for bioavailability of vitamin A in diet was least among mothers in Kai and highest in horego at 95.6% .In Junju, 89.2% of mother consumed fats/olis and this was consistent h consistent with the trends for food sumption among the study areas. Thus, se diets are likely to have poorer cronutrient density (Arimond et al., 2008) and or vitamin A bioavailability (de Pee et al., 95; de Pee et al, 2006) from the dark green afy vegetables that were widely consumed in ese study areas. Therefore, the less diversified ets in addition to documented low oavailability of vitamin A from plant sources robably explain the vitamin A deficiency of blic health problem observed in Kai and unju.

ssociation between, demographic and socio conomic characteristics of mothers, dietary ntake of Vitamin A and Maternal night lindness

hough the nature of association between revalence of maternal night blindness and onsumption of vitamin A rich foods at opulation level could not be statistically stablished due to limited sample size); results of the current study suggest that consumption of itamin A rich foods inversely associated with revalence of maternal night blindness at opulation level . However, other studies on this subject are not available to enhance our nderstanding on the nature of this relationship.

The current study did not observe significant ($p > 0.05$) associations between maternal night blindness and dietary diversity or consumption of vitamin A rich food at individual level. This is because dietary intake was assesed within the previuos 24 hours while maternal night blinndess was assessed within the previous 3 years. Therefore, these methods can only be compared at population level. Furthermore, there is high likelihood that the individuals who report consumption (or no consumption) of vitamin A rich foods on the recall day usually consume (or do not consume) or vice versa (Ashima et al., 1993). Nonetheless, percentages of those consuming vitamin A rich food groups gives a one-time measures of dietary intake of vitamin A among populations or sub-populations (FAO, 2008). Therefore, both dietary diversity and prevalence of history of maternal nightblindness are recommended for assessement of vitamin A deficiency at population level and not individual level.

Results indicate that maternal night blindness is significantly associated with study area, age of the mother, the number of children by the mother and number of children attending primary school within the household. Other studies have also documented association between occurrence of night blindness and socio-economic characteristics among affected women. Higher family income, higher mother's literacy level, and smaller family size were associated with lower prevalence of night blindness in Bangladesh (Hussain et al., 1993). Area of residence has been reported to be a strong and statistically significant determinant factor for occurrence of maternal night blindness (Hussain et al., 1993) and also prevalence of maternal night blindness at population level (Santos et al., 2010). These associations could be indirectly due to the association between socio-economic and dietary intake among mothers and populations which result from area of residence. In Most cases, the area of residence is a proxy indicator for economic status and consequently household food security. However, a recent study reports that prevalence of maternal night blindness is not significantly associated with socioeconomic or obstetric variables of women (Santos et al., 2010). This was not explored in the current study which only investigated associations at individual level because the data was not sufficient for such investigations.

IDDS is inversely correlated with age of the mother, number of children by the mother, household size and number of children attending primary school within the household. In addition, literacy level of husband and main source of household income are significantly associated with IDDS. These results can be explained by factors that affect food demand, access and food availability at household level. Households with younger mothers are more likely to be married to young men who have not yet attained financial stability as is common in rural settings. The school drop-out rates are high in rural areas for both boys and girls as evident in this study that majority of mothers and their husbands had only attained primary school education. Consequently, majority of young people marry at a young age and majority of mothers become housewives while husbands become the main bread winners through non-formal employment activities (e.g casual labor, small scale trade and farming).

The results indicate that consumption of vitamin A rich foods from animal sources is significantly associated with literacy level of the husband and main source of household income, while consumption of vitamin A rich foods from plant sources is associated with age of mother and number of vitamin A rich food groups consumed. These results agree with the findings of Torheim et al. (2004) that high DDS is positively associated with male sex, education and residence. The association between dietary diversity and socio- economic characteristics has also been reported at household level where the households' socioeconomic status was compared with dietary diversity at household level, not at individual level as in the current study (Gittelsohn et al., 1998; Hatloy et al., 1998; Hoddinott and Yohannes, 2002).

6.1 Conclusion from the study

Prevalence of maternal night blindness is highest in Kai, followed by Junju and Wathorego in that order. Consequently, prevalence of maternal night blindness is of public health concern in Kai and Junju sub-locations.

Diets of mothers in Kai and Junju are of poor diversity compared to Wathorego; mainly consisting of cereals and dark green vegetables with little animal source foods Consequently, percentage of mothers consuming vitamin A rich foods is highest in Wathorego, followed by Junju and Kai in that order. This trend is the same across the study areas when vitamin A rich foods are subdivided into plant and animal sources.

Finally, an inverse relationship exists between prevalence of maternal night blindness and consumption of vitamin A rich foods at population level although data. Generally, the higher the prevalence of maternal night blindness, the lower the percentage of mothers consuming vitamin A foods in the study area. In contrast, there is no association between maternal night blindness and consumption of vitamin A rich foods among mothers at individual level.

6.2 Recommendations from the study

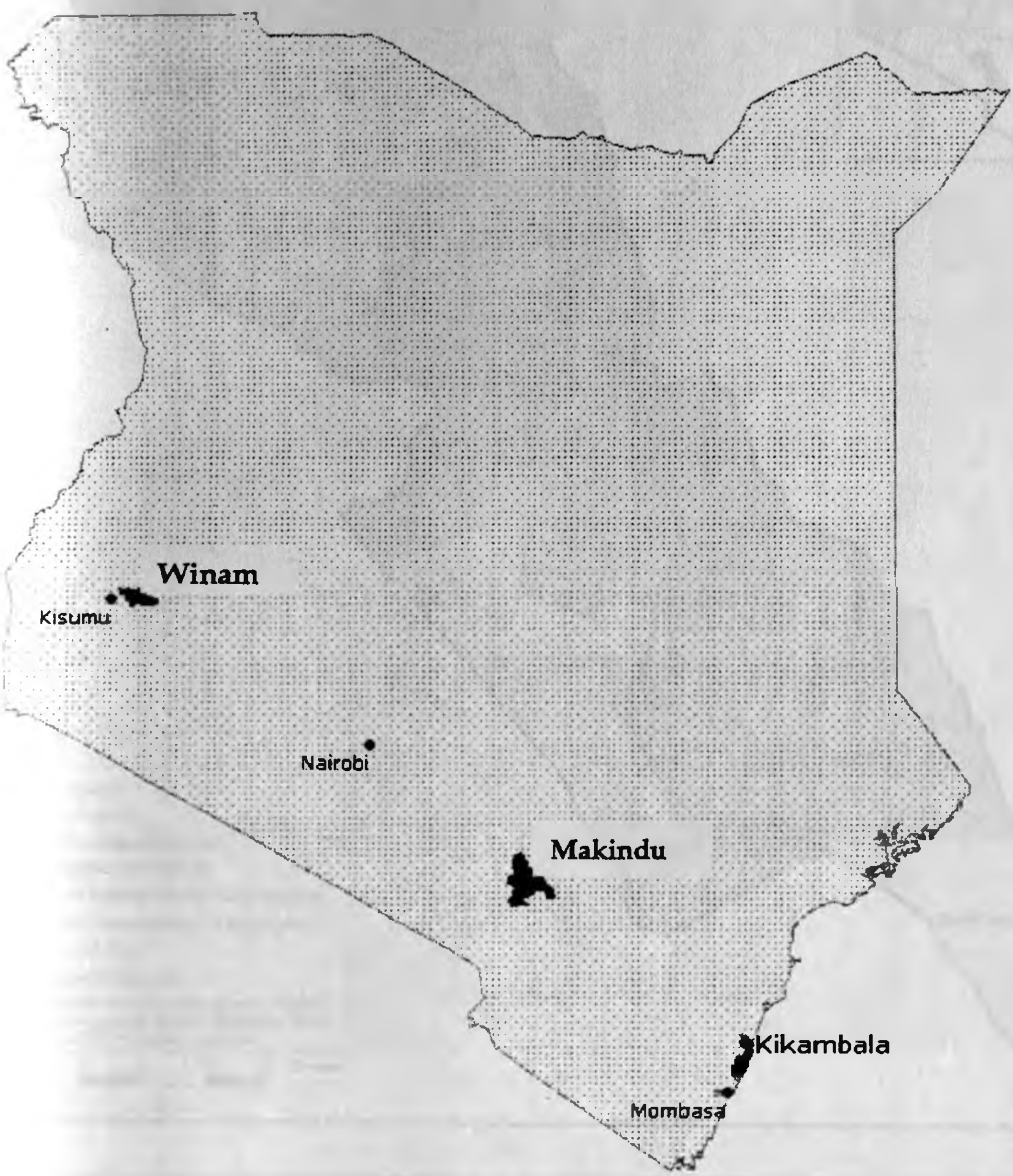
Kai sub-location should be prioritized for the bio-efficacy yellow cassava feeding trial due to the observed high prevalence of VAD and low dietary intake of vitamin A rich foods. Thereafter, the yellow cassava should be introduced in all the three sub-locations once proved to be efficacious in improving the vitamin A status of individuals.

However, larger studies are needed to understand the following: (1) association of women's socio economic status and prevalence of maternal night blindness at population level (2) demographic and social-demographic factors that predispose women to maternal night blindness in Kenya; (3 relationship between prevalence of maternal night blindness and dietary diversity indicators at population level and possible develop predictive models for maternal night blindness.

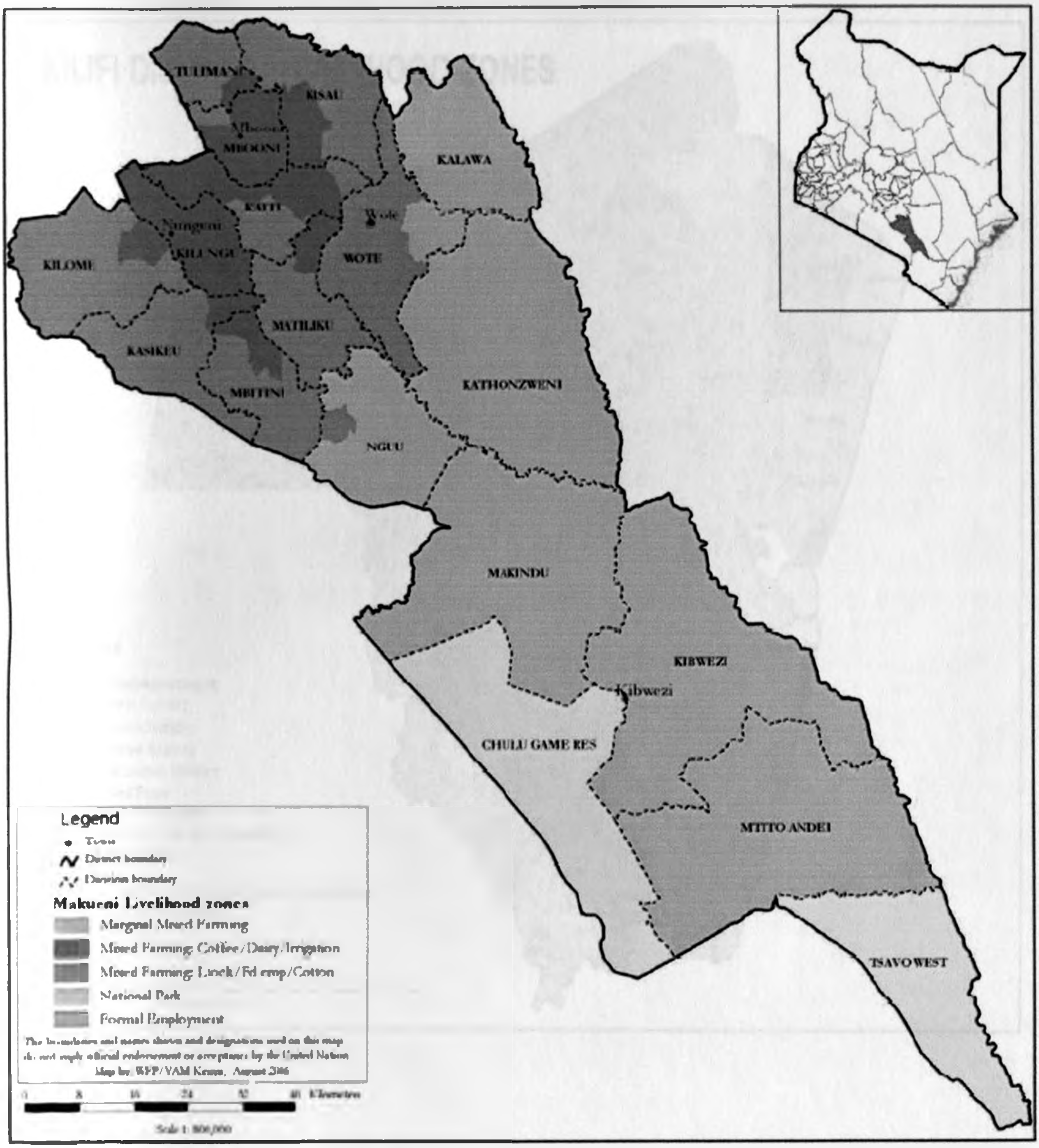
REFERENCES

APPENDIX

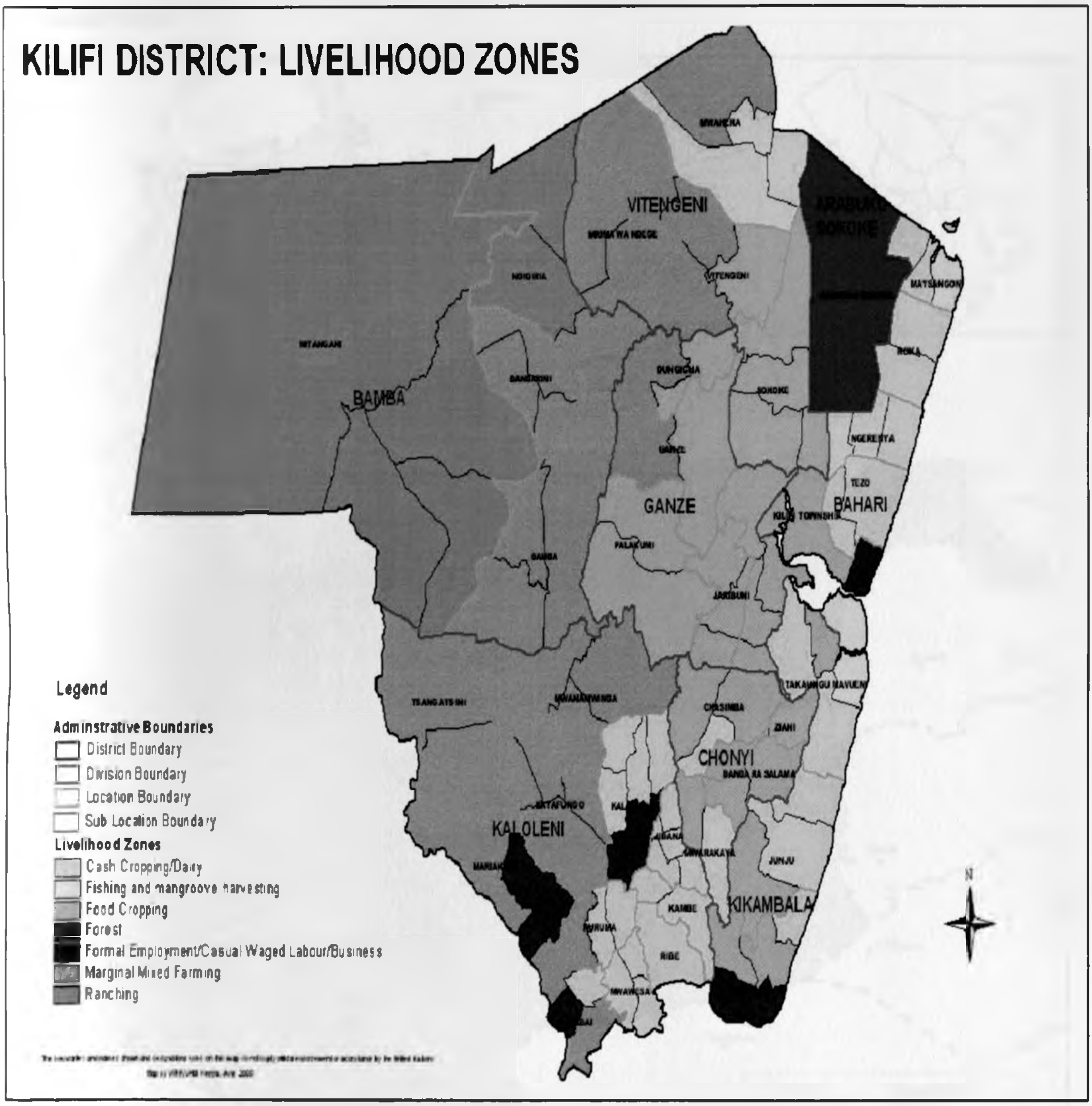
Appendix 1: Map of Kenya showing location of study areas



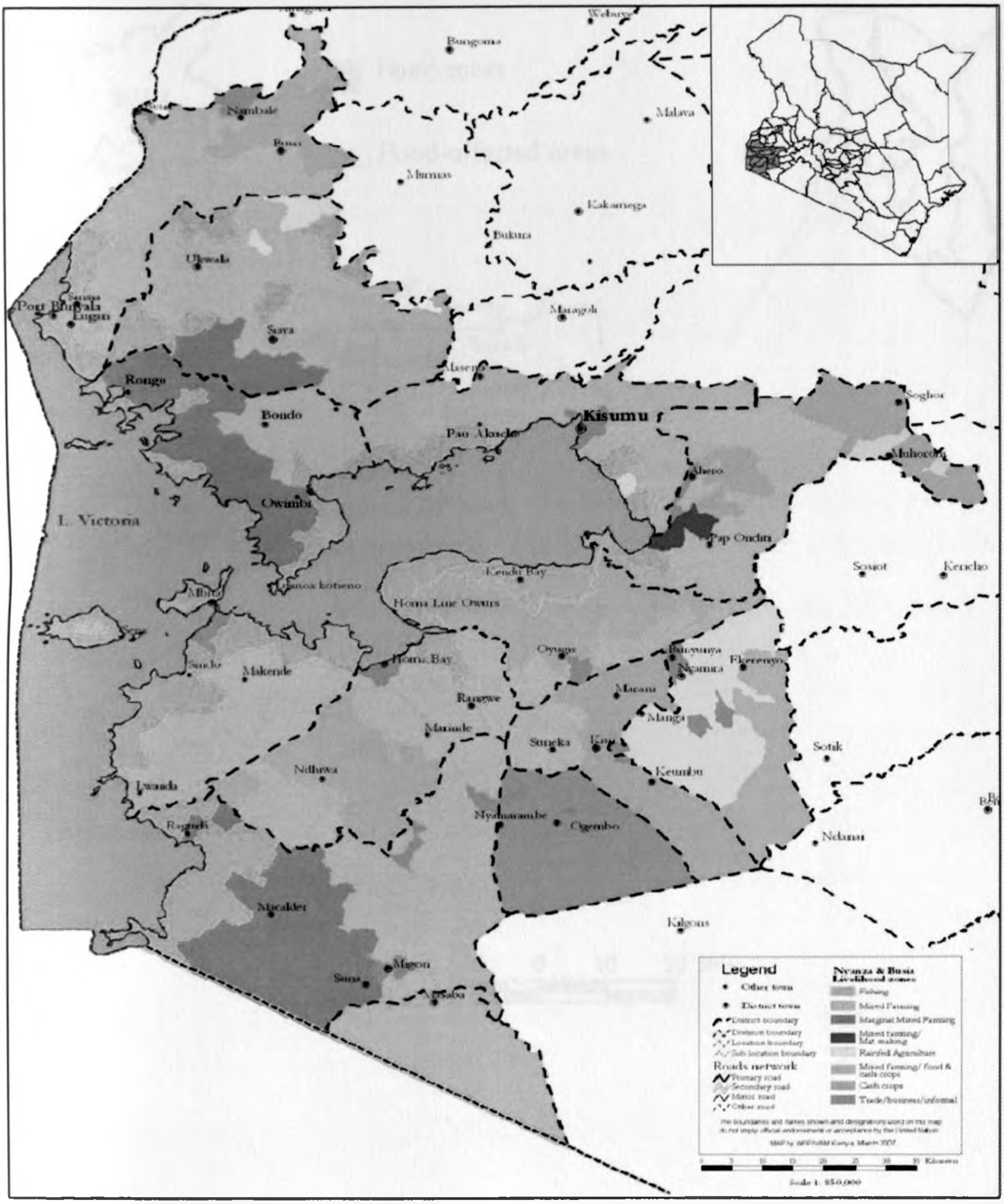
Appendix 2: Map of the larger Makueni district showing location of Makindu district and livelihood zones



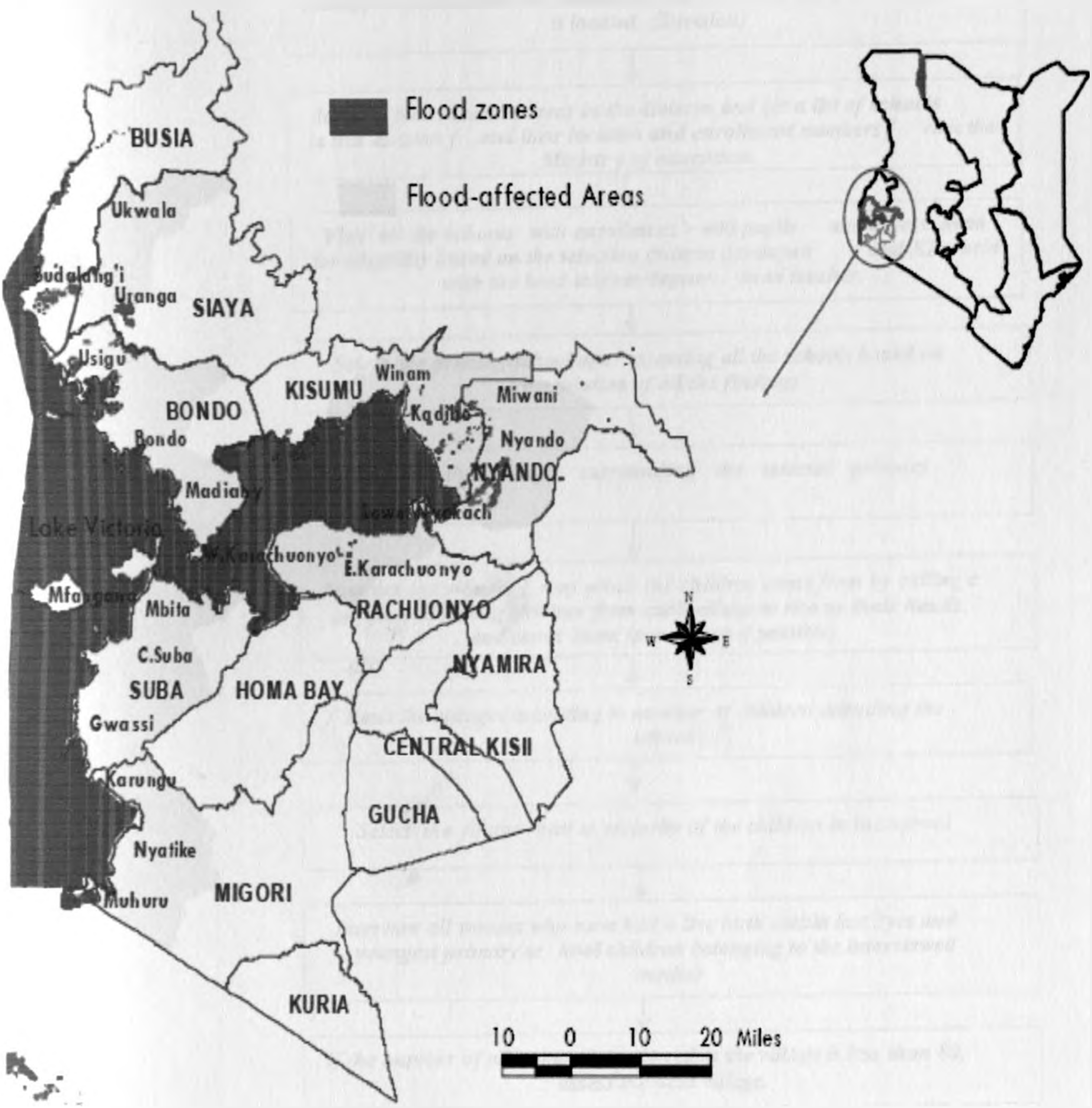
Appendix 3: Map of Kilifi District showing livelihood zones



Appendix 4: Map of the lake Region showing location of the larger Kisumu district and livelihood zones



Appendix 5: Map of the lake Region showing Winam Division among the flooding zones in the Kisumu District.



Appendix 6: Sampling schema

Identify the administrative boundaries within which the KA RI station is located (Division)

↓

Identify food insecure areas in the division and get a list of schools in this division f and their location and enrollment numbers f rom the Ministr y of education.

↓

Visit all the schools with enrollment > 400 pupils and assess them for eligibility based on the selection criteria developed and KI s held with the head teacher/deputy head teacher.

↓

Select one primary school after assessing all the schools based on triangulation of all the findings

↓

Identify the villages surrounding the selected primary schools

↓

Find out the villages f rom which the children come from by calling a parade and asking children from each village to rise up their hands and count them (per village if possible)

↓

Rank the villages according to number of children attending the school

↓

Select the village host to majority of the children in the school

↓

Interview all women who have had a live birth within last 3yrs and youngest primary sc hool children belonging to the interviewed mother

↓

If the number of all women interviewed in the village is less than 80, assess the next village.

↓

Continue select ing more villages till > 80 women are interviewed from exhaustive survey of all selected villages.

Appendix 7: Comparison of prevalence for maternal night blindness using direct standardization method

Age (yrs)	KAI			JUNJU			WATHOREGO			TOTAL		
	Pp^n[4]	ASPR / 100	Expected cases	Pp^n	ASPR / 100	Expected cases	Pp^n	ASPR / 100	Expected cases	Pp^n	ASPR/ 100	Expected cases
16	0	0	0	0	0	0	2	0	0	2	0.00	0
17	0	0	0	2	0	0	8	0	0	10	0.00	0
18	3	33.3	4.995	3	33.3	4.995	9	0	0	15	13.33	2
19	1	0	0	1	0	0	6	0	0	8	0.00	0
20	4	0	0	5	0	0	8	12.5	2.125	17	5.88	1
21	7	14.3	3.289	6	0	0	10	0	0	23	4.35	1
22	10	10	2.6	7	14.3	3.718	9	11.1	2.886	26	11.54	3
23	7	0	0	8	0	0	8	0	0	23	0.00	0
24	4	0	0	4	0	0	8	12.5	2	16	6.25	1
25	6	16.7	3.34	6	16.7	3.34	8	0	0	20	10.00	2
26	9	22.2	5.328	5	0	0	10	0	0	24	8.33	2
27	1	0	0	3	0	0	4	25	2	8	12.50	1
28	5	0	0	3	0	0	3	0	0	11	0.00	0
29	5	20	2.2	2	30	3.3	4	0	0	11	9.09	1
30	2	0	0	10	0	0	2	0	0	14	21.43	3
31	8	12.5	1.5	4	0	0	0	0	0	12	8.33	1
32	2	50	2.5	1	0	0	2	0	0	5	20.00	1
33	3	100	6	1	0	0	2	0	0	6	50.00	3
34	3	33.3	2.331	1	0	0	3	0	0	7	14.29	1
35	4	0	0	2	0	0	2	50	4	8	12.50	1
36	1	100	7	3	0	0	3	0	0	7	14.29	1
37	2	0	0	2	0	0	1	0	0	5	0.00	0
38	3	0	0	0	0	0	1	0	0	4	0.00	0
39	2	1	0.02	0	0	0	0	0	0	2	50.00	1
40	0	0	0	2	100	2	0	0	0	2	100.00	2
41	1	0	0	0	0	0	0	0	0	1	0.00	0
42	1	0	0	0	0	0	0	0	0	1	0.00	0
43	0	0	0	1	0	0	0	0	0	1	0.00	0
44	0	0	0	0	0	0	0	0	0	0	0.00	0
45	0	0	0	1	0	0	0	0	0	1	0.00	0
Total	94		41.103	83		17.353	113		13.011	290		28
Standardized prevalence rates			43.73%			20.91%			11.51%			9.66%

[4] Population of women interviewed in division

Appendix 8: Key Informant Interview Guide

Goal: To understand the current field situation at district and village level on related topics (see questions).

Activity: To conduct interviews with key stake holders on district and village level and describe health care & research that is being done in the areas including vitamin A supplementation programs.

Who: Local government (Ministry of Health, Ministry of Education, District officers), Schools, Health care providers (hospital/clinics), UNICEF/WFP/UNHCR, NGOs, village chiefs/elders, women groups.

Where: For every district.

Note: Question topics should be related to the work of the key informant. For example: you don't have to ask health care questions to a school teacher, then your focus is on the schooling.

Schools - Ministry of Education

Names and number of primary schools in the KARI area with enrolment numbers (ask for a list from the District Education Office for the whole district).

Are there school feeding programs? And if so, what kind, how often, etc?

Are there school health programs? And if so, what kind, how often, etc?

What is the distance to the main road? Accessibility of the school by car/truck?

Health - Ministry of Health

How is the health structure of the district?

How many health centers and clinics are there, and where?

Are there interventions/surveys going on in the area/village/school? What kind? Are there any nutrition interventions?

Any vitamin A supplementation being done? What exactly? (age group, number of international units (IU)/retinol equivalence, how often)

What are the top 10 diseases for children in the district?

Is malaria common? And if so, when?

Is night blindness common? And if so, local term/description?

<u>Water and Sanitation – village people</u>

Water and sanitation situation?

Are there toilets/latrines?

Source of water?

Storage of water in the home?

Eating habits / General – everyone

Do the inhabitants eat cassava and in what way? (boiled, fried, flour?)

Is cassava grown?

When is the rain season? When was the last rain?

What is the distance to the main road? Accessibility of the village?

Other issues like security, safety, criminality, or ......?

Appendix 9: Focus Group Discussion Guide

Basic questions for FGD with women

1. What are the common problems experienced during pregnancy?
2. Probe on vision problems and after that on night blindness. Try to get answered:
3. What is night blindness?
4. What are the causes of night blindness?
5. Have you ever come across a night blind person in this community?
6. What are the characteristics/ behavior of a night blind person?
7. Do you have a local term(s) for night blindness?

Additional questions for FGD with women

8. Which foods are available in this community and what are their local names? (according to DD questionnaire classification)
9. Which part is eaten and how is it prepared?
10. Are there foods reserved for women or not consumed during pregnancy?
11. Are there foods reserved for children or not consumed by children?

Appendix 10: Consent note

Hello, my name is ________________________________. I am a student at the University of Nairobi pursuing a master's degree human nutrition. In order to get information about the vitamin A status of this community, ________________________we are conducting a survey for all women who have had a live birth in the last three years and primary school children in this area.

All the information you give will be confidential. The information will be used to prepare general report but will not include any specific name. There will be no way to identify that you are the one who gave the information.

We encourage you to participate in this study and your cooperation will be highly appreciated.

If it is okay with you, may we proceed to ask you some questions related your last pregnancy and food consumption?

Respondent agreed to be interviewed _____________ 1=Yes 2=No

Signature of interviewer___________________________

Date_____________________________________

Time of interview: From: _____________ To: _____________

Appendix 11: Socio-demographic characteristics questionnaire

Household number ________________ Household size ____________________
Division ________________ Location ________________
Sub-location ________________ Village ________________

Name of respondent	Date of last live birth *(if alive check clinic card)*	Physiological state of respondent*	Vitamin A supplementation within 6 wks after delivery*	Number of children by respondent	Number of children in primary school	Age of respondent *(check on ID and record date)*	Literacy level of respondent*	Occupation of repondent*	Literacy level of husband *(if married)**	Occupation of husband*	Main source of household income*

** use codes below*

Physiological state

1. Pregnant
2. Lactating
3. None of these

Vitamin A

1. Yes
2. No

Literacy level

1. Not attended school (at all)
2. Completed 1-4 of primary
3. Completed 5-8 of primary
4. Attending primary-child
5. Attending secondary school
6. Completed secondary school
7. Post secondary school (technical)
8. Post secondary (tertiary educattion)

Occupation

1. Farmer
2. Housewife
3. Unemployed[5]
4. Student/pupil
5. Small-scale trader
6. Business (man/woman)
7. Casual labourer
8. Employed[6]

Main source of income for household

1. Animal & animal product sales
2. Crop sales
3. Salaried employment
4. Casual labour
5. Trade
6. Remittances
7. Destitute (gifts/begging)

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5 Above 18 and not in college or employed

6 On salaried job

Appendix 12: Maternal Night Blindness Questionnaire

Date of interview: ....../....../...... **Mother's name: ....**

Division: .... **Location: ....**
Sub location: .... **Village: ....**

*[**Note for the enumerator:** This questionnaire should only be administered to women who have had a live birth within the last three years (recall period July/August/September 2006 to July/August/September 2009) for the most recent pregnancy that ended in a live birth.]*

1. Did you ever have a problem seeing in the daytime during your last pregnancy?
   Yes = 1 No = 2

2. Did you ever have a problem seeing in the evening or in low levels of light during your pregnancy?
   Yes = 1 No = 2

3. Which problems did you experience during your last pregnancy?
   (put codes from FGD for description of XN/pXN)
   - ....
   - ....
   - ....
   - ....

4. Was this problem different from most people in your community?
   Yes = 1 No = 2

5. *(If local term for XN is identified)* Did you ever suffer from night blindness *(local term)* ______________ during your last pregnancy that ended in a live birth?
   Yes = 1 No = 2

Conclusion: *(tick appropriate box)*

- ☐ Crude case
- ☐ Adjusted case
- ☐ No case of night blindness

Appendix 13: Individual Dietary Diversity Questionnaire

(Adapted from FAO/FANTA, 2008)

Date of interview: ....../....../...... Mother's / Child's name: ....

Division: .... Location: ....
Sub location: .... Village: ....

[Note for the enumerator: stress that these questions apply only to the respondent and not to any other household member. If you are unsure about the group to fit the food, write it on the back of the paper.]

I would like to ask you about the foods and drinks you ate or drank yesterday during the day and at night (24 hours), whether at home or outside of home. Please recall all foods and beverages you consumed beginning with yesterday morning when you woke up.

Write down all food and drinks mentioned by the respondent. When the respondent has finished, probe for meals, fruits and beverages not mentioned.

Breakfast	Snack	Lunch	Snack	Supper	Snack

When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

Additional questions		Yes =1 No = 2
A.	Was yesterday a celebration or a feast day where you ate unusual foods?	
B.	Did you eat anything (meal or snack) outside of the home yesterday?	
C.	How many days over the past week did you eat something (a meal or a snack) not made in your home?	
D	Did you receive a supplement of vitamin A in the past 6 months? If yes, what kind of supplement?	

	Food group	Examples	YES = 1 NO = 0
1	Cereal grains and grain products	Grains and grain products (including stiff and thin porridges, breads, etc. but not pastries, cookies, other grain-based sweets)	
2	All other starchy staples	Cassava, taro, Irish potato; white-fleshed sweet potato, Plantain, banana (when staple), breadfruit	
3	Cooked dry beans and peas	All types like lentils, mbaazi, kunde, except soy beans	
4	Soy beans and soy products	Beans, tofu, tempeh	
5	Nuts and seeds	All, including groundnut, wild/foraged, coconut, cashewnut and sunflower-, simsim- and pumpkin seeds	
6	Milk/yoghurt	Including fresh, dried, tinned milk of any mammal, Mala	
7	Cheese		
8	Organ meat	Like livers, kidneys, intestines, heart, other organ meats or blood based foods	
9	Eggs	From any bird	
10	Small fish eaten whole with bones	Like omena/sardines	
11	Large whole fish/dried fish/shellfish, other seafood	Fresh, dried or fried-Ngege/Tilapia, Mbuta, Kiboma, sea fish – oysters, crabs	
12	Beef, pork, veal, lamb, goat, game meat		
13	Chicken, duck, turkey, pigeon, guinea hen, game birds		
14	Insects, grubs, snakes, rodents and other small animals		
15	Vitamin A-rich dark green leafy vegetables [a]	E.g. cassava leaves, sweet potato leaves, amaranth leaves, some pepper leaves, sukuma wiki	
16	Vitamin A-rich deep yellow, orange and red vegetables [a]	E.g. orange-fleshed sweet potatoes, pumpkin, carrot, and 100% juice from these	
17	Vitamin A-rich fruits [a]	E.g. *ripe* mango, papaya, some melons, and 100% juice from these	
18	Vitamin C-rich vegetables [b]	E.g. cabbage, peppers, broccoli, tomatoes, and 100% juice	
19	Vitamin C-rich fruits [b]	E.g. citrus, berries, guava, and 100% juice	
20	All other vegetables		
21	All other fruits	Including sweet banana, and 100% juice	
	Red palm fruit products	Red palm oil, palm nut pulp and any other product made from red palm fruit	
	Other fats and oils [c]	All other vegetable fats or "fruit" fats, e.g. coconut milk	
		Animal fats, including cream, sour cream, butter, lard, ghee, etc.	
	Sweets & added sugars [c]	All sweets, added sugars, including sweet beverages (soda, "juice drinks")	
	Alcohol [c]	Commercially produced and locally brewed spirits	
		Low-alcohol locally brewed beer, other low-alcohol fermented beverages	
	All other beverages [c]	Coffee, tea, clear broths	
	SCORE	Total	

[a] "Vitamin A-rich" is defined as > 130 RAE/100g

[b] "Vitamin C-rich" is defined as > 18 mg/100g

[c] Shaded groups do not contribute to any of the diversity indicator scores.

Appendix 14: Classification Guide for foods into food groups

	Food item	*Local names*	*Food group on IDDS-21*	*Notes*
	Vegetables			
1	Sukuma wiki (kales)		15	
2	Cowpea leaves (mukunde)		15	
3	Amaranth leaves (Terere)	chiswenya	15	
4	Spinach		15	
5	Brinjials(eggplant)		15	
6	Cabbage		18	
7	Muchunga		15	
8	Munavu		15	
9	Murenda		15	
10	Cassava leaves (mupeya)		15	
11	Tsalakushe (always mixed with other DGLVs)		15	
12	Mabenda (ocra)		15	
13	Chidiri(always mixed with other DGLVs)		15	
14	Kanzira(always mixed with other DGLVs)		15	
15	Pumpkin leaves		15	has 126 RAE/100g <130RAE/100g
16	Night shade /managu)		15	
17	Spider herb (Dhek)/sagget/sagga		15	
18	Osugga		15	
19	Tomato (cooking)		18	
20	Onions(cooking)		20	
21	Fresh tomato soup		18	
22	Raw tomato salad (in kachumbari)		18	
23	Raw onions used in salad (kachumbari)		20	
	Cereals and cereal products			
24	Maize (boiled in githeri/muthokoi)		1	
25	Poridge (Maize white/yellow)		1	
26	Thich porridge(white/yellow maize)	Ugali, sima	1	
27	Porrige (soughum/millet)		1	
28	Sour porridge (traditinal /commercial)		1	
29	Mandazi/mahamri		1	
30	Muthokoi		1	
31	Rice (cooked plain or in pilau/biriyani)		1	
32	Chapati		1	
33	Doughnuts		1	
34	Pancakes (wheat flour + water)		1	
35	Bread (white/brown)		1	
36	Rasted maize		1	
37	Bulgar wheat (cooked)		1	
38	Kaimati		1	
39	Scones		1	
	Starchy roots and tubers			
40	Irish potatoes		2	
41	Sweet potatoes (white fleshed)		2	
42	Sweet potatoes (yellow/orange fleshed)		16	
43	Cassava roots (boiled)		2	
44	Cassava thich porridge (ugali)		2	
45	Cassava poridge		2	
	Fruits			

	Food item	Local names	Food group on IDDS-21	Notes
46	Orange		19	
47	Banana		21	
48	Avocado		21	
49	Mango (ripe)		17	
50	Mango (unripe/green)		21	
51	Custard apple (matomoko)		21	
52	Guavas		19	
	Fish and Fish products			
53	Sardines (Omena/Kumbu)		10	
54	Tilapia (ngege)		11	
55	Nileperch (mbuta)		11	
56	Shark		11	
57	Other bonny sea fish (Tafi)		11	
58	Crabs		11	
59	Kiboma		11	
60	Oysters		11	
61	Octopus (Kamba nane)		11	
62	Other sea food *(kamba-prawns,*		11	
63	Mud fish		11	
	Legumes, nuts and seeds			
64	Beans (cooked dry)		3	
65	Pigeon peas (mbaazi)		3	
66	Split peas(yellow/green)		3	
67	Cowpeas		3	
68	Green grams		3	
69	Coconut/madafu flesh (madanga)		5	
70	Roasted groundnuts/peanuts		5	
	Milk and milk products		6	
71	Fresh Milk (Cow/Goat)		6	
72	Traditional Sour/fermented milk (Cow)		6	
	Meat and meat products			
73	Beef		12	
74	Offals -intestines, stomach,spleen(Matumbo)		8	
75	Pork		12	
	Poultry and eggs			
76	Eggs (hen)		9	
77	Chicken		13	
78	Duck meat		13	
	Cooking fats and oils			
79	Kimbo		Other fats /oils	do not contribute to food group
80	Mallo		Other fats /oils	do not contribute to food group
81	Vitamin A fortified oil(relief)		Other fats /oils	do not contribute to food group
82	Ufuta		Other fats /oils	do not contribute to food group
83	Golden fry		Other fats /oils	do not contribute to food group
84	Coconut milk		Other fats /oils	do not contribute to food group
85	margarine (blueband)		Other fats /oils	do not contribute to food group
	Sweets, Spces and condiments			
86	Salt			Not classiifed
87	Salt solution			Not classiifed
88	Sugar		Sweets/ sugars	do not contribute to food group
89	Sugar cane		Sweets/ sugars	do not contribute to food group
90	Royco/Onga			Not classiifed

	Food item	*Local names*	*Food group on IDDS-21*	*Notes*
91	Pilau spices		Sweets/ sugars	
92	Cakes			
93	Half cake (boboi qn. 20)		Sweets/ sugars	
	Beverages			
94	Black tea		All beverages	do not contribute to food group
95	Drinking chocolate		All beverages	do not contribute to food group
96	Chicken legs soup		All beverages	do not contribute to food group
97	Fruit Flavoured beverages (cordials)		All beverages	do not contribute to food group
98	Soda		All beverages	do not contribute to food group
99	Beer (senator keg)		Alcohol	do not contribute to food group
100	Whisky (African Gum)		Alcohol	do not contribute to food group
	NOTE			
	Mixed meals- INGREDIENTS SCORES SEPARATELY			
	Muthokoi			
	Githeri			
	Pilau			
	Biryani			
	Porridge-cassava+sorgum+millet			