PREVALENCE AND PREDICTORS OF VITAMIN A STATUS OF CHILDREN AGED 6-23 MONTHS IN BUNGOMA AND BUSIA COUNTIES OF WESTERN KENYA

BY

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DECLARATION

I, Oyunga Mary Anyango declare that this thesis is my own original work and has not been presented for a degree in any other University, and that all sources of information have been specifically acknowledged by list of references cited.

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DEDICATION

To my family I dedicate this success. Incredible persons in this life.

ABSTRACT

Subclinical vitamin A (VA) deficiency (VAD) continues to be a global problem widely affecting children within 1,000 days of life. Western Kenya experiences high infant mortality partly attributable to VAD. A community based cross-sectional survey among children 6-23 months was undertaken in Western Kenya. Socio-demographic and dietary intake information were collected. Analysis of retinol-binding protein (RBP) and C-reactive protein (CRP) was undertaken to estimate VA and sub-clinical inflammation. Values were adjusted for influence of inflammation and population prevalence of VAD estimated. Anthropometric data measured stunting, wasting and underweight, taking into account age and sex. ArcGIS and GeoDa 1.6 were used for spatial analysis. VAD clustering levels were assessed using Local Indicators of Spatial Association. Regression analysis was conducted to model the most significant spatial predictors for VAD. Qualitative data was collected to exam awareness and perceptions on VAD. The inflammation-adjusted mean (±SE) prevalence of VAD was high (20.1±1.1%) in this population. Intake of VA capsule was a predictor of VAD with children who have not taken VA during the past 1 year prior to the survey having a 30% increased risk of VAD (OR (CI): 1.3 (1.1-1.7); p=0.025. Age of child was a predictor with older children having a 30 % increased risk of VAD (OR (CI): 1.3 (1.1-1.9); p=0.035); caretaker's knowledge on VA and nutrition was a predictor of VAD with children whose caretakers had poor knowledge having a 40 % increased risk of VAD (OR (CI): 1.4 (1.0-1.9); p=0.027. The child's location was a predictor of VAD in all the sub-counties, where Bunyala showed the strongest predictor for a child developing VAD (Adjusted odds ratio=3.5, CI =1.7-6.9, p=0.000), followed by Bungoma North (Adjusted odds ratio=2.2, CI=1.2-3.9, p=0.011), Kimilili (Adjusted odds ratio=1.9, CI=1.0-3.7, p=0.045). This shows that among the four sub-counties, a child residing in Bunyala had the highest risk of developing VAD and least risk in Bungoma East. Analysis of Moran's Index in Bungoma and Busia revealed heavy clustering. Length of crop growing period, distance to health facilities, markets and towns emerged as significant spatial predictors of VAD. Majority of the people in the community had low awareness of VAD. Nutrition specific interventions need to focus on areas with high VAD clustering while nutrition sensitive interventions need to focus on low VAD clustering areas. There is need for health education to raise community's awareness on VAD in such settings in order to augment prevention, control and elimination efforts.

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LIST OF ABBREVIATIONS

APPs - Acute Phase Proteins
ARS - Agricultural Research Services
BLUE - Best Linear Unbiased Estimator
CDC - Center for Disease Control
CFs - Complementary Foods
CHWs - Community Health Workers
CRP - Creatine Reactive Protein
CSPro - Census and Survey Processing System
DALYs - Disability Active Lost Years
DBS - Dried Blood Spot
DDI - Dietary Diet Index
EHRP - Enzyme Horseradish Peroxide
EIA - Enzyme Immune Assay
ELISA - Enzyme-Linked Immunosorbent Assay
ERBs - Ethical Review Boards
FAO - Food and Agricultural Organization
FFQ - Food Frequency Questionnaire
FGDs - Focus Group Discussions
GoK - Government of Kenya
GPS - Global Positioning System
HH - Household
HDDS - Household Dietary Diversity Score
HIV - Human Immunodeficiency Virus
HKI - Hellen Keller International
HPLC - High performance liquid Chromatography
IDDS - Individual Dietary Diversity Score
KEMRI - Kenya Medical Research Institute
KIIs - Key Informant Interviews
KNBS - Kenya National Bureau of Statistics

LISA	-	Local Indicators of Spatial Association
MCH	-	Maternal and Child Health
MoH	-	Ministry of Health
MoPHS	-	Ministry of Public Health and Sanitation
OLSR	-	Ordinary Least Squares Regression
PPS	-	Population-Proportionate to Size
RBP	-	Retinol Binding Protein
RDA	-	Recommended Daily Allowances
ROH	-	Retinol
SA	-	Spatial Autocorrelation
SASHA	-	potato Action for Security and Health in Africa
SDG	-	Sustainable Development Goals
SPSS	-	Statistical Package for Social Scientists
USDA	-	United States Department of Agriculture
USIOM	-	United States Institute of Medicine
UNICEF	-	United Nations Children's Education Fund
UV	-	Ultra Violet
VAD	-	Vitamin A Deficiency
VADD	-	Vitamin A Deficiency Disorders
VACs	-	Vitamin A Capsule
VAS	-	Vitamin A Supplement
WHO	-	World Health Organization
WFP	-	World Food Program

DEFINITION OF TERMS

Nutritional status-Stunting (length-for-age Z-scores (LAZ <-2SD)), Wasting (<-2SD weight -for-height Z-scores (WLZ<-2SD), Underweight (weight-for-age Z-score (WAZ<-2SD)).

Household-Person or a group of persons related or unrelated, who live together and who share a common source of food (KHDS, 2009).

Vitamin A deficiency-WHO Serum retinol threshold levels of <0.70µmol/liter (WHO, 2009).

Severe VAD-Serum Retinol threshold levels of <0.35 µmol/liter (WHO, 2009 & Awasthi *et al*, 2013)

Mother/Caretaker-The person who is present in the household most of the time and takes care of the index child on a daily basis

Key Informant-Someone in charge of a local health facility and responsible for the day to day decisions and provision of health services Is also referred to in this study as front-line nutritionist

Catchment area-This describes an area where a health facility provided for the most part of their services to clients/patients.

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CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Subclinical vitamin A deficiency (VAD) is a problem in at least 75 countries worldwide (Lee et al, 2008). The most widely affected group includes up to 10 million malnourished children, who develop xerophthalmia and have an increased risk of complications and death from measles. Each year, 250,000-500,000 children become blind because of VAD (World Health Organization (WHO), 2009). A recent study by Stevens et al (2015) analyzed trends in the prevalence and mortality rate of VAD in children aged 6-59 months between 1991 and 2013 in low-income and middle-income countries including Kenya. Although the study found that the prevalence of VAD in these countries among children had decreased from 39% to 29, the prevalence was highest in sub-Saharan Africa (48%) and south Asia (44%) with 95% of deaths related to VAD still occurring in these regions. This form of VAD, which is defined as serum retinol concentration less than 0.70 μmol/L, reflects a severe public health problem (WHO, 2009). In Kenya, VAD remains a significant public health problem for young children (Ministry of Public Health and Sanitation (MoPHS), 2008). According to WHO regression-based estimates, Kenya is one of the countries with severe and moderate biochemical VAD of public health concern among pre-school children (WHO, 2009). According to Black, (2008), Kenya looses 121,000 Disability Active Lost Years (DALYs) that is attributable to VAD, which translates to, between 0.5 and 1 percent of the national product annually.

Western Kenya lacks data on VAD prevalence among children 6-23 months but this is likely important because the neighbouring province, Nyanza, has VAD of about 23% among children aged 6-59 months (Ruth, 2009**).** National micronutrient surveys among children 6-59 months

have been undertaken in Kenya since 1999 (MoH/KEMRI, 1999) and as recent as 2008 (MoPHS, 2008). These studies have consistently found very high levels of VAD prevalence; 76% and 84% respectively. They have not taken into account the fact that there will be individuals in the population with inflammation but no VAD, who will be assessed as VA deficient because of the effects of inflammation alone on retinol.

Much of the effectiveness of interventions depends on individuals, household, and community-level variables (Mosley & Chen 1984). A study by WHO (1995) has shown that occurrence of VAD tends to cluster rather than be evenly distributed possibly reflecting a convergence of several risk factors that precipitate VAD in the surrounding child population. The risks that typify these situations comprise economic, social, ecological, and host related factors, whereby a habitually deficient dietary intake of VA coexists with severe infections (Alvarez et al, 1995 &, Mitra et al, 1998). Addressing malnutrition such as VAD through integrated packages of nutrition-specific and nutrition-sensitive actions that focus on the first 1,000 days is one of WHO's global targets, endorsed by the 65th World Health Assembly, as part of the post-2015 sustainable development agenda (WHO, 2012). To achieve this, identification of the target population is crucial where local geospatial differences in VAD can be very useful in charting out several approaches that are sensitive and specific to improving child health for relevant government ministries. Determining the geospatial distribution of VAD by sub-locations and investigation into the factors influencing this distribution is therefore warranted.

The primary cause of VAD is inadequate dietary consumption of vitamin A and/or suboptimal use of the nutrient in the body. A number of underlying and basic factors contribute to

insufficient dietary intake of vitamin A, inadequate production of vitamin A-rich foods, lack of income to purchase foods rich in VA, unavailability of vitamin A-rich foods in markets, large family size, high maternal parity levels, low level of maternal education, low levels of awareness of the importance of vitamin A, and illness (UNICEF, 1992).

As the risk factors and determinants of vitamin A are context-specific (socio-economic, cultural, environmental, etc.), variations in factors contributing to VAD exist among countries, regions, and localities, underlining the need to assess country/region/area-specific risk factors. Unfortunately, studies relating to country and region or area-specific causes of vitamin A in Kenya are scarce, and hence, substantive information regarding factors contributing to VAD is lacking. Investigation of demographic factors that could potentially influence VA status such as household size (number of family members), wealth index score, household Head level of education, form of employment, sex of child, age of child, marital status of caretaker, socio-economic status, sub-County based location of a household and caretaker's main occupation is necessary. Knowledge on such specific risk factors will enable implementers and policy-makers to design and implement effective interventions.

Food intake and good nutrition that comes from adequate food intake is considered as a paramount component of health and development (Vakili et al., 2013). Food-based strategies have been recommended as the first priority to meet micronutrient needs including vitamin A (Allen, 2008). The importance of diet quality during childhood is progressively becoming implicit (Torjusen et al., 2012). Adequate nutrient intake necessary for good nutrition has often been associated with food variety and diet quality of individuals (Zainal-Badari et al. (2012). Consumption of a wide variety of foods, an integral component of diet quality is thus needed to

ensure adequate intake of essential nutrients particularly during the first 1,000 days of a child's life. Dietary diversity is associated with a good nutritional status. Dietary diversity refers to the number of different foods or food groups consumed over a given reference period (Swindale & Bilinsky, 2006). The value of a diverse diet has long been recognized and is considered as a key element of high quality diet (Arimond & Ruel, 2004; Jayawardena et al., 2013). Kennedy et al. (2009) argue that a sufficiently diverse diet reflects nutrient adequacy since no single food contains all the required nutrients for optimal health. In this regard, Labadarios et al. (2011) noted that the more food groups included in a person's daily diet the greater the likelihood of meeting their nutrient requirements. A variety of foods in the diet is therefore considered very important in ensuring an adequate intake of essential nutrients (Drimie et al., 2013). In developed countries, evidence has shown that dietary diversity is strongly associated with nutrient adequacy (Bernstein et al., 2002; Foote et al., 2004). Evidence from these countries is however, scarce due to consumption of monotonous diets that mainly rely on few plant based staples and sometimes few or no animal products, with occasional fruits and vegetables (Arimond and Rauel, 2004).

Despite its important roles and existing knowledge concerning the consequences of its deficiency and access to abundant cheap foods that are pro-vitamin A rich in poor resource areas, VAD still remains a widespread problem worldwide, particularly among young children (West KP., 2002). Promotions of nutrition education, home/kitchen gardens and rearing of small livestock to improve VA intake are traditional interventions for VAD control and prevention. Indeed, the Kenyan Ministry of Health through its national food and nutrition security policy has recommended that more research is needed on the knowledge, attitudes and practices towards VAD control (GoK, 2012). The success of these control initiatives involving the community depend on the level of the communities' uptake of the program, which is hinged upon

understanding community knowledge and practices towards VAD and recommended preventive and control measures.

1.2. Statement of the Problem

Subclinical vitamin A deficiency (VAD) is a global problem and widely affects children aged between 6-23 months often exhibiting symptoms of clinical xerophthalmia and increased risk of complications. Western Kenya lacks accurate data on VAD prevalence among children 6-23 months even though the neighboring Nyanza region seems to have recorded definite prevalence**.** Indications in Nyanza seem to suggest a substantial prevalence although for accuracy the actual prevalence needs to be established in Western Kenya (former western province). Geo-spatial distribution of VAD prevalence is hard to find in Western Kenya making targeted interventions difficult to implement with reasonable accuracy. Vitamin A deficiency has a long-term effect and unless high impact interventions are put in place Kenya will continue to record high Disability Active Lost Years (DALYs) which will translate into huge economic loss from the health sector. Establishment of accurate prevalence and spatial distribution was necessary for well-informed targeting. Furthermore, there seems to be major gaps on the etiology of Vitamin A status.

Establishment of the prevalence of VAD remains the initial step towards positive empirical move; however, understanding etiological complexities in relation to Vitamin A status would be additional empirical milestone in the field of Public Health. Some of the critical suspect factors in the etiology of Vitamin A deficiency include socio-demographic characteristics, food intake, nutrition status, knowledge and perceptions. Socio-demographic characteristics, food intake and nutritional status were treated as caregiver and household related factors in the study while knowledge and perceptions combined both health provider and caregiver perspectives.

1.3. General Objective

To assess the prevalence and predictors of Vitamin A deficiency among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

1.3.1. Specific Objectives

1) To determine the prevalence and the geospatial distribution of VAD in children aged 6-23 months in Bungoma and Busia counties of western Kenya.
2) To determine the relationship between socio-demographic characteristics and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.
3) To determine the relationship between food intake, nutrition status and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.
4) To determine the relationship between knowledge, perceptions and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

1.3.2. Research Questions

1) What is the prevalence of vitamin A deficiency and geospatial distribution of VAD among children aged 6-23 months in Bungoma and Busia counties of western Kenya?
2) What is the relationship between socio-demographic characteristics and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya?
3) What is the relationship between food intake (dietary diversity), nutrition status and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya?

4) What is the relationship between knowledge, perceptions and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya?

1.3.4. Study Hypothesis

Objective 1

H_0**:** There are no significant differences in prevalence and spatial distribution of VAD between sub-counties.

H_1: There are significant differences in prevalence and spatial distribution of VAD between sub-counties.

Objective 2

H_0**:** There is no relationship between socio-demographic characteristics and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

H_1: There is a relationship between socio-demographic characteristics and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

Objective 3

H_0**:** There is no relationship between food intake, nutrition status and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

H_1: There is a relationship between food intake, nutrition status and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

Objective 4 H_0: There is no relationship between knowledge, perceptions and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

H_1: There is a relationship between knowledge, perceptions and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

1.4. Significance of the Study

Vitamin A (VAD) deficiency, defined by the World Health Organization (WHO) as low serum retinol (<20 mcg/dl), is estimated to be decreasing only slowly internationally (UN-SCN, 2010). The rate of improvement has been about 0.3 percentage points (ppts)/year; e.g. a prevalence change from 30% to 25% is 5 ppts; in 5 years, 1 ppt/yr. At this rate, it will take another 100 years to eliminate the problem of VAD (Mason, et al, 2014). This failure to make more progress is not due to lack of evidence-based effective interventions, but may be attributed to a failure to adequately apply scientific knowledge to policy making. This stems in part from the complexities of vitamin A's physiological role and metabolism, so that the various potential interventions may have different effects.

Kenya has not escaped this unfortunate scenario because whether estimated locally through national surveys or through the use of World Health Organization regressed data, VAD remains a significant public health problem for young children. Losses of upto 121,000 DALYs annually in Kenya is attributable to VAD-amounting to losses of between 0.5 & 1 % of gross national product (Black et al, 2008). A lack of control in this trend is highly likely to get out of control and the current interventions have not made any meaningful change.

Over the years (1993 to 2008), the Kenya government has undertaken national surveys to estimate VA status among children 6-59 months obviously including children (24-59 months) already outside the first 1,000 days window of opportunity. Malnutrition early in life including VAD can cause irreversible damage to a child's brain development, immune system, and physical growth. Although these estimates have been critical in advancing policies and programs for control of VAD, they have largely been inaccurate because corrections for inflammations were not done resulting in overestimated prevalence of VAD (over 76%).

Factors that influence vitamin A deficiency are context-specific (socioeconomic, cultural, environmental, geospatial distribution), and variations in factors contributing to vitamin A deficiency exist among countries, regions, and localities, underlining the need to assess country/region/area-specific risk factors. In the absence of such context-specific information in Kenya, a large proportion of the children who are currently receiving VACs may have no evidence of VAD Due to the low VACs coverage (19.8%) in Western Kenya that is untargeted, it appears that the current vitamin A programmes are ineffective; may be consuming precious resources (human and material), obstructing other approaches to the prevention of vitamin A deficiency, that are best initiated at national and local level, where much support is needed. The consequence has been interventions that were in many cases inappropriate and unnecessary. This means that tackling VAD problems in Kenya needs policy rethinking and current interventions should now change.

Successful vitamin A programmes require appropriately designed information, education and communication strategies that are targeted and backed by accurate data. Furthermore, for VA programs to be accepted and adhered to by child caregivers and healthcare providers, it is

necessary to ensure that the rationale for VA is explained, specific questions answered and clear instructions given (Hill, 2007). This is because the success of these control initiatives involving the community depends on the level of the communities' uptake of the program, which is hinged upon understanding community knowledge and perceptions towards VAD and recommended preventive and control measures.

A starting point would be to; bring together correct prevalence data on VA status of children (taking inflammation in to account), identify context-specific risk factor/determinants of VAD and understand the knowledge and perspectives of the target population regarding VA and VAD. This information will guide policy rethinking, assist health workers to reorient their focus to understand and design appropriate and effective intervention programs that change specific undesirable situations and help the community where much support is needed. This would in effect support nutrition-specific interventions that would directly address the immediate causes of VAD such as dietary intake, nutrition-sensitive interventions that address VAD underlying causes such as identified socio-demographic factors and building an enabling environment that address basic causes of VAD.

1.5. Study Delimitations

Since the study was conducted in 2 counties that are close to each other, generalization to other counties, country or region should be made with utmost caution due to demographic and ecological variations.

1.6. Study limitations

The study was limited by individuals who have the desire to report only socially desirable behaviors, reluctance by individuals to report embarrassing behaviors, and forgetfulness. This

was overcome through confidentiality and privacy. It may not be easy to replicate the results of this study elsewhere since the study results reflect specific settings where communities may differ. Sources of GIS data related to spatial determinants were rather challenging to acquire in the ready to use formats. The study thus relied majorly on secondary online data sources recommended as an alternative to conduct detailed spatial analysis.

1.7. Study assumptions

The assumption made in this study was that the VAD as measured by corrected values of RBP would likely correlate with socio-demographic factors, vitamin A intake (dietary intake and diversity), knowledge by caretakers on VA and nutrition and spatial variables (distance to markets, rivers, nearest shopping center, health facility, and distances to towns, slope in degrees, altitude, topography, soil type and length of crop growing period). Other factors assumed to be correlated with VAD include poverty gap, poverty density, poverty rate, population, number of poor in both counties of Bungoma and Busia.

CHAPTER TWO

LITERATURE REVIEW

2.1. Vitamin A status of Children 6-59 years

This study reviews literature in this sub-section from two different perspectives with a focus on VAD prevalence and geospatial distribution prevalence.

2.1.1. VAD prevalence among children 6-59 years

Globally, 0.9% or 5.17 million preschool age children are estimated to have night blindness and 33.3% or 90 million to have sub-clinical VAD, while in Africa, 2.0% or 2.5 million preschool age children are estimated to suffer night blindness and 44.4% or 56.4 million to have sub-clinical VAD, which is as serum retinol concentration that is less than 0.70 μmol/L, reflecting a severe public health problem (WHO, 2009). Currently, WHO estimates reflect the time period between 1995 and 2005 indicating that 45 and 122 countries including Kenya have vitamin A deficiency of public health significance based on the prevalence of night blindness and biochemical vitamin A deficiency (serum retinol concentration <0.70 μmol/l), respectively, in preschool-age children (WHO, 2009). According to WHO regression-based estimates, Kenya is one of the countries with severe and moderate biochemical and night blindness respectively of vitamin A deficiencies of public health concern among pre-school children and pregnant women respectively (WHO, 2009). The current recommendations and decisions for Kenya to undertake any VAD interventions including the distribution of VACs to children are guided by regression-based estimates, by WHO (WHO, 2009). Annually, Kenya looses 121,000 DALYs that is attributable to VAD (Black, 2008). This translates to, between 0.5 and 1 percent of the national product, each year in Kenya (Black, 2008). Western Kenya lacks data on VAD prevalence

among children 6-23months but it is likely important because the neighbouring province, Nyanza, has VAD of about 23% among children aged 6-59 months (Ruth, 2009**)**. An interpolation models study on VAD for sub-Saharan Africa (using national data) showed that only 11.6% of children in Kenya had VAD (Aguayo and Baker, 2005); the national data has consistently sharply contrasted this with a high VAD prevalence of over 76%.

Over the years (between 1993 and 2008), Kenya government has undertaken national surveys to estimate VA status among children. Although these estimates have been critical in advancing policies and programs for control of VAD over the years, they were largely inaccurate because corrections for inflammations were ignored. The assessment of the true burden of VAD is complicated by the influence of infection such as malaria and HIV, on VA indicators, especially in developing countries (Thurnharn, 1997 & Duncan *et al*., 2012). The current cut-off of 0.7 μmol/L (equivalent to 0.83μmol/L of RBP) has been set for serum or plasma retinol concentration to indicate vitamin A status irrespective of inflammation (Mitra *et al*., 1998 & Gamble *et al.,* 2001). This approach however, ignores the fact that there will be people in the population with inflammation but no vitamin A deficiency, who will be assessed as vitamin A deficient because of the effects of inflammation alone on plasma retinol. This has been the case in several important studies in Kenya both at national and at community level where documented VAD prevalence among children less than 5 years (MoH/KEMRI, 1999, Ettyang, 2004, MoPHS, 2008), did not consider the use of correction factors for inflammation resulting in overestimated prevalence of vitamin A deficiency (over 76%) making VAD interventions in many cases inappropriate and unnecessary.

Several important nutritional biomarkers in plasma concentrations are influenced by inflammation (Louw *et al*., 1992); this includes retinol (Thurnharn, 1991 & Duncan *et al*., 2012). The most commonly used and sensitive acute phase protein for monitoring infection and inflammatory activity and is particularly useful in assessing bacterial and connective tissue diseases is creatine reactive protein (CRP) (Thompson *et al.,* 1992 & Sommer and Davidson, 2002). Furthermore, WHO/CDC recommends measurement of CRP together with the VA status indicators to assess VAD in areas of high inflammation burden such as in developing countries (WHO/CDC, 2004 & 2007).

Serum retinol concentration is commonly used as a biological indicator for vitamin A status (Sommer & West, 1996), but because of complications associated with its use (Engle-Stone *et al*., 2011) retinol binding protein (RBP) has been suggested as surrogate for measuring VA status. Retinol binding protein has certain advantages such as; being less costly and presumably more robust under field conditions such as exposure to light and heat. The primary carrier of retinol (ROH) in plasma is RBP. In developing countries, such as Kenya, accurate, affordable, and robust indicators of population VA status are essential for assessing need for and response to VA interventions. In an effort to better understand the relation between RBP and ROH for purposes of interpreting the results of VA status surveys using RBP and/or ROH, Thurnharn, (1997) found that RBP can be used in place of plasma ROH in population surveys. Analysis of plasma ROH in a subset of samples would increase the total study cost, however, in a large survey, the cost savings from the analysis of RBP would likely outweigh the cost of analyzing a small (e.g., 10%) subset of ROH samples. In this study, RBP was quantified with the use of the SCANLISA RBP Assay (Scimedx Corporation).

The SCIMEDX Corporation SCANLISA® Retinol Binding Protein (RBP) Assay is intended to quantify RBP in human serum as an aid to assess the Vitamin A status of a population in low-resource settings. RBP is a surrogate marker for retinol because of the close correspondence between retinol and RBP. A rapid and cost-effective quantitative enzyme-linked immunosorbent assay (ELISA) for detection of RBP has been developed. The RBP-EIA is an antigen competition assay that can detect and quantify RBP from human serum, which exists in a 1:1 ratio with retinol, making RBP an ideal surrogate marker. The test uses purified human RBP adsorbed to the microtest strip wells to compete with natural RBP found in serum. In order to determine a true VAD prevalence in western Kenya where this information is lacking among children 6-23 months, correction of inflammation using CRP was applied.

2.1.2. Geospatial distribution of VAD prevalence

Local geospatial unevenness in disease conditions including VAD which is often overlooked can influence the success of interventions in many ways. The physical location of a child can affect his/her health through several means. Macro-geospatial differences in mortality rates have been described involving African countries, as well as within regions within the same country (Mturi & Curtis 1995; Terra de Souza et al. 1999; Root, 1999, Central Bureau of Statistics (CBS) [Kenya] et al. 2004; Snow et al. 2004). The geospatial differences in child mortality in these studies have been attributed to national and regional differences in prevalence of diseases, such as malaria and HIV, and as well as socio-economic development. Geospatial differences in child mortality have also been shown, although this is not frequent, within smaller geographical areas (Binka et al. 1998; Sankoh *et al*. 2001; Becher *et al*. 2004; Kazembe *et al.* 2006). Addressing malnutrition such as VAD through integrated packages of nutrition-specific and nutrition-sensitive actions that focus on the first 1,000 days is one of WHO's global targets, endorsed by

the 65th World Health Assembly, as part of the post-2015 sustainable development agenda (WHO, 2012).

Studies by WHO (1995) have shown that occurrence of VAD tends to cluster rather than be evenly distributed possibly reflecting a convergence of several risk factors that precipitate VAD in the surrounding child population. Epidemiologic traits or risks that characterize these situations include economic, social, ecological, and host related factors, whereby a habitually deficient dietary intake of VA exists together with severe infections (Alvarez et al, 1995 &, Mitra et al, 1998). Clustering within countries at the macro-level is related partly to ecological factors and sometimes worsened by poorly developed infrastructures to distribute vitamin A-containing foods from overproduction to low production areas. The relative influence of some of these factors varies at various levels and will vary among countries, and even regions within countries. Since there are no documented studies in Kenya that have identified such clusters for targeted intervention, a large proportion of the children who are currently receiving VACs may have no evidence of lack of vitamin A, let alone deficiency, and also may be neither wasted nor stunted (Latham, 2010). With good amount of reservation, national and global projections may be made that could be inappropriately applied to local situations. Due to the low VACs coverage that is untargeted, it appears that the current vitamin A programmes are ineffective; may be consuming precious resources (human and material), obstructing other approaches to the prevention of vitamin A deficiency, that are best initiated at national and local level, where much support is needed. In order to develop interventions that are nutrition sensitive or specific as is currently recommended, there is a need to determine the geospatial distribution of VAD and factors that predict it. Local geospatial differences in VAD can be very useful in charting out several approaches that are sensitive and specific to improving child health for relevant

government ministries. This will support policy implementation and health workers to understand and design appropriate and effective intervention programs to change specific undesirable situations.

2.1.3. Socio-Demographic Characteristics and VAD Status

Vitamin A deficiency has long been a nutritional problem of public health significance in Kenya (Gitau, 1995, MoH/KEMRI, 2001 & MoPHS, 2008) and continues to be so even though the National Vitamin A supplementation Programme has been in operation for more than two decades. Although, the primary cause of vitamin A deficiency is inadequate Dietary consumption of vitamin A and/or suboptimal use of the nutrient in the body, a number of secondary (underlying & basic) factors contribute to insufficient Dietary intake of vitamin A. Inadequate production of vitamin A-rich foods, lack of income to purchase, unavailability of vitamin A-rich foods in markets, a large family size, high maternal parity levels, low level of maternal education, low levels of awareness of the importance of vitamin A, and illness are some secondary factors that are presumed to contribute to inadequate consumption of vitamin A in developing countries. A study in Madhya Pradesh, India found that Dietary intake of vitamin A, socio-economic status, caretakers' education level, and child age influenced level of VAD (Arlappa et al, 2011).

As the risk factors and determinants of vitamin A are context-specific (socioeconomic, cultural, environmental, etc.), variations in factors contributing to vitamin A deficiency exist among countries, regions, and localities, underlining the need to assess country/region/area-specific risk factors. In the context of western Kenya, this study has invested household size (number of family members), wealth index score, household head level of education, form of employment,

Sex of child, Age of child, Marital status of caretaker, Socio-economic status, Sub-county based location of a household & Main occupation.

Knowledge on such specific risk factors enables implementers and policy-makers to design and implement effective interventions. Unfortunately, studies relating to specific causes of VAD in Western Kenya are scarce, and hence, substantive information regarding factors contributing to vitamin A deficiency is lacking. The aim of this study was to partially fill the information gap on causes of vitamin A deficiency by providing information on some demographic and health-related risk factors.

2.1.4. Food intake, Nutritional status and VAD status

In resource-poor environments across the globe, low quality monotonous diets are the norm. When grain-or tuber-based staple foods dominate and diets lack vegetables, fruits, and animal-source foods, risk for a variety of vitamin A deficiencies is high. Those most likely to suffer from deficiencies include infants and young children. Depending on which risk factors that are related to feeding, these may include; child feeding practices, cultural practices & health conditions of the child. The primary cause of vitamin A deficiency is inadequate Dietary consumption of vitamin A and/or suboptimal use of the nutrient in the body. The complementary feeding period of 6–23 months is characterized by vulnerability to VAD and growth faltering. Important to this study is the target population of children aged 6-23 months, who are within the critical window of opportunity (first 1,000 days) where linear growth responds most to environmentally modifiable factors related to feeding, infections and psychosocial care (UNICEF-WHO-World Bank, 2014 & Black *et al* 2013). Improving the vitamin, A status of young children in developing countries reduces child death rates by 20– 50% (Beaton, et, al,

1993), which suggests that a substantial portion of their mortality is attributable to vitamin A deficiency. Considering that a large number of foods contain pro-vitamin A carotenoids, many of which are accessible and inexpensive even for the very poor, vitamin A deficiency is still a widespread worldwide problem, especially among young children. Children become vitamin A deficient because: *1*) their mothers are deficient and produce breast milk low in vitamin A. These mothers mainly in developing countries such as Kenya consume diets low in vitamin A and also experience high fertility with prolonged breast-feeding. During lactation, well-nourished women in developed countries transfer about 250 _mol (71,500 _g) of vitamin A [130 L of breast milk consumed (Chappell, et al. 1985 & Fomon, 1993) containing 1.92 _mol of vitamin A per liter (55 _g/dL) (Wallingford & Underwood (1986)], whereas women in developing countries transfer only about half that amount, because average milk vitamin A concentrations are about 1.05 _mol/L (30 _g/dL) (Wallingford & Underwood, 1986).

Introduction of complementary foods that are lower in vitamin A than the breast milk increases the child's risk of deficiency when breast-feeding stops. Children are given complementary diets that provide too little or no vitamin A. Between the ages of 6 and 24 months children experience highest expected growth, but they are also at the greatest risk of growth faltering due to poor complementary feeding practices and high susceptibility to infections, especially diarrhea (Black et al, 2008). If the growth of children is maintained at a higher level throughout this 6 to 24-month period, it is expected that not only short-term, but also long-term benefits for growth will be achieved. Dietary diversity is defined as the number of individual food items or food groups consumed over a given period of time (Ruel, 2003). At the household level, dietary diversity is usually considered as a measure of access to food, (e.g. of households' capacity to access costly

food groups), while at individual level it reflects dietary quality, mainly micronutrient adequacy of the diet. The reference period can vary, but is most often the previous day or week (FAO, 2011; WFP, 2009). Study of diets of children 6-23 months from ten sites in developing countries was undertaken to test the association between dietary diversity and mean micronutrient density adequacy of complementary foods. Significant positive correlations were observed in all age groups and in all countries except one (Working Group on Infant and Young Child Feeding Indicators, 2006*).*

In general, young children in industrialized countries receive most of their vitamin A from animal sources, whereas poor children in developing countries consume most of their vitamin A from the less expensive plant sources (West et al, 2002). For example, the median intake of retinol (preformed vitamin A in animal sources) by 1- to 3-y-old children in NHANES III (NHANES III, 2000) was 404μg/d, which exceeded their RDA of 300μg/d by 35%. In studies of preschool children in Egypt, Mexico, Kenya (Callowa et al, 1993), and India (Ramakrishnan et al, 1999) median intakes of animal sources of vitamin A were 174, 119, 50 and 33 μg/d, respectively, providing only 11–58% of the RDA and leaving these children largely dependent on plant sources.

Children in developing countries such as Kenya spend a substantial part of childhood being sick, where anorexia, malabsorption and increased catabolism further deteriorate their vitamin A status. Illness worsens vitamin A status primarily by reducing intake due to anorexia and malabsorption and increasing utilization through greater catabolism and urinary loss. Diarrhea particularly seems to result in reduced intake of non–breast-milk foods; intake of breast milk is

reduced to a lesser degree or not at all. It is probable that reductions in vitamin A intake during illness are similar to reductions in energy; however, primarily for children on introduced to complementary foods, vitamin A intake may be reduced proportionately more if milk, fruits and vegetables are particularly avoided during illness. Malabsorption of vitamin A can occur during diarrheal illness and lower respiratory infection (Sivakumar and Reddy, 1972). Increased catabolic losses are a result of the acute-phase response to infection, including fever and metabolic breakdown of muscle and adipose tissue (Beisel, 1972). Haskell et al. (1999) reported that the catabolic rate in rural Peruvian 12- to 24-mo-old children was 2.2%/day. Food intake, specifically dietary diversity and minimal acceptable diet is an indicator of VA status. This study therefore aims to establish whether the current feeding practices, nutritional status and illness have any influence on VA status of children aged 6-23 in Western Kenya.

2.1.5. Knowledge, Perceptions and VAD status

A key barrier to sustainable programming remains the lack of recognition of the need for VA nutrition. Although linkages with other interventions produce high coverage, minimum efforts have been made to effectively communicate the importance of vitamin A for child survival. Knowledge and perceptions, surveys have revealed this failing at various levels, from policy makers to caregivers. Unless this knowledge gap is addressed, a transition from a push-driven to a demand-driven intervention cannot be expected (Dalmiya, 2006). Successful vitamin A programmes require appropriately designed information, education and communication strategies. To ensure VA programs are accepted and adhered to by caregivers, it is necessary to ensure that the rationale for VA is explained, specific questions answered and clear instructions given (Hill, 2007). Ante Natal Clinics (ANC) act as a key entry-point for implementing nutrition such as vitamin A and health educational interventions that promote preventive health

behaviours to improve maternal and infant health through better knowledge, attitudes and practices. Studies conducted in Turkey, Pakistan and Laos provide evidence to support the role of ANC in improving health knowledge, attitudes and practices (KAP) among women who utilize the service (Ochako et al, 2011). In the implementation and evaluation of a community-based ANC education programme in Istanbul (Turan, 2003), women in the ANC education group were reported to be more likely to initiate breastfeeding within the first two hours after delivery, bring infants for check-up within seven days after birth and to implement family planning measures at three months after birth, compared to the control group. Similarly, in a cross-sectional survey in Islamabad, Pakistan, Alam and colleagues showed that women attending ANC clinics were more likely to recognize signs of a difficult pregnancy, to realize the importance of eating a healthy diet, and to indicate tetanus immunization uptake, compared to their non-attending counterparts (Ochako et al, 2011). And in rural Laos, women who had received ANC were more likely to utilize health services at delivery and had a greater mean knowledge score regarding obstetric care compared to the women who had not received any antenatal care (Turan, 2003).

Despite a 92% national average for at least one ANC visit in 2008, the maternal and infant mortality rate in Kenya remains at a high of 488 maternal deaths per 100,000 live births (KNBS, 2010). While this disparity may reflect challenges in feasibility and acceptability of the ANC package due to limited resources for materials and supplies, lack of training for service providers, and lack of clear policy direction (Birungi, 2006), it may also be an indication of gaps in service provision at the ANC clinics, particularly in educational components. As Nikiema et al. (2009) showed in a cross-country analysis of Demographic Health Survey data from 19 sub-Saharan countries, healthcare providers do not routinely provide women with information as part

of ANC or fail to provide information in a way that is remembered by women (Nikiéma,2009), which further impedes the efforts to improve health and nutrition knowledge including vitamin A among women.

In a cross-sectional survey of women in rural Kenya, van Eijk et al. (2006) found that 11% of the women, who attended ANC clinics prior to delivery, were receptive to the health information provided during their visits (van Eijk et al. 2006). In rural Nigeria women identified midwives and nurses as the major source of health information on maternal and child health during focus group discussions (Akin-Otiko, 2012). Recognizing the disparities in knowledge and perceptions of women regarding nutrition has important implications for assessing the impact of education interventions provided through ANC services.

Promotions of nutrition education, home/kitchen gardens and rearing of small livestock to improve VA intake are traditional interventions for VAD control and prevention. Indeed, the Kenyan Ministry of Health through its national food and nutrition security policy has recommended that more research is needed on the knowledge, attitudes and practices towards VAD control (GoK, 2012). The success of these control initiatives involving the community depend on the level of the communities' uptake of the program, which is hinged upon understanding community knowledge and practices towards VAD and recommended preventive and control measures. This study therefore assessed community awareness on existence, signs and symptoms, causes, control of VAD as well as attitudes, so as to identify knowledge gaps among health workers and caretakers/mothers, the findings of which will inform bridging of identified gaps in order to strengthen VAD control interventions at community level in Busia and Bungoma Counties of western Kenya.

2.2. Conceptual framework and Operational Framework

Potential predictors for VAD have been born out of the Conceptual frame work (UNICEF, 1992) (Fig. 2.1) and literature review. As immediate causes, Vitamin A deficiency results from inadequate dietary intake of VA to satisfy physiological needs and this may be exacerbated by high rates of infection, especially diarrhea and measles. Other factors that may result in VAD include underlying causes such as consumption of foods low in VA/VA-precursors, or poor bioavailability, or inadequate breast feeding, infrequent feeding and inappropriate foods or inadequate sanitation, unsafe water, lack of measles vaccination and lack of supplementation. Between the basic and underlying causes of VAD is an inter-phase of inadequate knowledge about VA and deficiency of VA rich foods.

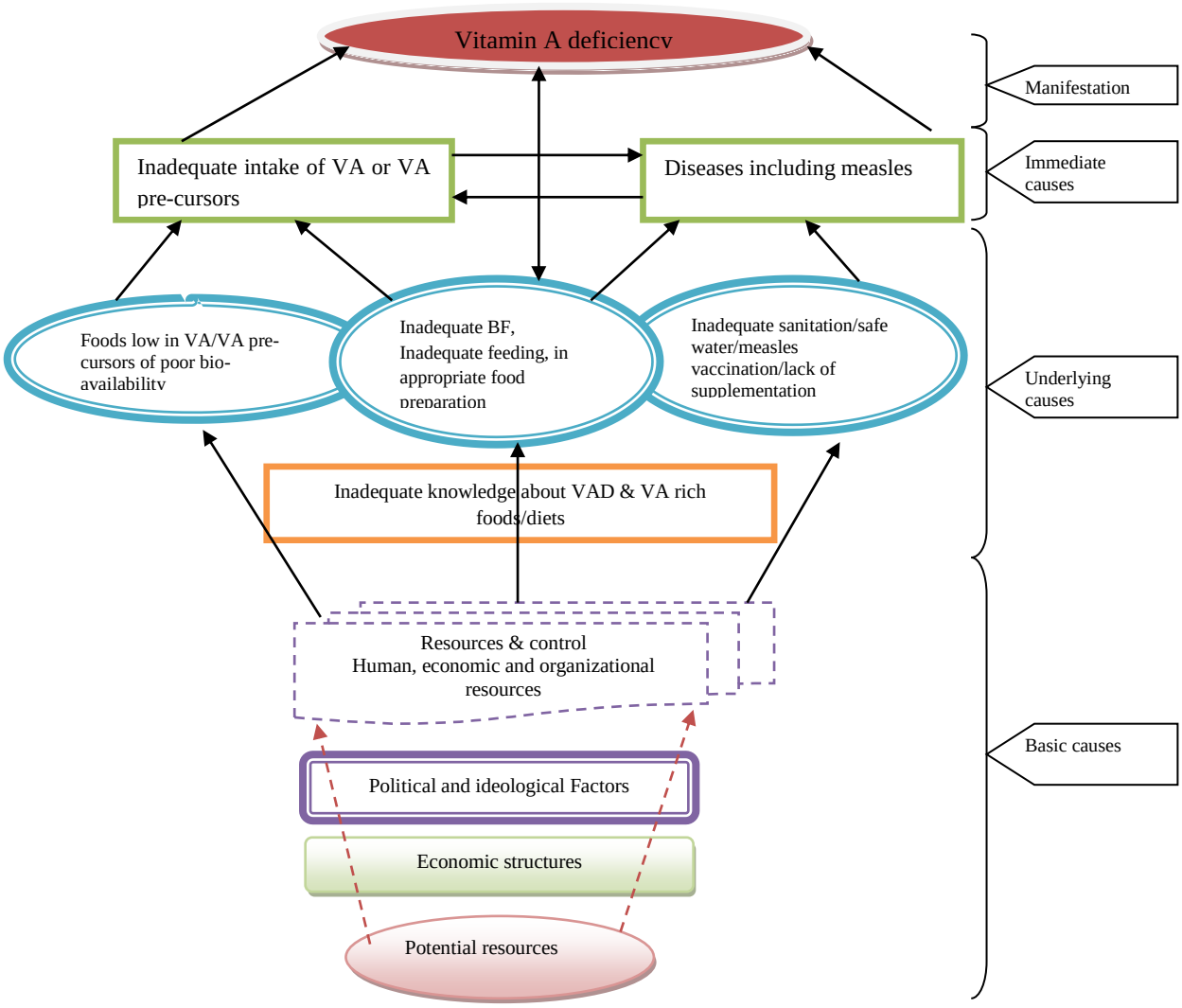

Figure 2.1: Vitamin A Deficiency Conceptual frame work (adopted from UNICEF, 1992)

This study has borrowed from the UNICEF framework to explore the possible predictors in the Vitamin A status among children with a focus on underlying causal factors. Based on existing, literature Vitamin A status outcome was proposed in two forms including Vitamin A status prevalence and geospatial distribution of Vitamin A deficiency within the study settings.

In this conceptual framework, the outcome of vitamin A status may be directly predicted by three domain factors namely food intake and nutritional status, socio-demographic factors and

knowledge and perceptions domains. In the food and nutrition domain a number of indicators seem to be critical. Aspects of IDDS and HDDS, frequency of VA consumption, nutritional status indices (stunting, wasting and underweight) seems to be critical. Socio-demographic factors such as household size (number of family members), wealth index score, household headship, level of education, form of employment, sex of child, age of child, marital status of caretaker, socio-economic status, sub-county based location of a household and main occupation.

Knowledge and perception domain focuses on caregiver knowledge about Vitamin A, health provider's knowledge about Vitamin A, caregiver perception about Vitamin A, health provider perception about Vitamin A and caregiver's knowledge about study area. In this new domain of scientific thinking, the study attempted to develop pre-classical theoretical proposition that borrows from the UNICEF**,** 1992 framework with a focus on nutrition specific associated factors. This relationship is expected to build a classical theoretical relationship (Fig. 2. 2).

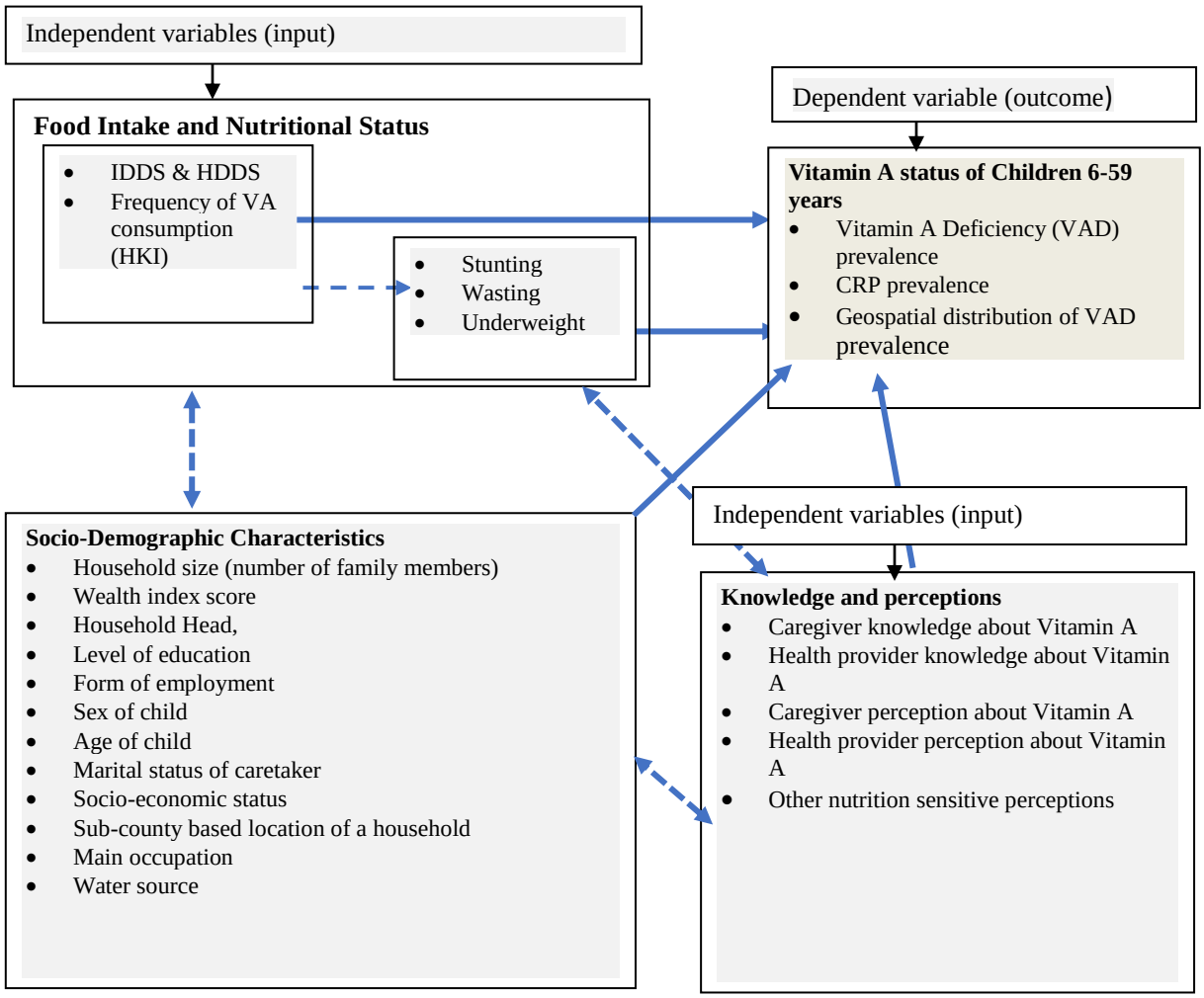

Figure 2.2: Conceptualization Framework for Potential Predictors of Child Vitamin A Deficiency (independent & dependent variables)

2.3. Gaps in Knowledge

Most research in Kenya has concentrated on determining vitamin A status in children 6-59 months using procedures that do not correct for inflammations. Most of these children (24-59 months) are already outside the 1,000-day period, a critical time and a unique window of opportunity to shape healthier and more prosperous futures for these children. The physical location of a child affects his/her health through several means. There is no documentation of accurate VA status and how the affected children (6-23 months) are distributed in Bungoma and Busia counties of western Kenya. This scenario does not support targeted action and investment to improve VA status for these children.

Accurate information on VA status and a child's physical location (spatial distribution) with regards to VAD is not adequate to enable effective interventions. Food intake (IDDS, HHDS, frequency of VA consumption) & nutritional status are important predictors of VA status. Furthermore, socio-demographic factors that could potentially influence VAD status need to be documented. Food intake and socio-demographic factors that influence VA status in children 6-23 months in western Kenya have not been documented in order to undertake effective and targeted interventions within the 1,000 days window of opportunity.

Despite many years of research and interventions, VAD scourge still persists particularly in western Kenya. The success of any intervention involving the community depend on the level of the communities' uptake of the program, which is hinged upon understanding community knowledge and perceptions towards such initiatives. There are no documented studies that specifically focus on VA and VAD with regard to clear knowledge and perceptions among mothers/caretakers and frontline health takers in western Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents the research methodology which includes study area, research design, target population, sampling frame, data collection methods, data analysis.

3.2. Study Setting

The study area comprised of selected Sub-Counties in Bungoma and Busia Counties of Western Kenya (formerly Western province). Farming is the main economic activity in the two counties. Bungoma is a sugarcane growing area, with one of the country's largest sugar factories, as well as numerous small-holder sugar mills. Maize is grown for subsistence, alongside pearl millet and sorghum. Dairy farming is also widely practiced, as well as poultry keeping. The area experiences high rainfall throughout the year, and is home to several large rivers, which are used for small-scale irrigation (GoK, 2009). The study sub-Counties included in the study in Bungoma were Kimilili, Bungoma North and Bungoma East.

Busia County Borders Lake Victoria to the South West, the republic of Uganda to the West, North and South East. The County constitutes seven constituencies namely Teso North, Teso South, Nambale, Matayos, Butula, Funyula and Budalangi. The study site was Bunyala sub-County which has an area of 306.5km^2, out of which 120km^2 is under permanent water surface of Lake Victoria. The County lies between Latitude 0° 1’36” South and 0° 33” North and Longitude 33°54’32” East and 34°25’24” East (App. VII). The main economic activity in larger Busia is trade with neighboring Uganda, with Busia town - the County Headquarters - being a cross-border center. Away from town, the County’s economy is heavily reliant on fishing and agriculture, with cassava, millet, sweet potatoes, beans, and maize being the principal food crops

(GoK, 2009). This area was chosen on the basis that they have been previously marked to have VAD and had health facilities where VAD interventions were being implemented.

The study was finally conducted within the catchment area of the selected health facilities based on certain criteria including number of service providers, antenatal clinics (ANC) attendance numbers, and population served), coverage with community health workers (CHWs) linked to community health units and location criteria.

3.3. Study Design

This study adopted an exploratory cross-sectional design with concurrent mixed methods design combining quantitative and qualitative methods. Quantitative methods included use of household questionnaires, laboratory analysis of blood samples and geospatial data collections methods and qualitative data. Major priority was given to quantitative aspects with less priority to qualitative. The latter was included in the final objectives and knowledge and perceptions in relation to Vitamin A status.

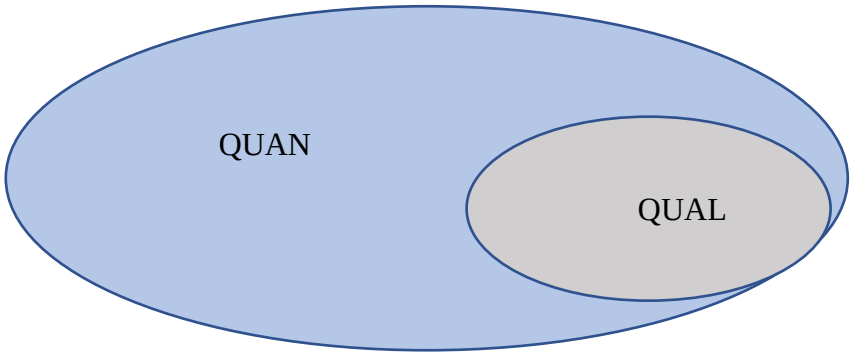

Figure 3.1: Cross-Sectional Study with Concurrent Nested Mixed Methods Quantitative Priority Approaches

3.4. Study Population

The total population was 232,256 in Bungoma and 129,895 in Busia Counties. According to the *Kenya Demographic and Health Survey (KDHS) 2009*, *the Kenyan Population Census 2009*, and

an exploratory investigation in the area, it was assumed and estimated that an average of 0.366 (approximately 0.183 assuming each County was to be treated as equal) children aged 6-23 months would be found in each household within the catchment area of the health facilities.

3.5. Sampling Methods

Sampling was done at two levels which included quantitative sampling and qualitative sampling techniques.

3.5.1. Quantitative Sampling Techniques

This initial stage of quantitative sampling was to determine an appropriate sample size based on sampling unit. In this an appropriate sample was determined based on Fisher's (1998) formula for sample size determination with inclusion of three sample size parameters:

(i) the estimated prevalence of VAD in the two counties,

(ii) the desired level of confidence and

(iii) the acceptable margin of error.

$$\frac{n = t^2 \times p\,(1-p) \times D}{m^2}$$

Description;

n= required sample size

t= Critical probability value for 95% confidence level (1.96)

p= estimated prevalence of VAD in Western Kenya (believed to be between 20-23%, hence p was taken as 43% or 0.43 (Gorstein *et al.*, 2007)

m= margin of error at 5% (standard value of 0.05)

D= Design Effect=2

Based on this formula, the required sample size for children in each county was:

$$n = \frac{(1.96)^2 \times .43\ (1-.43)}{0.05^2} \times 2$$

$$n = \frac{3.8416 \times 0.2451 \times 2}{0.0025}$$

n=376.6304X2=754 children per site

This was further computed by doubling the sample size of 754 to take into account the two study areas to get 1,508 children required for external validity. To account for 10% non-response rate, the sample size was adjusted by 2 factors raising the actual required sample size to 1,659 mother-child pairs. The final sample size was then distributed using population-proportion-to-size (PPS) with a simple random distribution within the selected districts in Western Kenya. This distribution is displayed in Table 3.1. The probability of getting a child per household was approximated 0.366 among the 4,880 households covered by the selected health facilities.

Table 3.1. Sampling distribution of households selected from the health facilities that met the criteria.

County	Sub-County	Population Reduced as per the number of health facilities included in the study (By approximation) (N)	Estimated Sample Size per pair	Actual sample Size distributed per pair (n)
Bungoma	Bungoma-North	2,955	1,082	**987**
	Bungoma-East	407	122	**136**
	Kimilili	1,063	319	**355**
	Total			
Busia	Bunyala	365	137	**152**
Total		**4,880**	**1,659**	**1,630**

3.5.2. Qualitative Sampling Techniques

Purposive sampling was applied to identify key informants (KIs) for the study (Sandelowsky, 2000; Teddlie & Yu, 2006). This sampling technique was based on homogeneity strategy where KIIs who offer services at MCH clinics were interviewed. Eight (8) KIIs (Key Informant

Interviews) were conducted until saturation. Likewise, homogenous groups of mothers were also involved in four (4) focus group discussions (FGDs) while eight (8) FGDs (4 in Busia and 4 in Bungoma) each comprising 10–12 individuals were conducted based on a criterion that included two groups (pregnant and lactating mothers) so as to minimize bias of chance. The number of FGDs met the saturation threshold of information.

3.5.3. Validity and Reliability of qualitative data collection tool

The study applied methods for establishing validity and reliability of research findings by designing and incorporating methodological strategies to ensure the 'trustworthiness' of the findings. These included; accounting for personal biases (researcher own perceptions, dislike for certain responses, and subjective views) which could have influenced findings as suggested by Morse, (2002). The study acknowledged biases in sampling and ongoing critical reflection of methods to ensure sufficient depth and relevance of data collection and analysis as recommended by (Sandelowski, 1993). Furthermore, meticulous note taking, demonstrating a clear decision trail (what participants decide consistently) and ensuring interpretations of data are consistent and transparent was done. A comparison was established for seeking out similarities and differences across accounts to ensure different perspectives are represented, including rich and thick verbatim descriptions of participants' accounts to support findings.

Quality Assurance and Instruments Pretesting

Quantitative data collection instrument

After a thorough recruitment process and training, potential enumerators visited selected households for a practice in a nearby village. They practiced household listing, filling out the form, and taking GPS information. Based on their performance during the listing exercise, enumerators were selected to undergo further training and act as interviewers and anthropometry

measurers for data collection. Training of laboratory technicians was done including a field test in a nearby health facility. The survey tools and procedures were adapted after the trainings and pre-tests.

Qualitative data collection instrument

In the qualitative survey tools were developed and pretested in different health facilities where the main interview was not done. These pretest facilities had similar characteristics as those where the actual qualitative survey was carried out

3.6. Data Collection Instruments and Variables

These included interviewers administered questionnaires, anthropometric measurements, blood sampling collection, KII guides and FGD guides.

3.6.1. Household Survey Questionnaire variables

This section had interviewer administered surveys and anthropometric measurement

Interviewer administered Survey: This included statement of agreement to participate in the survey, information on sub-counties, Division, Location, sub-location, village, household identification; status of HH Head, contact information, name of selected woman with child of correct age (6-23mo), and taking of GPS coordinates.

Demographics of household members: This included information on sex of HH, whether currently enrolled in formal schooling, level of formal school completed, marital status and type of union, current agricultural activities and whether this is the primary activity, whether they were involved in agri-business, any salaried employment or self-employment. This also included

name, sex, date of birth; age (months), whether the child has a health card, mother and father's name.

Household level dietary diversity and young child diet diversity: This section included information on ***food groups*** such as Grains, roots and tubers, Legumes and nuts, Dairy products (milk, yogurt, and cheese), Flesh foods (meat, fish, poultry and liver/organ meats), Eggs, Vitamin-A rich fruits and vegetables, and Other fruits and vegetables. Each food group was quoted as 0 if not consumed during the past 24 h and 1 if consumed. The dietary diversity index was obtained by summing up the quotes for the 7 food groups. The possible range of the dietary diversity index was from 0 to 7. The cut-off of at least 4 of the above 7 food groups was used to define minimum dietary diversity (FAO, 2011).

Health and nutrition practices: This variable sought to collect information on the use of health care services after delivery (VA supplementation) and morbidity in the household.

Consumption of vitamin A rich foods during past 7 days- FFQ: The study used the Hellen Keller International (HKI-7-day recall) food frequency method to assess the community risk of Vitamin A deficiency (HKI, 1993). Before the implementation of the questionnaire the HKI food table was adjusted to fit with the local requirement/conditions and the total number of the foods included recorded. A food frequency method counts how often certain foods are eaten over a period of 7 days. Though the method is not as accurate as other techniques it can be used to predict whether or not a nutritional deficiency is a public health problem in the population. To calculate the score, we added all the number of days the child or the mother consumed VA rich food that comes from animal source. Then add the number of days the child or mother consumed VA rich food item that comes from a plant source. The consumption of the food items from plant

sources was divided by 6. For the weighted consumption, the total number of days the child or mother consumed VA rich food item and the adjusted consumption from the plant source was add. The community is considered to have VAD problem if: the mean frequency of consumption of animal sources of vitamin A is 4 days per week or less; or the mean frequency of total consumption of animal and plant sources of vitamin A (weighted by the food sources) is 6 days per week or less.

Household assets & their characteristics including water sourcing: The respondents were expected to give information about whether they own certain assets that are either usable or repairable for use. They were also expected to give an approximation of their value. Information on sources of water, toilet, materials for house construction, sources of energy for cooking and lighting were sought. These have been used for wealth index analysis.

Anthropometric measurements: Anthropometric data included weight and height collected to compute three indices-namely, length-for-age weight-for-length and weight-for-age, of which age and sex was taken into consideration.

3.6.2. Qualitative Instruments

Focus Group Discussion guide administered to pre and post natal mothers with children 6-23 months

This tool sought to understand mothers' understanding of VA and VAD, foods consumed frequently by pre and post natal mothers, fed to babies from 6-23 months, mothers' understanding of a balanced diet, importance of having a balanced diet during and after pregnancy, food availability in the community, consequences of not having a balanced diet after

delivery, difficulty in seeing at night, importance of vitamin A, signs of VAD main factors contributing to VAD (Appendix IIA).

Key Informant Interview guide administered to the KIIs at the MCH Clinic

This tool sought to understand KIIs understanding of VA and VAD, signs of VAD in pregnant/lactating mothers and children (6-23 months), whether there were pregnant mothers having difficulty seeing at night and whether they came from particularly areas of the community, their understanding of causes of VAD in the community, how these problems could be solved, if there were other nutritional problems in the community and the causes, and if these were specific to certain areas (Appendix IIB).

3.7. Data Collection Process and Procedures

Data collection procedures covered two aspects of the study design which included both quantitative and qualitative approaches.

3.7.1. Quantitative Data Collection Processes

This covered household listing, household survey process, and blood sample collection process. These processes are described in the subsequent section.

Listing of households: This encompassed enumerating households in randomly selected villages in the larger Bungoma and Busia Counties, and identifying households with eligible participants for the cross-sectional survey. It also included informed consent, referral section for women and identification of potential locations for the set of further activities. The initial activities included:

i. *Identification of a village guide:* The village guide was an individual with a good working knowledge of surrounding villages. He/she assisted enumerators to locate all

households within a cluster as well as identification of village elders and logistical information.

ii. *Enumeration of all households in the selected clusters:* One of the main activities carried out was household enumeration followed by household selection. Every household was numbered.

iii. *Identification of eligible households and consent seeking from potential participant:* To make efficient use of limited time, consent to participate in the interview, undergo anthropometric measurement and provide a blood sample was obtained during this phase after household selection. Enumerators obtained consent from selected households willing to participate in the study.

iv. *Distribution of referral form:* Once consent was obtained, the enumerator issued a referral form to the participant indicating the date, time and location of interview, anthropometric measurement and blood sampling. The activities took place at health facilities, schools, churches and other selected venues. After consent, the participants were interviewed within a period of not more than 2 months. The enumerators were careful not to include children who were more than the required age at the survey time. Participants were compensated at Ksh.100 for transport.

a) Household Survey process: The quantitative component involved community based cross-sectional surveys conducted in selected districts in Bungoma and Busia Counties of western Kenya. After appropriate sensitization, population within the catchment area of selected health facilities offering antenatal care was included in the study based on eligibility criteria. A survey was conducted to gather data on demographic information, prevalence of vitamin A the nutritional status of the population-6-23 months. Geo-

coordinates of compounds were collected and used to mark the village boundaries and the specific locations of the households with children 6-23 months. Anthropometric weight measurements were obtained using Calibrated SECA® electronic UNISCALE. Height measurements were carried out using a measuring board. All children were measured lying down (recumbent length) on the board. Each child's length was measured twice to the nearest 0.1 cm and measurements and repeated if there was a deviation of > ± 0.5 cm. Weight were measured to the nearest 0.1g using digital Seca Model 881 Scale. Children wore light clothes to avoid errors created by the extra weight of the clothes. The weighing scales were adjusted to read zero before taking the measurements.

b) ***Blood sample collection process:*** A technician, specifically trained in collection of blood samples obtained a finger prick sample of blood from children between 6 and 23 months of age that were -stored on filter paper. For this dried blood spots (DBS) collection, the child's hand was first warmed by rubbing the palms together. Then the finger was cleaned with 70% alcohol and pierced with a sterile lancet. The first drop of blood was wiped with sterile gauze and the subsequent drops were spotted on a filter paper to make five circles on each filter paper labeled with participant identification number. The filter papers were dried for two to three hours in plastic boxes closed air tight and covered with black paper to prevent any potential photo oxidation of the sample. After the spots were completely dried, the filter papers were placed in zipper-locked polythene bags along with silica gel. Individual bags were placed in a polythene bag and sent within the following week to the laboratory to be stored in deep freezers at KEMRI (< –20°C) until analysis.

In order to validate DBS as a sample matrix for RBP and CRP it was first recognized that use of the RBP values from dried blood spots require that correction factors be generated to account for how the filter paper matrix affects the extraction of RBP from the filter paper and, what effect, if any the matrix has on the amount of RBP that can be measured from the filter paper. This is because the reference sample is serum and the DBS methodology is based on a serum-based assay. We needed to know if the amount of RBP in the filter paper is comparable to the same amount of RBP in a similar volume of serum obtained from capillary blood collected in tubes. In order to answer this question, we first have to know what is the 'true' amount of RBP in the serum from the capillary sample and then compare this with the amount of serum we approximate to be in the DBS sample (blood in the disk is eluted in a buffer and RBP is measured in the eluate). To accomplish this paired capillary and DBS samples were obtained from a subsample of children participating in the survey. Fifty matching serum and DBS samples were used to validate DBS as a sample matrix for quantitative analysis of RBP and CRP respectively. Serum was diluted 1:25 for both RBP and CRP analysis, while DBS samples were eluted as previously reported for RBP and CRP. Matching DBS eluate and diluted serum were loaded onto the same microwell plates for RBP and CRP, respectively, in order to exclude potential variations arising from the use of different calibration curves when matching samples are analyzed on separate plates and were analyzed as previously reported for RBP and CRP. The validation experiment demonstrated that the correlation between RBP and CRP values of matching serum and DBS analyzed on the same microwell plate was excellent. The relationship between serum and DBS RBP and CRP respectively, was used to obtain factors to correct DBS RBP and CRP values to serum RBP and CRP values, respectively. Serum values were divided by

their matching DBS values to obtain a set of correction factors. The median of these correction factors was then applied to all DBS for RBP and CRP, respectively. The validation data is summarized in Table 3.2.

Table 3.2. Validation of dried blood spot as a sample matrix for RBP and CRP

	RBP	CRP
Correlation between serum and DBS	0.85	0.93
Mean serum (95% CI)	1.09 (0.95-1.24 μmol/L	2.19 (1.37-3.01) mg/L
Mean unadjusted DBS (95% CI)	0.74 (0.63-0.85) μmol/L	0.88 (0.57-1.19) mg/L
Correction factor	1.439	2.363
Mean adjusted DBS (95% CI)	1.06 (0.90-1.22) μmol/L	1.34-2.81) mg/L

Retinol Binding Protein (RBP) was quantified with the use of the SCANLISA RBP Assay (Scimedx Corporation). All reagents, with the exception of deionized water, were provided as part of the assay kit. The assay uses purified human RBP adsorbed to microtest strip wells to compete with natural RBP found in serum. The inter-assay and intra-assay precision of the assay is 8.9% and 6.7%, respectively and the quantitation limit is 7.7 μg/mL RBP (Scimex Corporation). To perform the assay, one ¼ -inch punch was taken from the center of one DBS (two punches from two dried blood spots for assay in duplicate) into the appropriate deep microwell, and 150 μL of sample diluent (300 μL for duplicate assay) was added. Each ¼ -inch punch contains approximately 6.1 μL of serum, thus giving a 1:25 dilution. Samples were vortexed for 20 seconds, centrifuged at 5,000 g for 2 minutes, and left to elute at 4° to 8°C for 18 to 20 hours. The next day, the samples and reagents were removed from the refrigerator and allowed to attain room temperature before analysis. The samples, calibrators, and controls were vortexed for 20 seconds and centrifuged at 5,000 g for 2 minutes, then 100 μL each of DBS dried blood spot eluate, calibrators, and controls were added to the appropriate individual test wells following a plate map. A monoclonal anti-RBP antibody conjugated to horseradish peroxidase was immediately added. The test

was incubated at room temperature for 15 minutes and then washed with buffer. Enzyme substrate was added, followed by 10 minutes of incubation, and the reaction was stopped with acid. The test was read immediately at 405 nm using a microplate reader (Molecular Devices, Spectra-max Plus 384). The results were calculated on the basis of the best-fit log-log calibration curve for each plate with the use of SoftMax Pro software. Results were expressed as ug/mL of RBP.

c) Creatine-Reactive Protein (CRP) was quantified with the use of the high sensitivity CRP Elisa kit (Immuno-Biological Laboratories, Inc., Cat.: IB59136). All reagents, with the exception of deionized water, were provided as part of the assay kit. The assay uses a monoclonal antibody specific for CRP adsorbed to microtest strip wells and another monoclonal antibody specific for a different region of CRP is conjugated to horse radish peroxidase (HRP). The inter-assay variation is 7.8- 9.9% and the intra-assay variation ranges from 5-15.2%. The quantitation limit is 10 ng/mL of CRP (Immuno-Biological Laboratories Inc 2010). To perform the assay, one ¼ -inch punch was taken from the center of one DBS into the appropriate deep microwell, and 150 µL of Calibrator A (contains 0 ng/mL CRP) was added. Each ¼ -inch punch contains approximately 6.1 µL of serum, thus giving a 1:25 dilution. Samples were vortexed for 20 seconds, centrifuged at 5,000 g for 2 minutes, and left to elute at 4° to 8°C for 18 to 20 hours. The next day, the samples and reagents were removed from the refrigerator and allowed to attain room temperature before analysis. The samples were vortexed for 20 seconds and centrifuged at 5,000 g for 2 minutes, then 20 µL each of DBS eluate, calibrators, and controls were added to the appropriate individual test wells following a plate map. 200 µL of assay buffer added to each well using a multi-channel pipette and the plate was incubated at room temperature on

a plate shaker rotating at 200rpm. The plates were washed 3 times with wash buffer. A monoclonal anti-CRP antibody conjugated to horseradish peroxidase was immediately added. The plates were incubated at room temperature for 15 minutes on a plate shaker rotating at 200 rpm and then washed with wash buffer. Enzyme substrate was added, followed by 20 minutes of incubation, and the reaction was stopped with acid. The test was read immediately at 405 nm using a microplate reader (Molecular Devices, Spectra-max Plus 384). The results were calculated using a 4-parameter logistic calibration curve for each plate with the use of SoftMax Pro software. Results were expressed as mg/L of CRP.

3.7.2. The Qualitative Data Collection Process

A Socio-demographic profile questionnaire was administered to all the participants to characteristic them. Qualitative data were collected through FDGs and key informant interviews (KIIs). The KIIs on VAD and its control were conducted with frontline health workers at health facilities. The officer in-charge assisted in mobilizing the women at the health facility and worked with a community health worker to mobilize women at the community. The KIIs were conducted before the FGDs in order to get views of frontline health workers about VA and VAD which would facilitate focused questions to understand the feelings of the pregnant and lactating mothers, thus both were used to complement each other. The data was collected by trained Kenya Medical Research Institute (KEMRI) personnel using both audio recorders and field notes. Interviews addressed knowledge, attitudes and perceptions on VA, VAD and other nutritional problems. Key informants were informed of the intention to use tape recorders (Appendix II B).

The FGDs were conducted with pregnant and lactating mothers to gauge their awareness on existence, signs and symptoms, causes, control of VAD as well as attitudes towards VAD. The participants were screened for eligibility before the discussion commenced to avoid selection bias. The criteria were that one must have lived in the study area for more than six months, be an adult and able to articulate their speech bearing in mind the representation from all the sub-units. The FGDs lasted one and half hours and the KIIs took about one hour. The KIIs were conducted with one in-charge from each Health facility (Appendix II A).

3.8. Measurement of variables

3.8.1. Dependent variables

a) *Vitamin A deficiency*: RBP as used in the measurement of vitamin A status determine the threshold for VAD levels. For influence of inflammation, values were adjusted using CRP (CRP >5 mg/L cut-off) and population prevalence of VAD (RBP <0.83µmol/L, biologically equivalent to 0.70µmol/L cut-off) were estimated. Vitamin A status was classified as follows:

    i. <0.70 µmol/L versus ≥ 0.70 µmol/L-WHO serum threshold level of VAD (WHO, 2009)

    ii. below 0.35 µmol/l versus ≥ 0.35 µmol/l-severe VAD (WHO, 2009 & Awashthi, et al, 2013)

b) *Geospatial Distribution of VAD:* To demonstrate geospatial mapping of VA deficient households within selected study sites, arc GIS software was used to develop maps showing the geo spatial distributions. The geographic positioning system (GPS) coordinates variables such as Longitude, Altitude and Latitude were collected using GPS devices and used to develop the maps. The maps were linked to the nutritional data collected at the household

level. Different colors were used to describe vitamin A deficient areas stratified by the levels of deficiency. Possible clustering of vitamin A deficient households by geographical locations was described to indicate any patterns.

3.8.2. Independent variables

a. *Child Nutritional status*- Mean z-scores (Weight-for-height, length-for-age and weight-for-age) using the WHO standards were generated using the EPI info nutritional software and the score was used to classify nutritional status into four groups i.e. stunting, wasting, underweight and normal. Mean z-scores (Weight-for-height, length-for-age and weight-for-age) using the WHO standards were generated using the EPI info nutritional software and the scores were used to classify nutritional status into four groups i.e. stunting (length-for-age z-scores (LAZ <-2SD)), wasting (<-2SD weight -for-height z-scores (WLZ<-2SD)), underweight; (weight-for-age z-score (WAZ<-2SD)) and normal.

b. *Young child feeding practices*- Diet diversity index score-HDDS & frequency of VA consumption). These are continuous variables that were categorized and analyzed with the following cut-offs i) HDDS: - Scale 0-7, IDDS: - scale 0-7 (0 to 4 Low, 4 to 7 moderate & 7 & above-high. Diet diversity index score-HDDS & frequency of VA consumption). These are continuous variables that were categorized and analyzed with the following cut-offs i) HDDS: - Scale 0-7, IDDS: - scale 0-7

c. *Children Characteristics*-Age (Age categories were generated by first running frequencies to identify their distribution). Sex (Male/ female)-This was generated through questionnaires. Age (6-11 months, 12-17 & 18-23 months) and Sex (Male/ Female) were critical measures.

d. *Demographic and socio-economic factors-*

i. Household size-categories were generated by first running frequencies to identify their distribution. These were then categorized accordingly.

ii. Age of HH head - categories were generated by first running frequencies to identify their distribution. These were then categorized accordingly.

iii. Marital status: Married monogamous, married polygamous, single, other- categories were generated by first running frequencies to identify their distribution. These were then categorized accordingly.

iv. Wealth index (Wealth index score was categorized into quintiles from 1st quintile for the poorest to 5th quintile the richest household)

v. Level of education of HH (none, primary, secondary, college and graduate) - categories was generated by first running frequencies to identify their distribution. These were then categorized accordingly.

vi. Form of employment of HH: Salaried, casual worker, informal business, livestock production, self-employment- categories were generated by first running frequencies to identify their distribution. These were then categorized accordingly.

Knowledge about VA: This investigation sought to understand participants' *knowledge* about the kinds of foods the respondents eat when pregnant and when breast feeding. Information about their opinion on what makes a child grow whether they have heard of VA, why VA is important, examples of sources of VA, and listing of the 3 key food groups was collected.

Perceptions about VA and VAD: A comparison was made through FGDs and KII to qualitatively gauge what the community perceived about VA and VAD. The participants were asked whether they were knowledgeable about VA or VAD, whether there were any local name(s) and

existence as well as signs and symptoms of VAD. This investigation sought to get a deeper understanding of what the community thought about VA and VAD.

3.9. Data Analysis Process

Data were planned to be analyzed at two levels which included both quantitative and qualitative domains. These are described in the subsequent sections.

3.9.1. Quantitative Data

Quantitative data were manipulated using the Statistical Package for Social Sciences statistical software package version 19.0 for Windows (SPSS Inc., Chicago IL, USA). Normal distribution of quantitative data was tested using normal distribution curve. Two-sample proportion z-test (Insilco soft ware) was used for child characteristics (age & gender), prevalence of VAD between sub-counties, and nutritional status of children (stunted & wasted). Pearson's $\chi 2$ test was used to compare knowledge scores of caretakers by individual and household characteristic and determine predictors for VAD in the multivariate analysis. First, a bivariate analysis was carried out to identify potential predictors for the main study outcome.

Descriptive statistics such means, median and frequency distribution was used. Continuous variables were tested for normality by plotting histograms and where they followed a normal distribution, student t-test was used to compare means and where they were not normally distributed, Mann–Whitney's test to compare the medians was used. Continuous variable is RBP as used in the measurement of VA status.

The criteria for selection of potential predictors was to eliminate variables whose risk estimate based on odds crude ratio were insignificant ($p>0.05$). A multivariate logistic regression analysis

was then used to test the association between potential predictors. The study explored underlying spatial patterns formed by vitamin A deficiency (VAD) in Busia and Bungoma counties.

Spatial Analysis was conducted in a GIS environment using Arc GIS 10.1 as the main analysis software. ArcGIS was used in the creation and manipulation of GIS datasets. Exploratory Spatial Data Analysis (ESDA) was conducted to discern the hidden patterns in the spatial data before running OLSR models. Spatial Regression Analysis and Model estimations were carried out in Geoda (Anselin 2003, 2005). Best Linear Unbiased Estimator Model (BLUE) was developed in Geoda based on Contiguity Weight Matrix created from the Vonoroi Tessellation Maps. Vonoroi maps were developed from sampled measurements of VAD from household in Bungoma and Busia counties. Through the tessellated polygons, the study created a weight matrix file based on rook weights as the most appropriate neighbors based on polygon adjacency. No islands were expected in the process. Modeling of the regression equation was done based on the Maximum Likelihood Criterion as well as further tests based on the Langrangian Multiplier where the Spatial Lag and Spatial Error Models were tested on best predictors of VAD. A number of independent spatial potential predictors of VAD were explored. To assess the quality of the model on the independent variables, regression diagnostics tests were examined at 95% significance level. Test of Normality of the Residuals and Errors, Tests of Multicollinearity as well as test of Homoscadisciticity/ Heteroscadisticity was conducted. Other regression tests of Spatial Autocorrelation (SA) were conducted and results visualized using the Local Indicators of Spatial Association (LISA) Maps. The study examined Global and Local Moran's Index as a measure of similarity & dissimilarity in observations against their distances of separation in geographical space of Bungoma and Busia Counties. As a result, variety of spatial maps was developed as visualizations of the level of clustering of VAD in the region. The results of the

model were then generalized to the entire region that could be used to develop a strategy to alleviate VAD.

A three stage-process to investigate associations between the above potential predictors and main study outcome was used.

1. The first step was bi-variate analysis where each factor was compared to outcome variable using Pearson chi-square test. Results with p-value> 0.05 were included in the regression analysis. The crude odds ratios are reported at this stage.
2. The second step was backward selection criteria. This involved adding all potential variables with p-value> 0.05 in the logistic regression analysis.
3. The last step was to select predictor variables with *p* values <0.05 considered as predictors of vitamin A deficiency. Adjusted Odds ratio and 95% confidence intervals are reported. At this stage, the confounders were detected and controlled for.

3.9.2. Qualitative Data

Qualitative data was analyzed pre-thematically using *framework analysis* and manipulated using ATLAS. *ti* qualitative data analysis software (Ritchie & Spencer 1994). The process of data analysis began during data collection, by *skillfully facilitating* the discussion from FGDs/KII, complementing them with observational notes and typing the recorded information. This stage was followed by *familiarization* with data, achieved by listening to voice records, reading the transcripts several times and reading the observational notes taken during interviews and summary notes written immediately after the interview. The third stage, *indexing,* comprised of sifting of the data, highlighting and sorting out quotes and making comparisons both within and

between cases. The fourth stage, named charting, involved lifting quotes from their original context and re-arranging them under the newly developed appropriate thematic content.

3.10. Ethical Considerations

Privacy, Protection and Confidentiality of Data: Blood data was analyzed for groups and no individual response was identifiable. This was done at KEMRI/CDC malaria laboratory in Kisian, Kisumu. Survey forms and DBS were archived and accessible to only research team for at least five years.

Potential Harm/Risk and Benefit: It was not expected any risk by participating in the study. Blood sampling consisted of a finger prick to allow collection of about 5 drops of blood on filter paper. It was expected that there may be some discomfort associated with the finger prick. However, there was no side effect expected. The specimen collection was carried out by well-trained, experienced laboratory technicians. All participants were given a flat rate of 100 KSh to contribute to their travel costs to and from interview site. Although the results of the child's blood test while in the field were not available, it was checked whether or not the child had received a vitamin A capsule during the past six months on his/her health card. If the card indicated that no capsule had been received or if there was no health Card available, the mother was given a piece of paper referring the child to the nearest health facility for vitamin A capsule. Although participants did not benefit directly from participating in the study, their participation was expected to make a major contribution to the information known about the vitamin A status, risk factors associated with VAD and the predictors important for proper intervention in this area.

Informed Consent and Assent: The women/caregivers were informed on the purpose and procedures of the survey, risk and constraints due to participation, strict confidentiality of the personal data, possibility to refuse the consent without having to justify the refusal and the lack of interference with usual health care provision. There was one consent form: for the mother-child pair (mothers with children 6-23 months old) that specifically described what procedures to be performed on the child and obtain consent from a guardian of the child. A signed informed consent was obtained by the enumerator from the women, with parental or guardian assent for the child, before including the household and members in the survey. If a male household head was present, he was asked to sign as well although technically this was not required.

Approval by ethical review boards (ERBs): The protocol, questionnaire available in English but where a respondent had difficulty understanding English, a translation was done in Kiswahili and Luyhia. Consent forms available in English, Kiswahili and Luyhia, were sent to the ethical review board (ERB-KEMRI/CDC) for approval. A further approval was sought from Local administration from both larger Bungoma and Busia Counties.

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CHAPTER FOUR

RESULTS

4.1. Introduction

The key results of the study are presented as follows: Prevalence of adjusted vitamin A deficiency, malnutrition among children 6-23 months, demographic and spatial predictors of VAD and their distribution among children 6-23 months, and the perceptions of frontline nutritionists on VAD.

4.1.1.VAD prevalence among children 6-23 months

The determination of VAD prevalence among children 6-23 months in Bungoma and Busia counties of western Kenya is undertaken. This has been done using low levels of retinol binding protein (RBP) that is RBP value of 0.825 µmol/L which is biologically equivalent to 0.7µmol/L of retinol (Gorstein et al, 2008). Sub-clinical inflammation was determined by higher levels of CRP i.e. if the CRP levels are greater than 0.5 *mg/L*. Overall VAD in the study area was 20.06% while the elevated C-reactive protein (CRP) was 18.1% (Fig. 4.1).

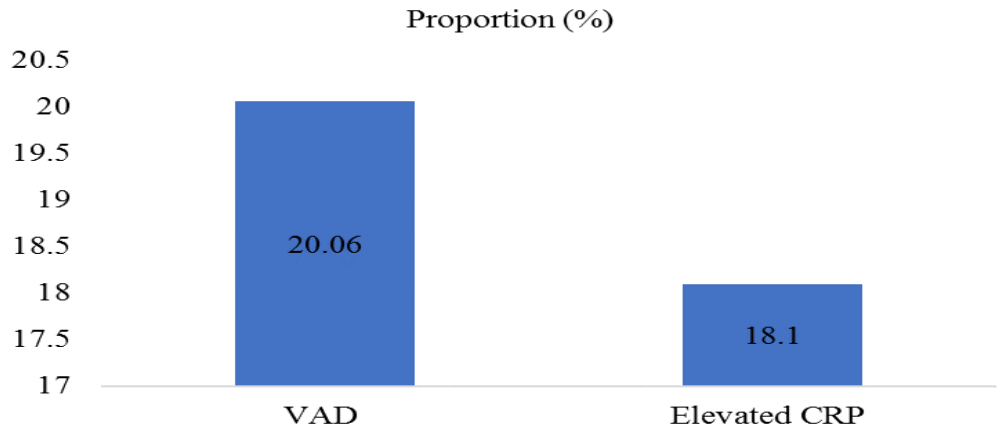

Figure 4.1: Overall prevalence of VAD and elevated CRP for children 6-23 months in Busia and Bungoma

Analysis by sub-County showed that the prevalence of VAD was highest in Bunyala (30.3% n=120), followed by Bungoma North (20.7%, n=924), Kimilili (17.8% n=325), and Bungoma East (10.3% n=113). A comparison of proportional differences in the sub-Counties, revealed that Bungoma North had a significantly higher VAD prevalence than Bungoma East (z=2.63, CI=0.03-0.18, p=0.001) while Bunyala had a significantly higher prevalence than Bungoma North (z=2.40, CI=0.02-0.17, p=0.017), Bungoma East (z=3.77, CI=0.01-3.04, p=0.002) and Kimilili (z=2.86, CI=0.04-0.2, p=0.004). The mean (geometric± SD) level of RBP was however adequate in this population (1.56±0.79μmol/L) and the level (geometric mean) of CRP was within normal range (1.06±4.95 *mg/L*). Bunyala also had the highest (29.0%) prevalence of sub-clinical inflammation as indicated by elevated CRP (>5 *mg/L*) among the four sub-Counties with Bungoma North having the least prevalence (15.3%). However, further comparison of the different prevalence between sub-Counties revealed that Bungoma East had a significantly higher prevalence of sub-clinical inflammation compared to Bungoma North (z=1.96, CI=0.00-0.09, p=0.005), while Bunyala had a significantly higher prevalence of sub-clinical inflammation compared to Bungoma North (z=3.77, CI=0.066-0.21, p=0.000) while the rest did not significantly differ (Table 4.1).

Table 4.1. Distribution of children by VAD prevalence and elevated CRP in Busia and Bungoma

	sub-County							
Indicator	**Bungoma North (924)**		**Bungoma East (113)**		**Kimilili (325)**		**Bunyala (Busia) (120)**	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
VAD	191	20.7	12	10.3	58	17.8	36	30.3
CRP > 5*mg/L*	141	15.3	24	21.3	65	20.0	35	29.0

There is statistical difference p<0.05); 2- proportion z-test; 95%CI. RBP <0.825 μmol/L which is biologically equivalent to 0.7 μmol/L of retinol; VAD values have been adjusted for the influence of sub-clinical inflammation (CRP ≤ 5mg/L).

4.1.2. Geospatial distribution of VAD prevalence

Geospatial distribution of VAD in children aged 6-23 months in Bungoma and Busia counties of western Kenya is undertaken. This is demonstrated in Fig. 4.2a & b. The categories have been generated using the WHO (1996) cut-off points, where in Bungoma County, among the selected sub-locations VAD was distributed as follows; Kibisi (39.8%), Kabuyefwe (33.3%), Soysambu (23.1%), Sitabicha (22.7%), and Mbakalo (19.7%) had VAD prevalence of > 20% which is considered as severe, Tongaren (19.4%), Mituwa (18.6%, Makhonge (17.9%), Nabikoto (17.6%) Ndalu (17.0%), Sirakaru (16.9%), Milima (12.1%) and Mihuu (9.5%) had VAD prevalence of between 10-19% which is considered as moderate, while only three sub-locations; Magemo (8.6%), Naitiri (6.6%) and Mitukuyu (5.4%) had VAD prevalence of between 2-9% which is considered as mild (Fig.4.2a).

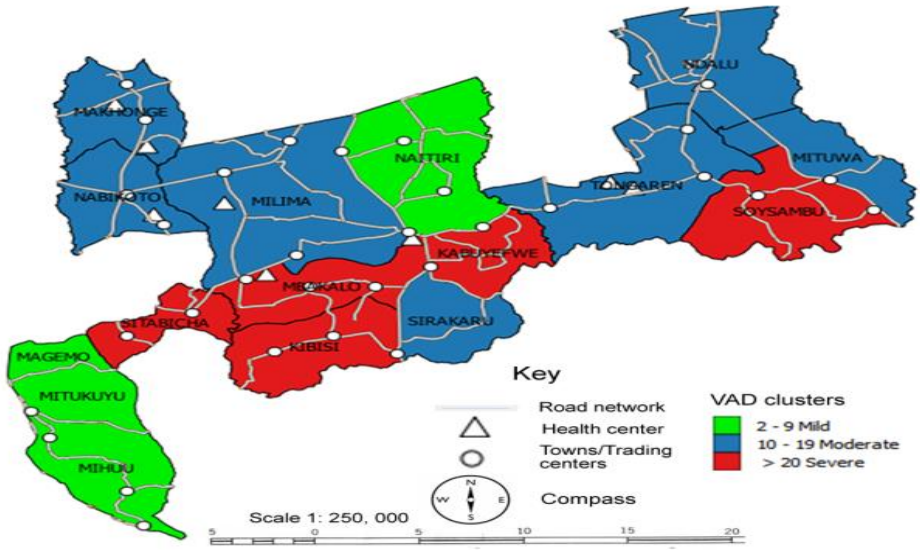

Figure 4.2 (a): Geospatial Distribution of VAD Prevalence among Children in Bungoma County (Source: Author)

In Busia County five out of six selected sub-locations had VAD prevalence of > 20% i.e. Magombe West (55.6%), Magombe Central (40.0%), Ruambwa (29.0%), Budalangi (25.6%), Mudembi (25.0%), which is considered as severe while only one sub-location i.e. Magombe East

(12.5%) had a VAD prevalence of between 10-19% considered as moderate, and there was no category with mild VAD.

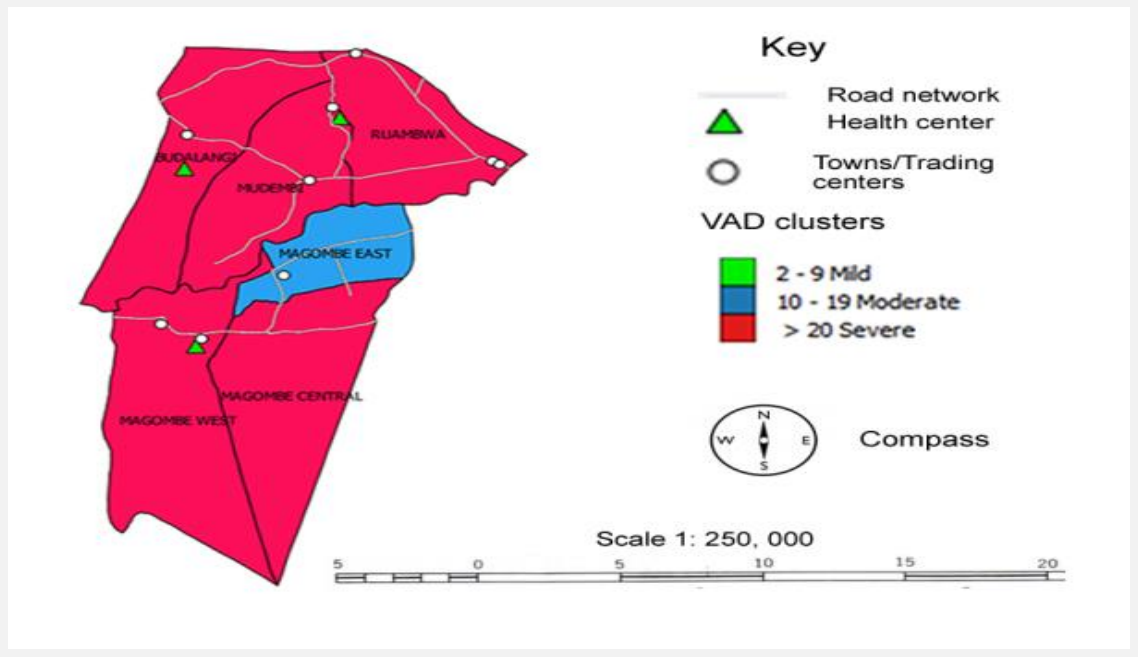

Figure 4.2(b): Geospatial distribution of VAD prevalence among children in Busia County (Source: Author)

Frequency histograms for Bungoma and Busia revealed that VAD distribution is not normally distributed in both sites (Fig.4.3a&b).In order to investigate the non-normality of the data, interpolation with a kurtosis of 3 is recommended. However, in this case kurtosis was equal to 5.27 with a mean VAD of 27.59 and standard deviation 12.92 (Fig. 4.3 a & b).

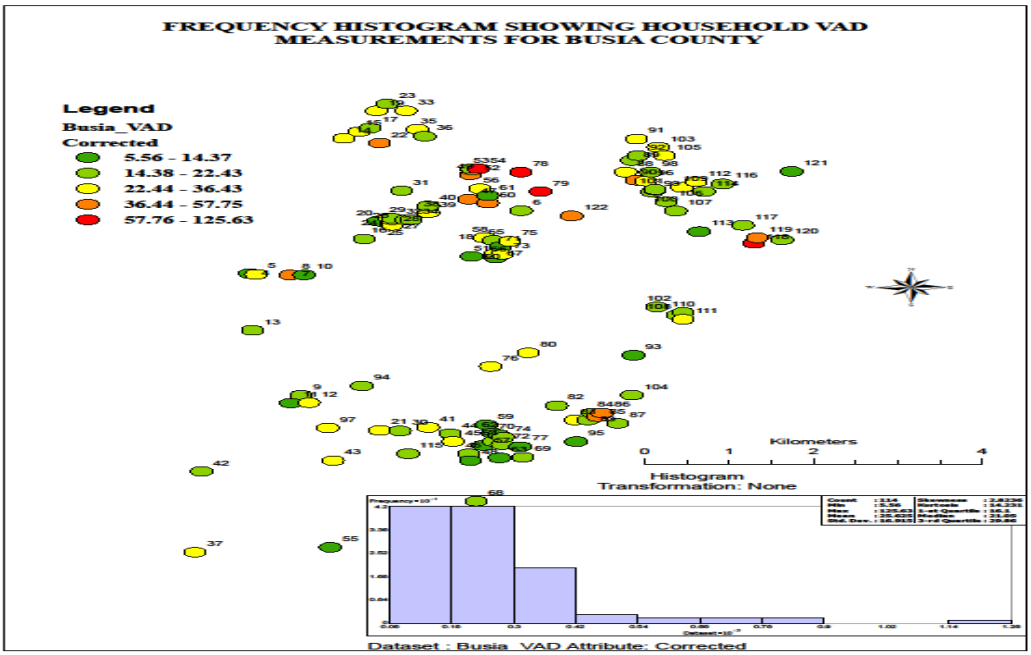

Figure 4.3(a): Frequency Histogram of VAD Levels by Households, Busia County

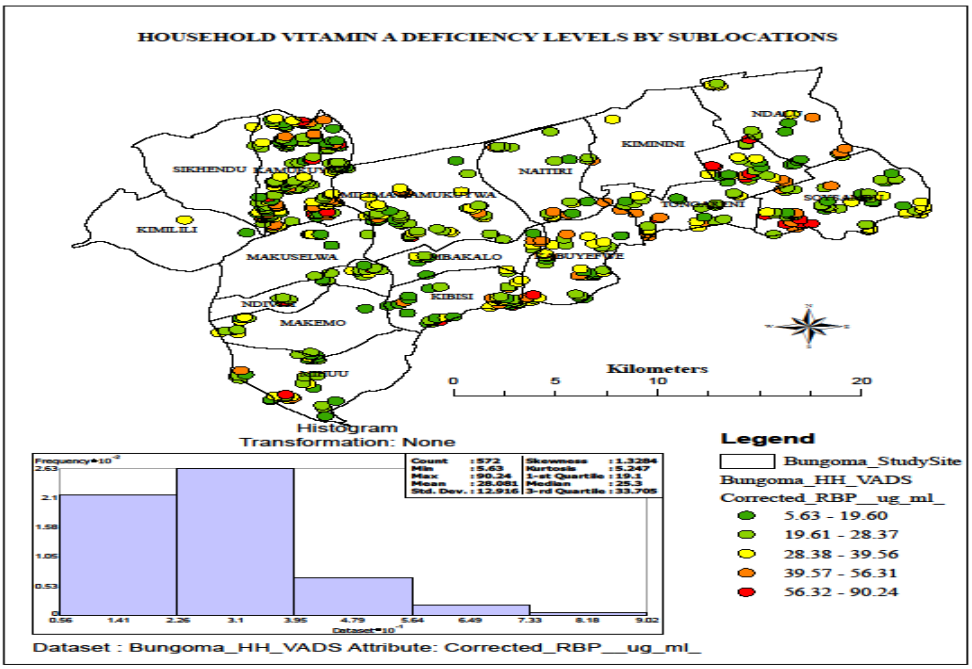

Figure 4.3(b): Frequency Histogram of VAD Levels by Households, Bungoma County

To confirm non-normality in the data distribution, and to further undertake interpolation surface through Kriging, a graphical plot of the quartiles was done using Q-Q plot. The graphical plots indicate that at lower quartiles a significant number of households deviate from the normality line. The situation is true of a similar number of households at upper quartiles (Fig. 4.4a & b). The medium or 50th percentile falls below the normality curve which further clarifies that the distribution of the data is not perfectly Gaussian for both Busia and Bungoma Counties.

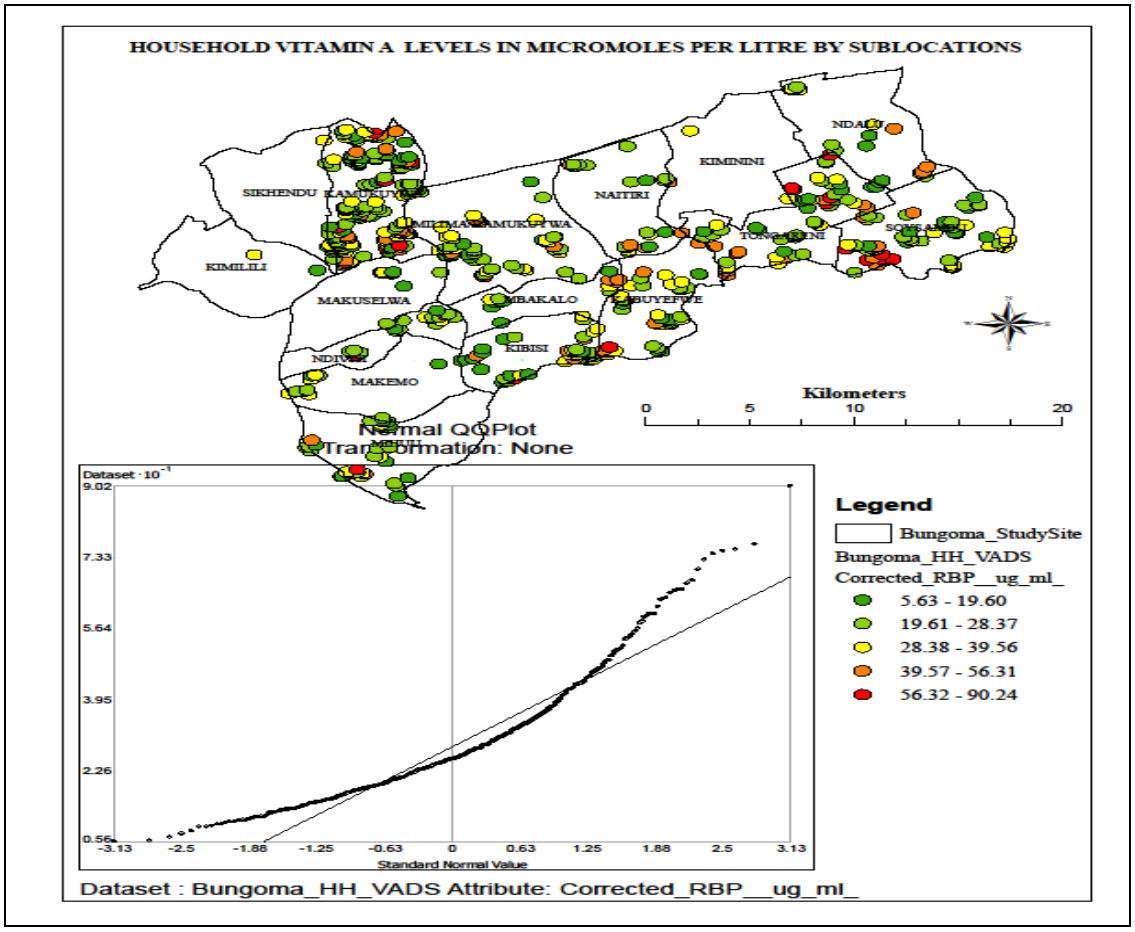

Figure 4.4 (a): Q-Q Plots for VAD Levels by Household, Bungoma County

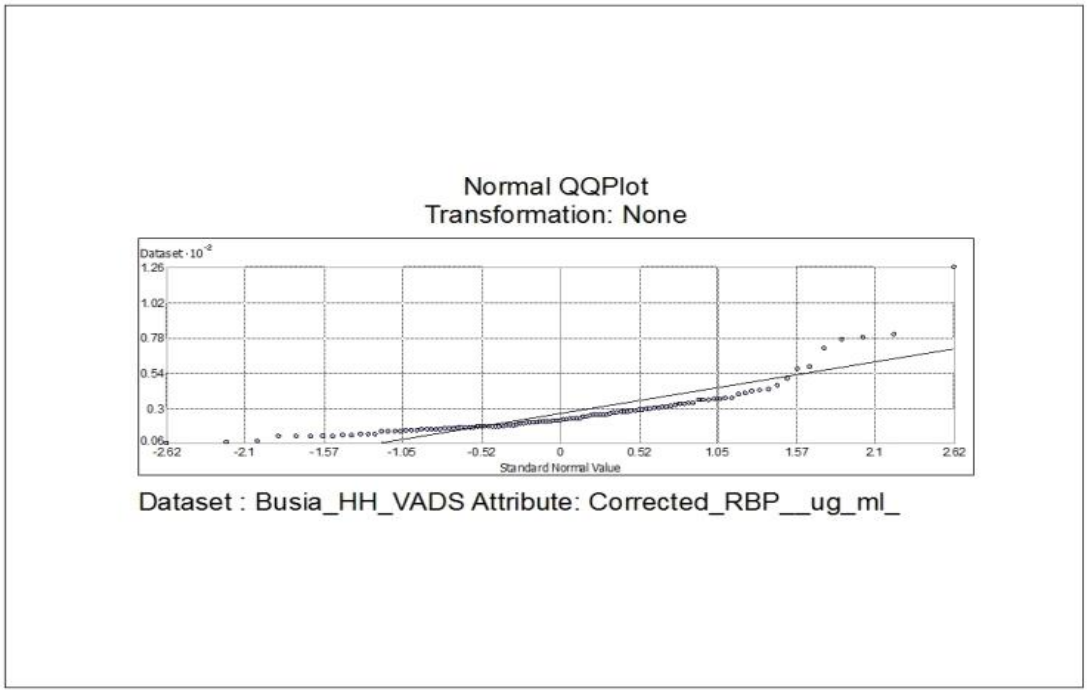

Figure 4.4 (b): Q-Q Plots for VAD Levels by Household, Busia Counties

Data would have been considered randomly distributed if majority of the household VAD measurements fell alongside the straight line, this however, was not the case and is suggestive of some level of clustering (Fig. 4.4 a & b). Further examination of the data contravened Waldo Tobbler's first law of Geography which states that everything is related to everything else and closer things tend to be more alike unlike far things (Tobler, 1970). In this case, household VADs were similar and also varied across the four (4) sub-locations where the study was done i.e. there would be households in Bunyala with similar VAD levels as for example in Kimilili but would also have certain households differ in the same counties. This confirms the existence of Spatial Auto Correlation (SAC). The SAC was further examined in details using Local Indicators of Spatial Association (LISA) as well as the Global Moran's index (MI) which are tested with the assumptions of Complete Spatial Randomness (CSR).

Empirical Bayesian Kriging (EBK) which performs interpolation based on locally repetitive simulations was used for the creation of predictive as well as a standard error surface (maps) based on the VAD measurements. The dependent variable, i.e. VAD was treated as a regionalized variable that would be used in an interpolation process to help estimate VAD levels at household not visited during the survey.

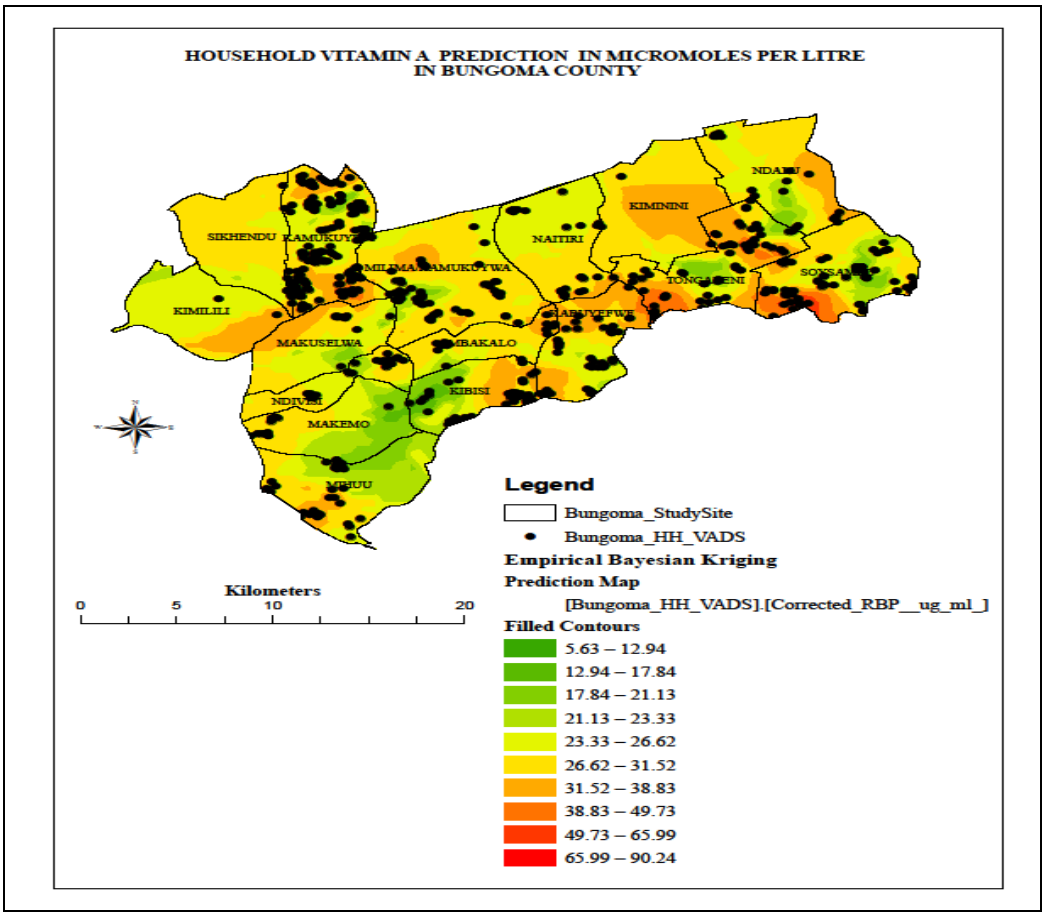

Figure 4.5 (a): Prediction Surface, Bungoma County

Prediction surface (Fig. 4.5a) indicated by color gradient in the entire study area shows Bungoma as likely high significant VAD area. The surface areas showing different shades of red colors are high VAD zones while those with green represent low values of VAD.

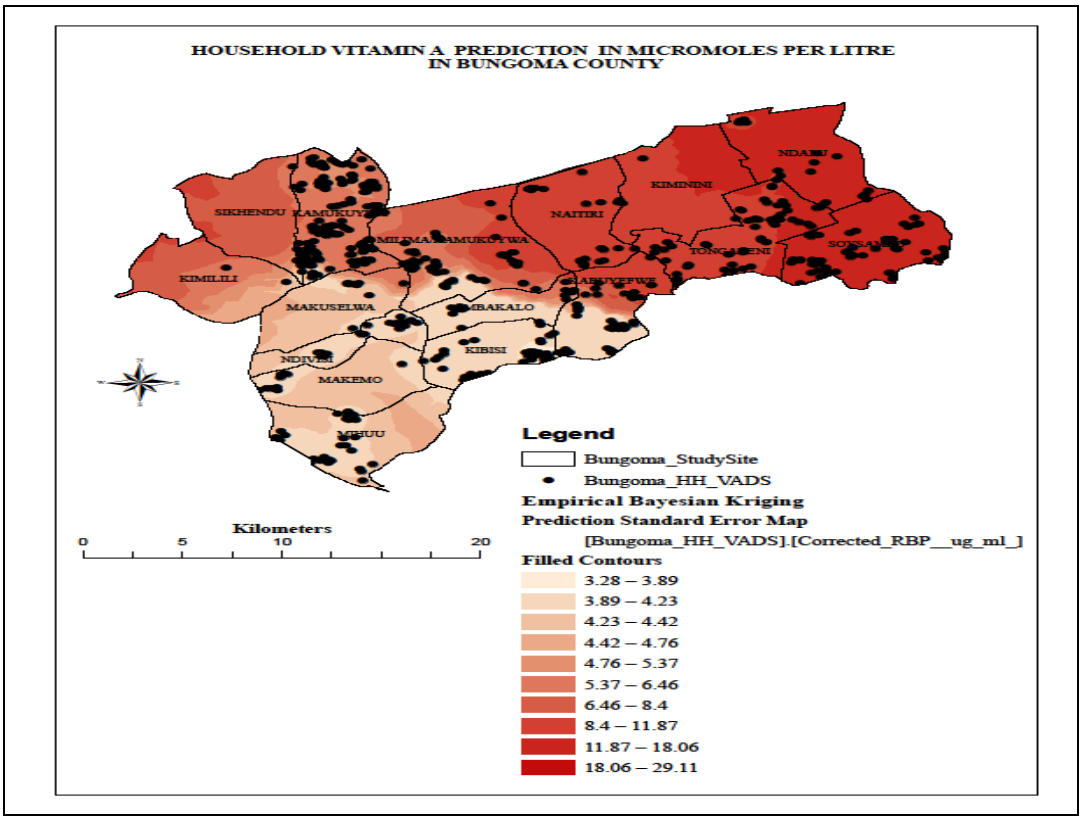

Figure 4.5(b): Standard Error Surface, Bungoma County

For every estimate of the predicted surface values, a similar and corresponding error map was created to assist in quantifying the power of the prediction model. The Standard Error Surface (SES) exemplifies that the top upper right (North Eastern) region of Bungoma (Fig. 4.5b) has high levels of error associated with measurements. In terms of prediction, the distinct colors i.e. red and green are closer to the accurate figures of VAD as compared to the lighter shades.

Prediction surface indicated by color gradient in the study area generalizes Busia as a likely significant high VAD prevalence area. The values of VAD are highest in areas with deep orange colors as indicated in arrow (a) (Bunyala North-Sisenye, Mundere and Budalangi) and decreases towards the light orange colors defined as moderate VAD indicated by arrow (b) (Bunyala west,

most of Magombe). The colors marked blue to light green (c) (Bunyala South-Bukala, Ebuluani and Obaro) have been categorized as with mild VAD (Fig. 4.6a).

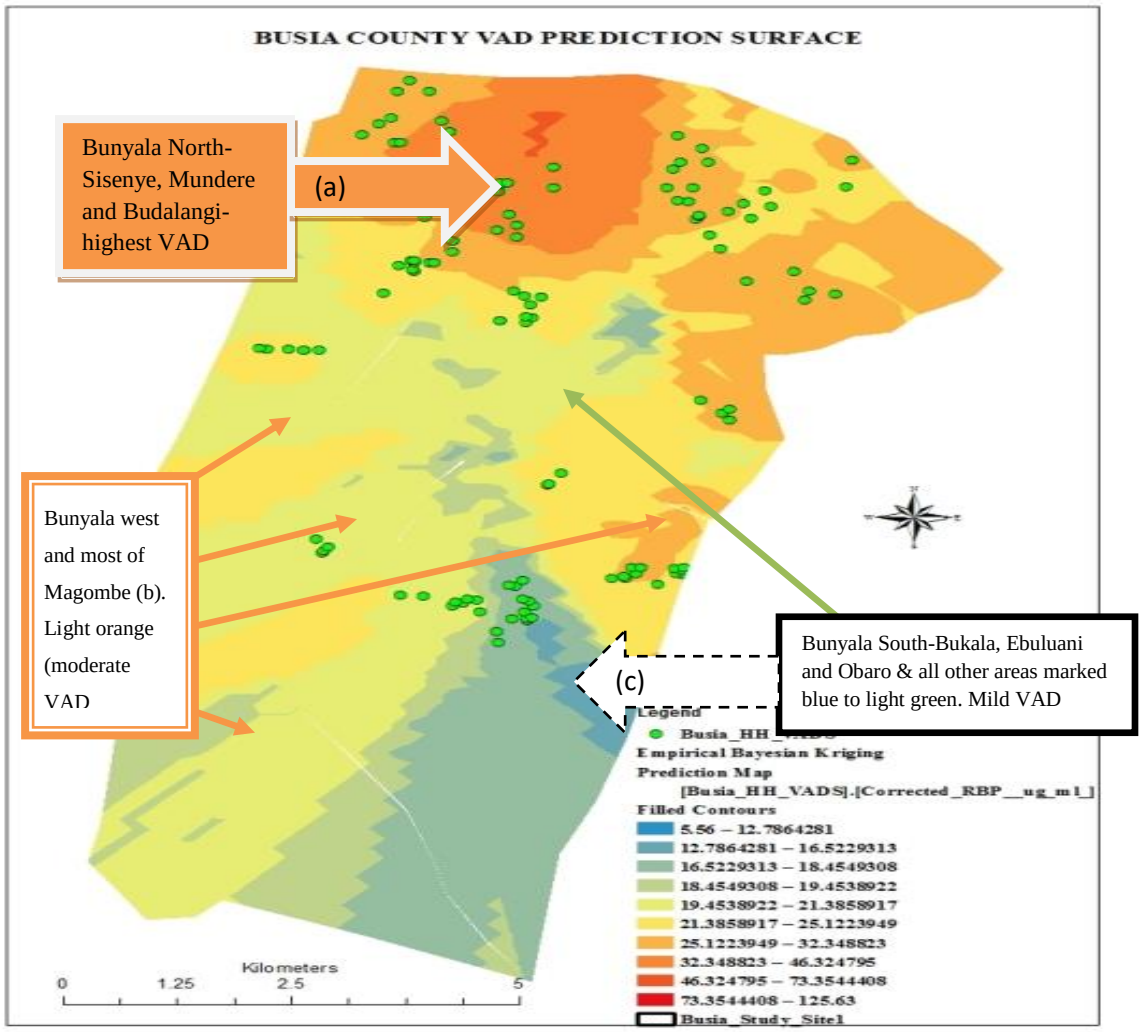

Figure 4.6 (a): Prediction Surface, Busia County

Similarly, a corresponding error map was created to assist in quantifying the power of the prediction model.

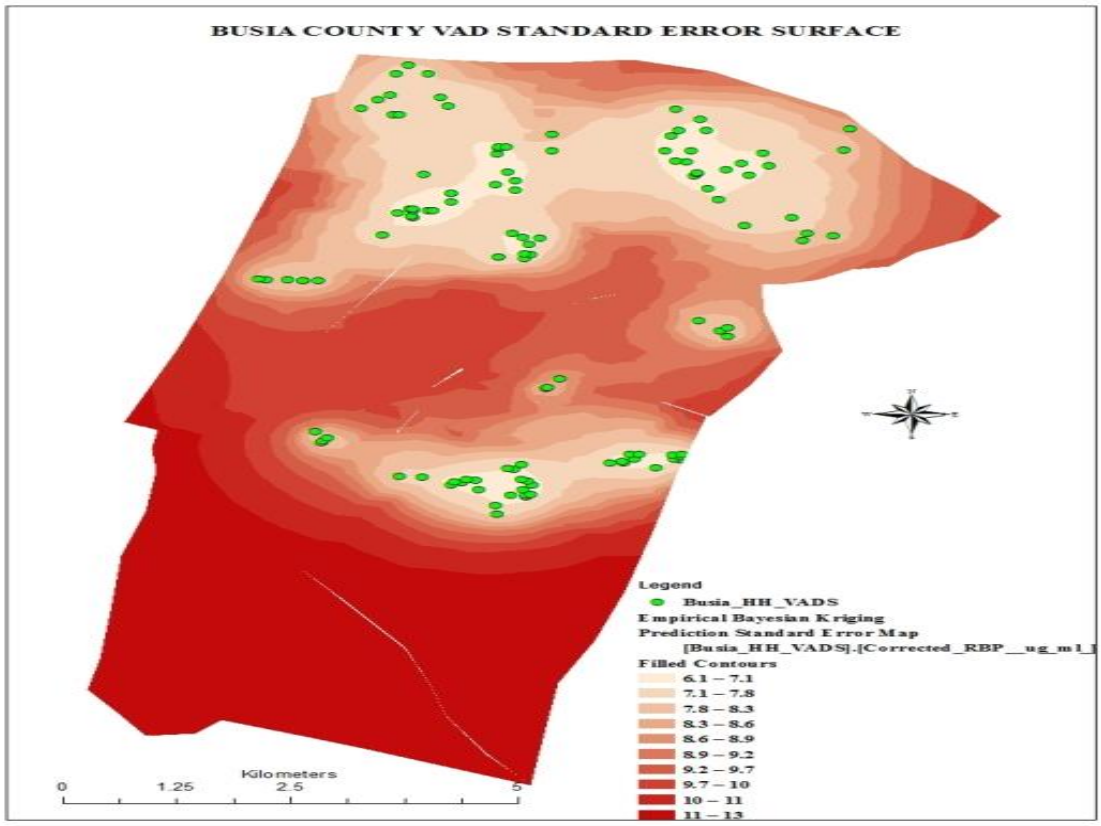

Figure 4.6 (b): Standard Error Surface, Busia County

The Standard Error Surface (SES) shows that the top upper right (North Eastern) region of Busia (Fig. 4.6b) has high levels of error associated with measurements. In terms of surface prediction, the distinct colors i.e. dark to light red are closer to accurate VAD levels compared to the lighter shades appearing as light grey to white (Fig. 4.6b). Spatial analysis generated from further investigations using the Household VAD levels and the Voronoi Maps in both Counties are presented in the next section.

4.1.3. Spatial Analysis of VAD in Busia County

A visualization of descriptive exploratory data analysis of the percentile distribution in maps of the VAD prevalence in Busia sampled areas indicates that 10 cases occur in the first 10%, 46 cases occur in the next 40%, 46 cases in the next 46% (90^{th} percentile) while only 11 cases falls

in the last 10%. The distribution indicates a Gaussian distribution in the data points. The figure indicates that there are high and low values as well as dominance of the median values across the geographical space in Busia (Fig.4.7).

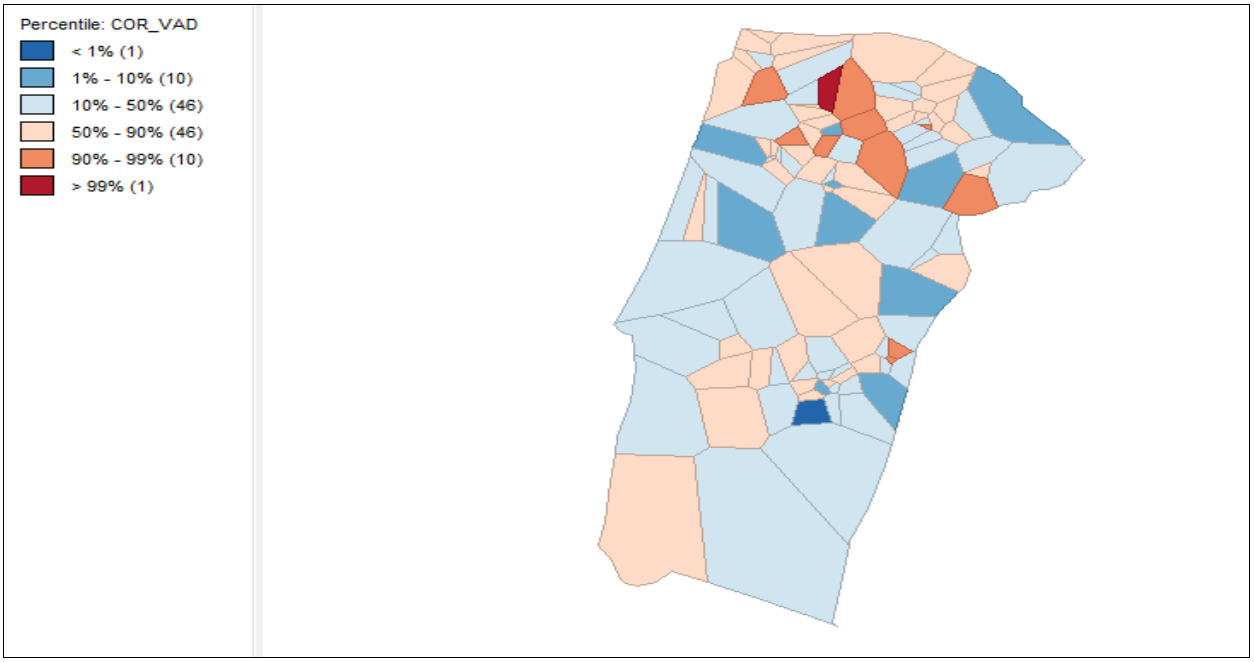

Figure 4.7: Percentile distribution of VAD, BPusia County

This kind of visualization is important in understanding the randomness in space because it is the assumption on which spatial autocorrelation is based. Similarly, variations that exist by geographical space as a measurement of VAD was examined hence the standard deviation map of Busia County. Only three (3) cases fell between -8.52 & 8.52 while the rest of the cases were between 8.52 & 59.7. The mean was highly affected by high values necessitating an investigation (Fig. 4.8).

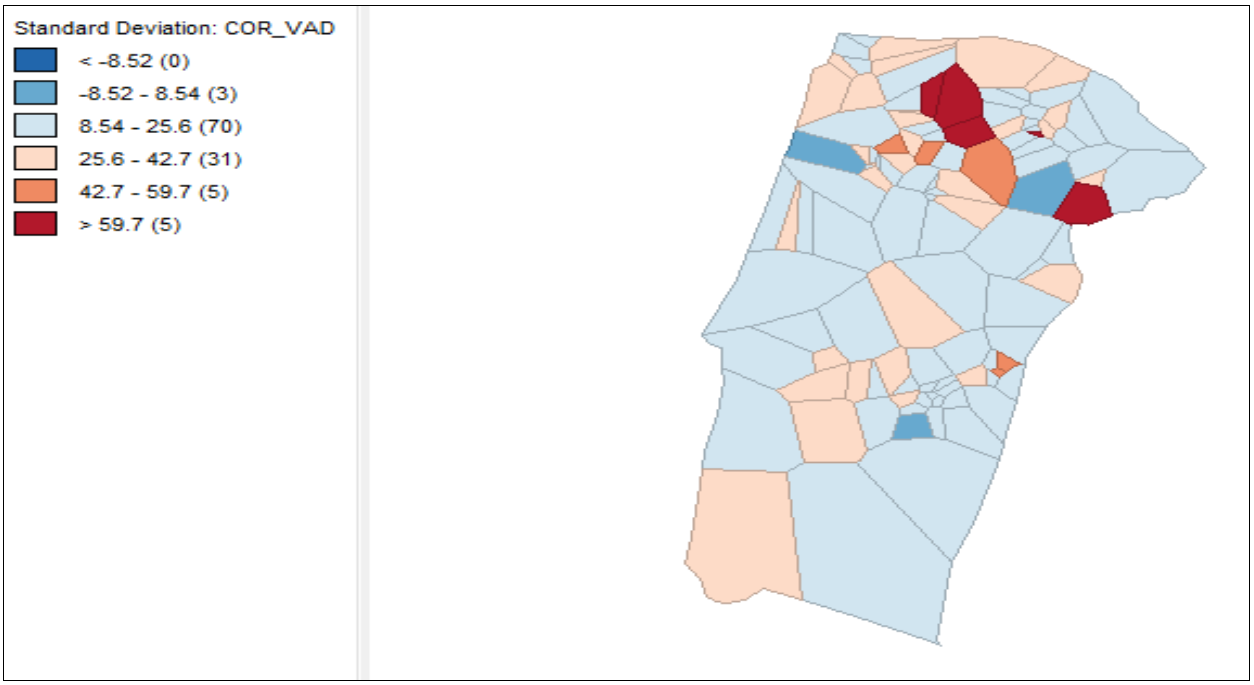

Figure 4.8: Standard deviation Map of VAD, Busia County

The level of clustering (spatial regimes) in the data was identified through exploratory spatial data analysis as recommended by Anselin, (1999) & Cook et al, (1996). A positive and a significant Moran's I, indicates the presence of spatial clustering in space. Results (scatter plots Fig. 4.9) indicate outlier scores in the upper northern regions occupying Rwambwa sub locations as regions with significantly high-high scores (4) of VAD and the lower Central regions covering Magombe Central, Mudembi and Magombe East & West as low-Low (7) areas of VAD. The other areas were categorized as low-high (7) and high low areas (1) (Fig.4.9). The high-high and low-low locations are referred to as spatial clusters and the high-low and low-high locations are spatial outliers (Anselin 2005). Although the LISA Cluster Map showed various levels of clustering as described above, with a Moran's Index of 0.0994579 (indicator of clustering) the LISA Significance Map showed only 2 levels of significance in clustering i.e. 11 areas were significant at p=0.05 and 8 areas were significant at p=0.01(Fig.4.9). Both levels of significance are appropriate for this analysis.

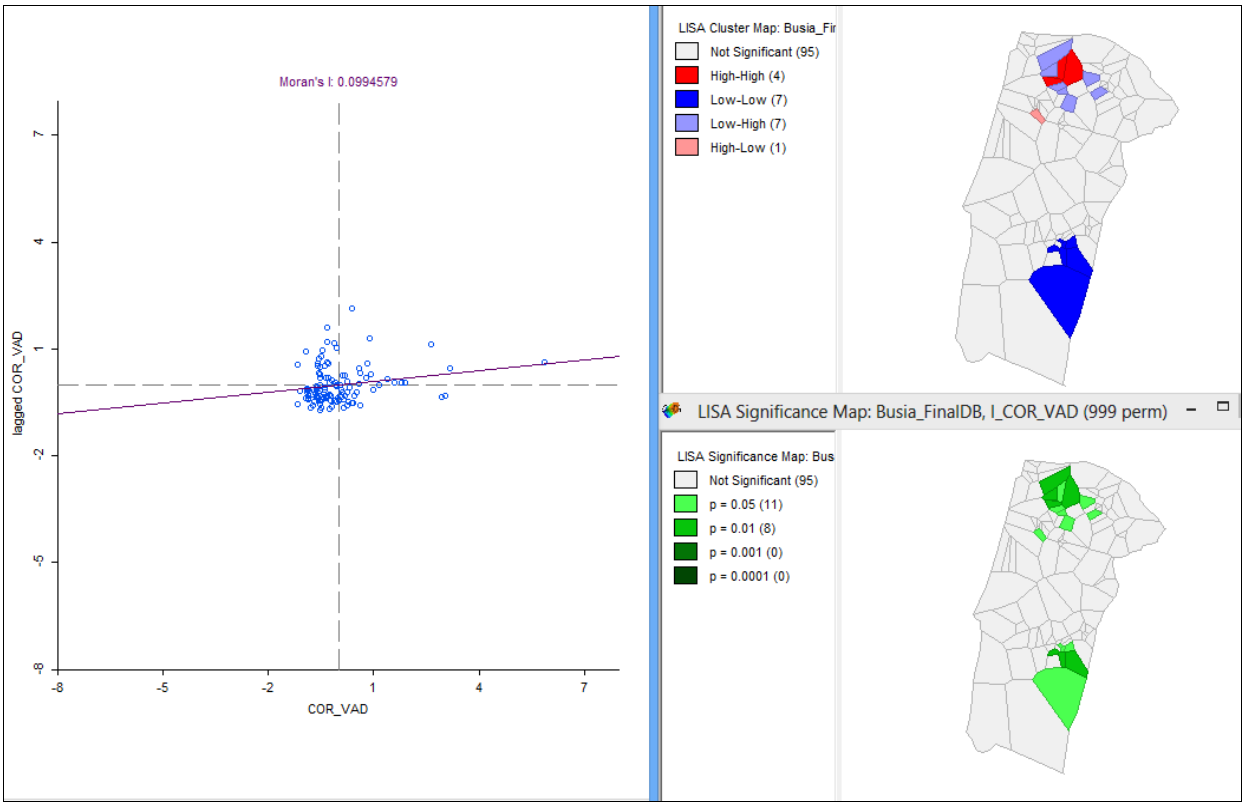

Figure 4.9: Local Indicators of Spatial Association, Busia County

The correlation of distances between observations is known as residuals. Test for spatial autocorrelation in OLS residuals was done and this showed an existence of a significant ($p<0.05$ and 0.01) spatial autocorrelation with a high Moran's Index of 0.950621, confirming clustering (Fig. 4.10).

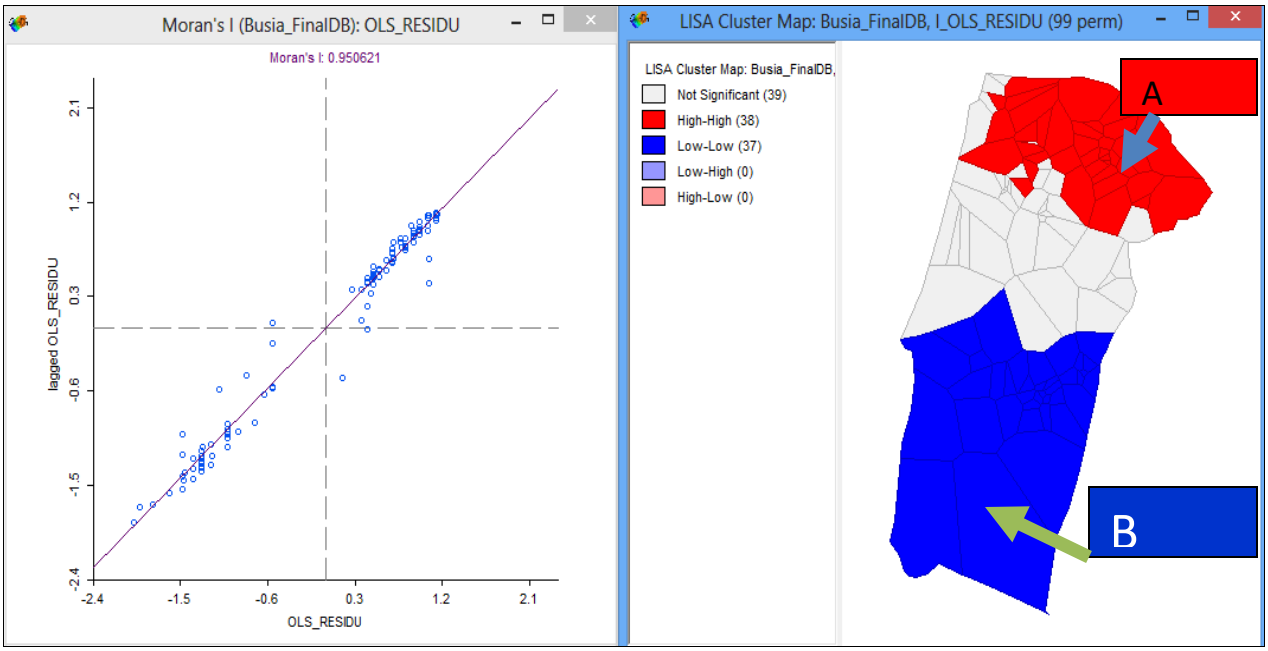

Figure 4.10: Busia OLS_Residual Map, Busia County

Heavy clustering occurs in the residuals across the regions marked (A & B). These are spatial regimes that need investigation so as to understand what is causing the clustering in the residuals. High-High areas are (38) while Low-Low areas are 37. Low-High=0 while High-Low = 0 (Fig. 4.10). The slope of the graph is very steep which is an indicator of positive spatial autocorrelation. In line with the residuals, the predicted values in Busia County arising out of the OLS model parameters were examined and also showed clustering. LISA Maps generated indicate the extreme zones marked as spatial regimes spanning Northern and Southern sub locations. Moran's Index of 0.950621 which is high and evident by the very steep slope of the graph in the scatter plot (Fig. 4.10).

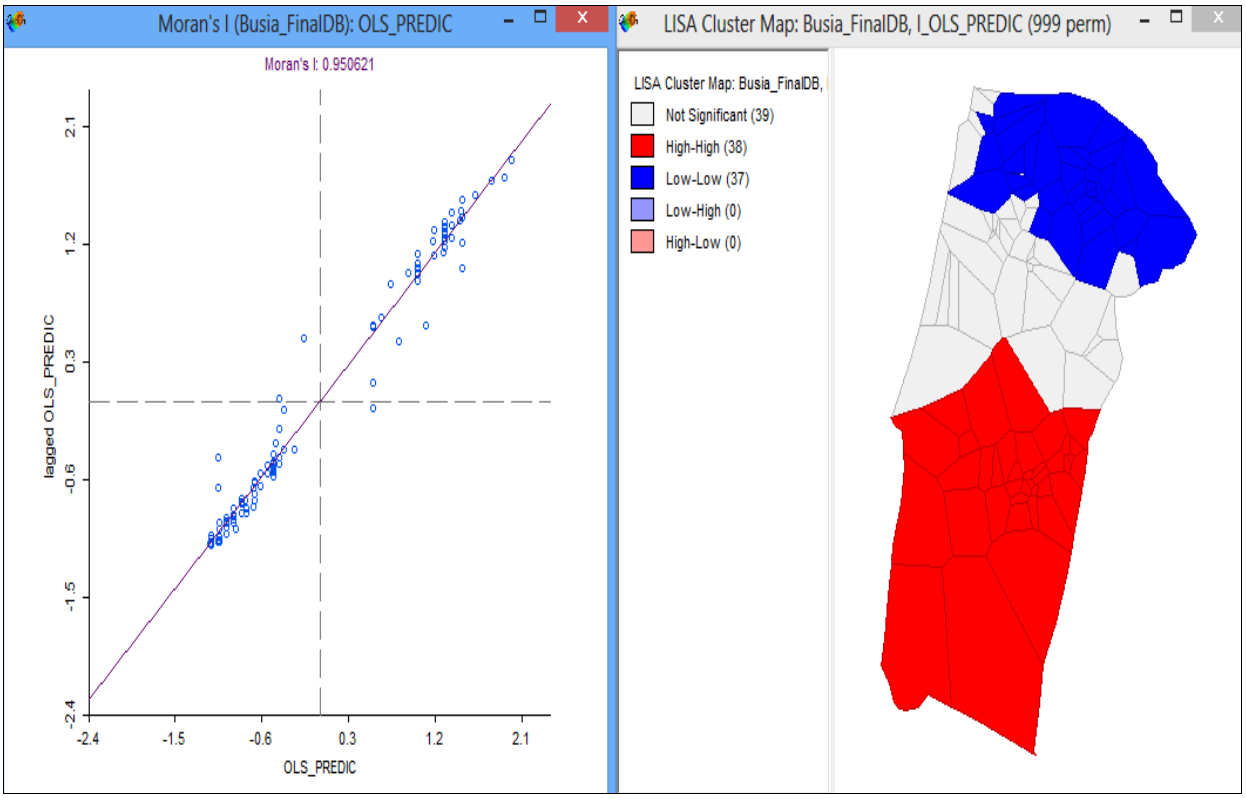

Figure 4.11: Busia OLS Predicted LISA Cluster Map, Busia County

The remaining regions (70) report average values between High-Low and Low-High. Further tests of measures of the Local Indicators of Spatial Association (OLS LISA cluster Map) revealed the regions of clustering as well as the Moran's Index of 0.950621. Moran's Scatter Plot is a graphical plot of the variances against VAD measurements and gives four quadrants that each indicates the extent of spatial association in the VAD areas. Four regions showed High levels of VAD surrounded by other neighboring areas of High values of VAD. However, seven (7) regions indicated Low-Low areas of VAD levels surrounded by similar low values of VAD levels. This observation is in agreement that there are clusters in the northern part as well as the southern part of Busia (Fig. 4.11).

4.1.4. Spatial analysis of VAD in Bungoma County

The residuals are very highly clustered in Bungoma which is clear indicator that there exist extreme spatial regimes. An examination of the Moran's Index (0.697019) through mapping of residuals and consequent scatter plots indicates massive spatial auto correlation of the residuals. This is qualified by the large numbers of High-High and low-low respectively of 106 and 125 The Low-High was only 1 and High-Low only 4 (Fig. 4.12)

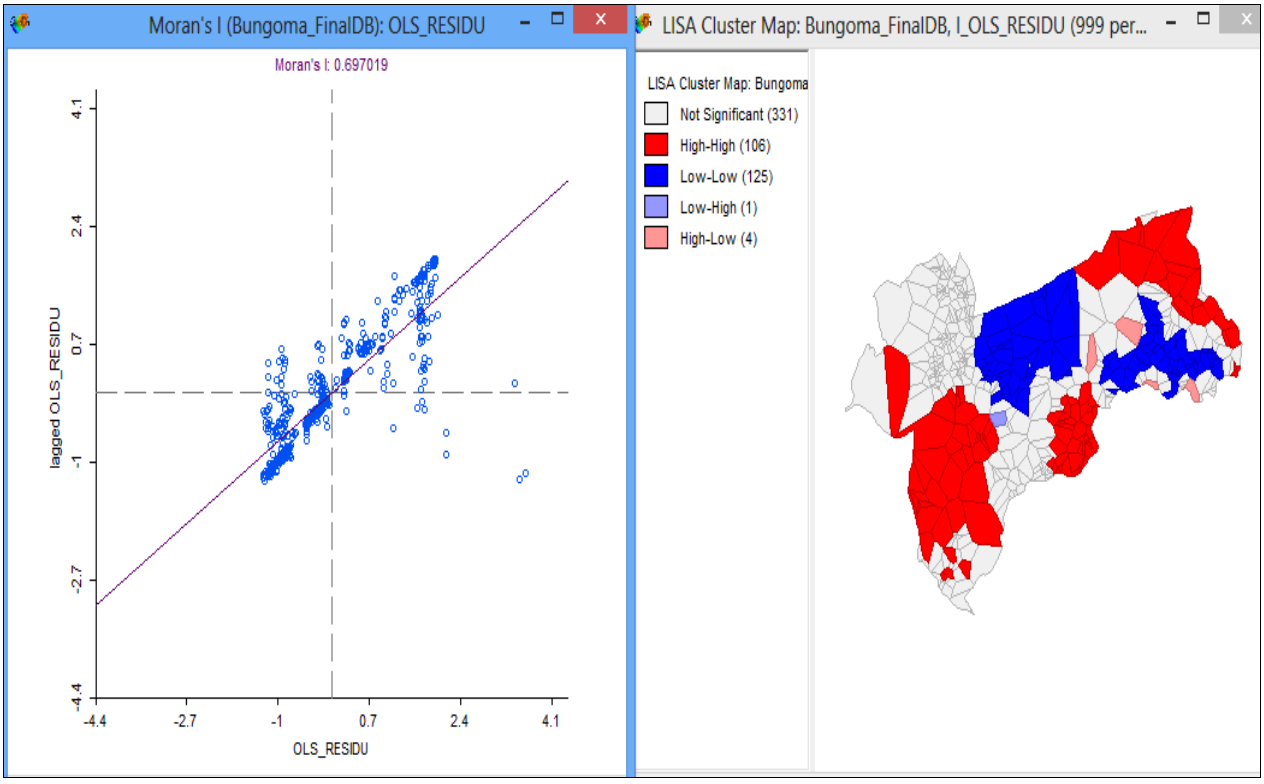

Figure 4.12: Bungoma OLS_Residual LISA Cluster map, Bungoma County

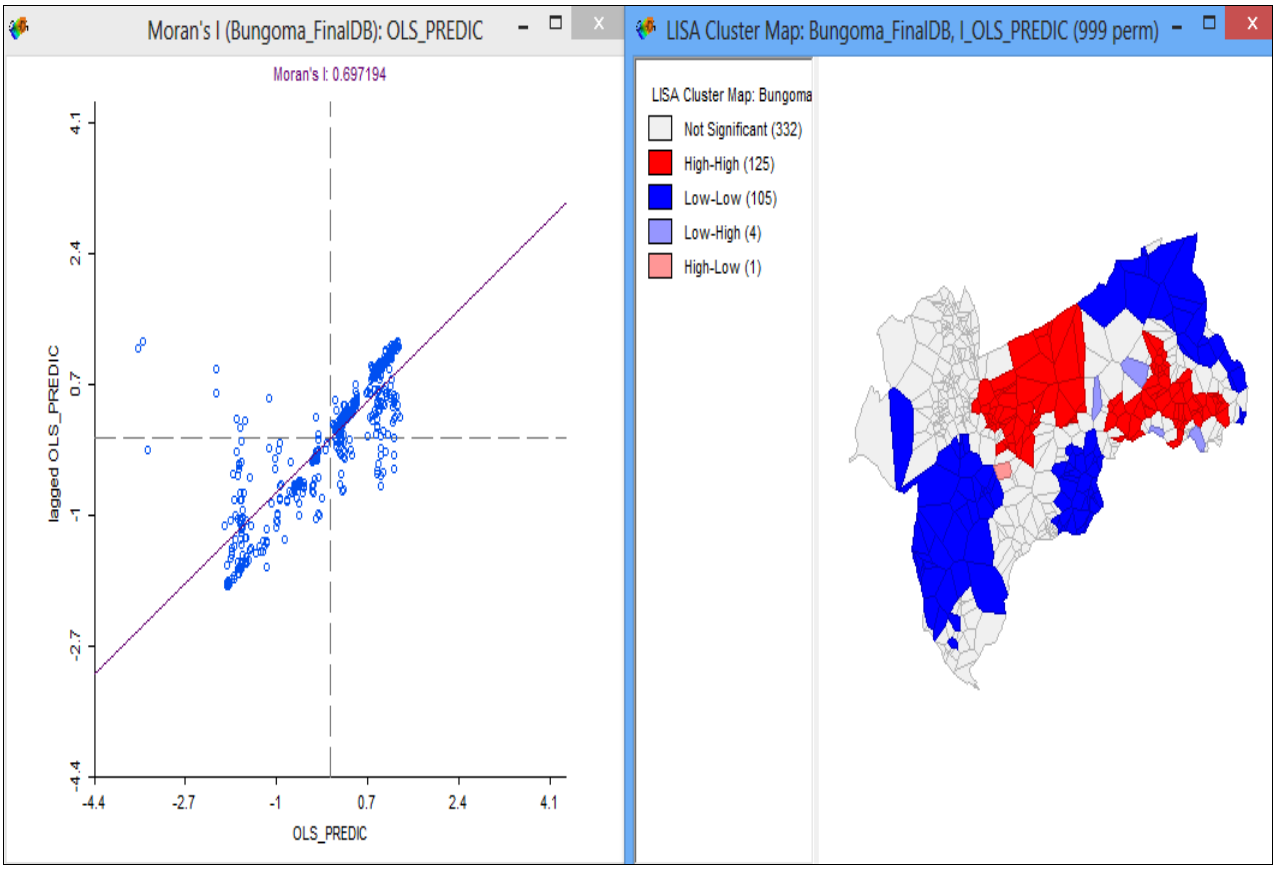

Figure 4.13: Bungoma OLS_Predicted LISA Cluster Map, Bungoma County

Similarly, the predicted maps were developed based on the observations (Fig.4.13), where High-High areas were 125, Low-Low areas were 105, Low-High areas were 4 and High-Low areas was just 1. An examination of the Moran's Index (0.697194) prediction of clustering is evident (Fig. 4.13).

The data exploration above indicates that there are patterns of VAD distribution that are forming clusters at different levels. Due to these clusters, regression analysis and modeling was done to investigate any relationships between selected independent variables and the dependent variable VAD levels in the study sites. Both spatial and demographic explanatory factors that could potentially predict VAD in children in the study area were investigated. They include poverty rates, population, and population density as well and household incomes. Spatial factors

investigated included geology, type of soils, elevation, slope, rainfall, temperatures, length of growing periods, agro-ecological zones, distance from main roads, and distance from the rivers as well as distances from market and health centers. On examination of these factors various coefficients of regression were established and compared against levels of significance ($p<0.05$) to establish if they had any associations with the VAD levels.

First, a diagnostic for spatial dependence for weight matrix was done to investigate the stability of the models to be used for modeling the predictors of VAD. This included Lagrange Multiplier (lag), Robust LM (lag), Lagrange Multiplier (error), Robust LM (error) and Lagrange Multiplier (SARMA). Lagrange Multiplier Error as well as the Robust Lagrange Multiplier tests showed steady models. Moran's test was significant (0.9953) at p=0.0000 (Table 4.2).

Table. 4.2: Diagnostics for Spatial Dependence for Weight Matrix in Bungoma & Busia

TEST	MI/DF	VALUE	PROB
Moran's I (error)	0.9953	-0.7087	0.47851 (from the Lagrange model)
Lagrange Multiplier (lag)	1	-0.0000	-1.00000
Robust LM (lag)	1	-6.7472	-1.00000
Lagrange Multiplier (error)	1	1733.9962	0.00000**
Robust LM (error)	1	1727.2490	0.00000**
Lagrange Multiplier (SARMA)	2	1727.2490	0.00000**

A regression model was thus run based on the Lagrange Multiplier Error Model. Regression equations were developed for both Busia and Bungoma based on significant coefficients (OLSR model) (Table 4.3).

Table. 4.3: Modeling Spatial Predictors of Vitamin A Deficiency in Bungoma & Busia Counties

Independent Variable	Regression Coefficient/Significance - OLSR Model	
	Bungoma	**Busia**
CONSTANT	2394	-1.644
	0.9848	1.0000
Distance to rivers	1.706	38.6582
	0.9308	1.0000
Distance to health Centers	0.0074	1.2797
	0.9207	1.0000
Length of food crops growing period	-2.0286	2.081
	0.9736	1.0000
Distance to towns	0.0113	37.5931
	1.0000	1.0000
Altitude	-0.4746	0.3448
	0.9862	1.0000
County population (1999)	0.1658	-9.5989
	0.9811	1.0000
No. of poor (1999)	0.6370	-9.5252
	0.9555	1.0000
Poverty density (1999)	-0.2636	-2.0789
	0.9870	1.0000
Poverty rate (1999)	-0.6284	2.8882
	0.9870	1.0000
Poverty gap (1999)	-0.6197	9.5244
	1.000	1.0000
Average travel time to various places	2.0386	-8.2085
	1.0000	1.0000
Land slope	0.3015	-515.42
		1.0000
R-Squared	0.00000	00000
	0.00000	0.0000
Adjusted R Squared	-0.21661	-0.1188
	1.00000	1.0000

VAD $_{\textbf{Bungoma}}$ = $a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + a_7x_7 + a8x8 + a_9x_9 + a_{10}x_{10} + a_{11}x_{11} + a_{12}x_{12}$

VAD $_{\textbf{Bungoma}}$ =2394 + 1.706 $x_1 + 0.0074x_2 - 2.03x_3 + 0.011x_4 - 0.47x_5 + 0.1658x_6 + 0.6370x_7 - 0.2636x_8 + 0.6284x_9 - 0.6197x_{10} + 2.0386x_{11} + 0.3015x_{12}$

VAD $_{\textbf{Busia}}$ = $a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + a_7x_7 + a_8x_8 + a_9x_9 + a_{10}x_{10} + a_{11}x_{11} + a_{12}x_{12}$

VAD $_{\textbf{Busia}}$=-1.64+38.65x_1 + 1.279x_2 + 2.08x_3 +37.59x_4 + 0.344 x_5 -9.59 x_6 -9.54 x_7 -2.0789x_8 +0.288x_9 + 9.52 x_{10}-8.208x_{11} -515x_{12}

Whereby[1];

a_0 = Constant of Regression Equation
x_1= Distance to Rivers
x_2= distance to Health Facility
x_3 = Length of growing period
x_4 = Distance to Towns
x_5 =Altitude

[1] **The above are the explanatory variables used in Regression Equation Modeling**

x_6 = Population in 1999
x_7=Number of poor in 1999
x_8 = Poverty Density 1999
x_9 =Poverty Rate
x_{10} =Poverty Gap
x_{11} =Travel time to towns
x_{12}= Slope in Degrees

Langrage Multiplier models were used to investigate the most significant independent predictor of VAD clustering in Busia and Bungoma Counties. A hypothesis was tested given chance or random processes for the independent variables. Some variables were significant while other were not significant predictors of VAD clustering in Bungoma and Busia Counties. Based on the main hypothesis on VAD prevalence, two sub-hypotheses related to objective 1 (one) of the studt were introduced for geospatial distribution as follows:

> H_0**:** The independent Variables are not significant determinants of VAD in Bungoma and Busia Counties
>
> H_1: The independent Variables are the significant determinants of VAD in Bungoma and Busia Counties

Hypothesis is tested at 95% (p= 0.05) with 999 permutations. Two regression equations are produced on the entire area both for OLS and Spatial Multiplier (Error) models. Diagnostic tests of spatial dependence were used to decide on what kind of model was most favorable. Spatial error Model was adopted against the Spatial Lag Model. The results of the tests (Table 4.3) illustrates that Lagrange Multiplier Error is significant at 0.00000 probabilities being less than 0.05.

Table. 4.4: Regression Coefficient/Significance for OLS & Spatial Error Models

Independent Variable	OLS Model	Error Model	OLS	ERROR
CONSTANT	289.4642	-53.9910	+	+
	1.0000	0.99801		
Distance to rivers	-0.0870	0.09830	-	-
	1.0000	0.9486		
Distance to health Centers	0.01143	-0.1392	-	+
	1.0000	**0.0430***		
Length of growing period	-5.2083	-4.7700	-	-
	1.0000	**0.0000***		
Distance to towns	-0.00568	-0.0861	-	-
	1.0000	**0.0036***		
Altitude	-0.0074	-0.0230	-	-
	1.0000	0.9909		
Population (1999)	0.0035	0.2984	+	+
	1.0000	0.4041		
No. of Poor (1999)	-0.0081	-0.2242	-	-
	1.0000	0.7058		
Poverty Density (1999)	0.0069	0.0895	+	+
	1.0000	0.9785		
Poverty Rate (1999)	-0.6785	-0.324	-	-
	1.0000	0.99735		
Poverty Gap (1999)	1.0755	0.6670	+	+
	1.0000	0.9977		
Average Travel Time to various	1.2245	-4.770	+	-
places	1.0000	**0.0000***		
Slope	0.0910	-0.5324	+	-
	1.0000	0.9982		
R-Squared (BUSE)	0.0000	0.0000		
	0.0000	0.0000		
Adjusted R-Squared	-0.0179			
	1.0000			
Lag Coefficient (λ)		0.3819		
		0.0000		

***Statistically significant at p<0.05 under spatial error models**

Results of the Lagrange Multiplier for the combined area of Bungoma and Busia was run and compared against the OLS coefficients. It was observed that out of the 12 explanatory variables 4 were significant at $p \leq 0.05$. Spatially, average travel time to various places p=0.00, distance to health centers p=0.04, distance to towns p=0.00 and length of food crop growing period p=0.00 were significant predictors of VAD. Distance to rivers, altitude, population, number of poor people in Busia and Bungoma, poverty density, Poverty Rate in Busia and Bungoma and slope did not predict VAD among children. Higher population, poverty density, poverty gap and slope had both positive and negative influence on VAD but which were not significant (Table 4.4).

4.2. Socio-demographic characteristics and VAD status

This section as a second objective investigated the relationship between socio-demographic characteristics and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

4.2.1. Characteristics of Household heads in the study area

Table 4.5 summarizes the Characteristics of Household heads in the study area. The mean age (years) of the household heads in Bungoma North was 38.2, in Bungoma East it was 38.6, in Kimilili it was 37.4 while in Bunyala it was 38.6. Older (36-93 years) household heads were more in Bungoma East (52%) and lowest in Kimilili (46.5%). Majority of the households were male headed, ranging from 94% in Kimilili to 87% in Bunyala. The average household size was approximately 6 persons for all the sub-Counties. Education levels of the household heads were highest in Kimilili followed by Bungoma North and lowest in Bunyala. Proportion of household heads that had formal education higher than the primary level was highest in Bungoma North sub-County (30%) and lowest in Bunyala sub-County (16%). Similarly, the proportion of uneducated household heads was highest in Bunyala and least in Kimilili (8% vs.1%, respectively). Majority of household heads were in monogamous marriages and the proportion ranged from 67% in Bunyala to 81% in Bungoma North. Bungoma East had the highest number of household heads who practiced agriculture as their principal activity (87%) while Bunyala sub-County had the list of the same (78%) (Table 4.5).

Table 4.5: Household size and characteristics of household heads in the study area

	sub-County							
	Bungoma North (n=987)		**Bungoma East (n=136)**		**Kimilili (n=355)**		**Bunyala (n=152)**	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Age of household head	**38.2[1]**	**12.2[2]**	**38.6[1]**	**12.4[2]**	**37.4[1]**	**11.5[2]**	**38.6[1]**	**13.0[2]**
16-35	497	50.4	56	48.1	190	53.5	75	49.5
36-93	490	49.6	80	51.9	165	46.5	77	50.5
Sex of household head								
Female	85	8.6	10	7.0	21	6.0	19	12.7
Male	902	91.4	126	93.0	334	94.0	133	87.3
Household size	**5.8[1]**	**2.1[2]**	**6.0[1]**	**2.1[2]**	**5.8[1]**	**2.1[2]**	**5.7[1]**	**2.3[2]**
0-5	496	50.25	60	44.12	172	55.26	84	55.26
6-10	462	46.81	72	52.94	174	40.13	61	40.13
11-16	29	2.94	4	2.94	9	4.61	7	4.61
Highest level of formal education completed								
None	24	2.43	7	5.15	3	0.85	12	7.89
Primary	678	68.69	92	67.65	250	70.42	115	75.66
Secondary	256	25.94	35	25.74	95	26.76	23	15.13
College	18	1.82	2	1.47	3	0.85	2	1.32
Graduate	11	1.11	-	-	4	1.13	-	-
Marital status								
Married monogamous	796	80.65	109	80.15	273	76.90	103	67.76
Married polygamous	191	19.35	27	19.85	82	23.10	49	32.24
Single								
Other								
Agriculture is principal activity	760	79.25	115	87.12	279	83.04	108	77.70
Has sold agriculture or livestock products last year	755	76.49	104	76.47	266	74.93	87	57.24
Has undertaken salaried employment Last year	57	5.78	6	4.41	19	5.35	4	2.63
Has done casual labour last year	468	47.42	59	43.38	153	43.10	58	38.16
Has been I involved in informal business last year	153	15.50	17	12.50	48	13.52	28	18.42
Has been involved in some other form of self employment last year	273	27.66	38	27.94	126	35.49	38	25.00

[1] Mean [2] (SD)

4.2.2. Characteristics of child caretakers in the study area

The characteristics of caretakers are presented in Table 4.6. The mean age (years) of caretakers was 30 in Bungoma North, Bungoma East and Bunyala while in Kimilili it was 28. The average household size was approximately 6 persons for all the four districts. Similarly, the proportion of

households with a household size of 4-16 persons was almost the same in all the sub-Counties with a narrow range of between 89% in Bungoma East and 85% in Bunyala.

Table 4.6: Characteristics of child caretakers in the study area

	sub-County							
	Bungoma North (n=987)		**Bungoma East (n=136)**		**Kimilili (n=355)**		**Bunyala (n=152)**	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
Household size	***5.8[1]***	***2.1[2]***	***6.0[1]***	***2.1[2]***	***5.8[1]***	***2.1[2]***	***5.7[1]***	***2.3[2]***
0-5	496	50.25	60	44.12	172	55.26	84	55.26
6-10	462	46.81	72	52.94	174	40.13	61	40.13
11-16	29	2.94	4	2.94	9	4.61	7	4.61
Age (years)	***30.09[1]***	***8.9[2]***	***30.38[1]***	***9.2[2]***	***28.46[1]***	***7.9[2]***	***29.97[1]***	***6.7[2]***
Below 35	755	76.5	99	72.8	298	83.9	138	90.8
36-50	199	20.2	32	23.5	48	13.5	12	7.9
Above 50	33	3.3	5	3.7	9	2.5	2	1.3
Currently in school								
Yes	33	3.3	3	2.2	15	4.2	3	2.0
No	954	96.7	133	97.8	340	95.8	149	98.0
Formal education (Yrs)	***8.0[1]***	***3.0[2]***	***7.6[1]***	***3.0[2]***	***8.2[1]***	***2.9[2]***	***6.8[1]***	***3.1[2]***
Highest education								
None	24	2.4	7	5.2	3	0.9	12	7.9
Primary	678	68.7	92	67.7	250	70.4	115	75.7
Secondary	256	25.9	35	25.7	95	26.8	23	15.1
College	18	1.8	2	1.5	3	0.9	2	1.3
Graduate	11	1.1	-	-	4	1.1	-	-
Marital status								
Married monogamous	796	80.7	109	80.2	273	76.9	103	67.8
Married polygamous	191	19.4	27	19.9	82	23.1	49	32.2
Agriculture is principal activity	760	79.3	115	87.1	279	83.0	108	77.7

[1]Mean, [2](SD)

Bungoma North and East had the highest percentage (3.3% & 3.7%) of caretakers above 50 years who were mainly grandmothers. Percent of caretakers in formal schooling during the survey was highest in Kimilili (4%) and lowest in Bunyala (2%). Uneducated caretakers were highest in Bunyala (8%) and lowest in Kimilili (1%). More caretakers in Kimilili (27%) had education higher than primary-school level compared to lowest in Bunyala (15%). Average years of formal education were highest for caretakers in Kimilili (8.2 years) and lowest in Bunyala (6.8 years). Majority of the caretakers were in monogamous marriages ranging from 67% in Bunyala to 81% in Bungoma North. The majority of caretakers who practiced agriculture as a principle

activity were from Bungoma East (87%) while Bunyala sub-county had the least of the same (78%) (Table 4.6).

4.2.3. Characteristics of children in the study area

Statistics of the target children defined across the four sub-counties is presented in Table 4.7 where the mean age of the children across the four sub-counties was about 14 months, although children aged 6-11 months were the majority; Bungoma North- about 38%, Bungoma East-37%, Kimilili-40%, and Bunyala-39%.

Table 4.7: Characteristics of children aged 6-23 months in the study area

	sub-County							
	Bungoma North (987)		**Bungoma East (136)**		**Kimilili (355)**		**Bunyala (152)**	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
Age (mo):	***14.0[1]***	***5.1[2]***	***13.7[1]***	***4.7[2]***	***13.7[1]***	***4.9[2]***	***13.7[1]***	***5.0[2]***
6-11	373	37.8	50	36.8	142	40.0	59	38.8
12-17	316	32.0	51	37.5	116	32.7	52	34.2
18-23	298	30.2	35	25.7	97	27.3	41	27.0
Sex:								
Female	465	47.1	67	49.3	183	51.6	81	53.3
Male	522	52.9	69	50.7	172	48.5	71	46.7

Mean[1] (SD) [2]. Statistical difference at p<0.05); 2- proportion z-test

The results showed that there were no statistically significant differences in proportions of age across the sub-counties. Age of the children 6-11, 12-17 and 18-23 months were comparable and further analysis to compare the proportional differences, revealed that there were no significant differences among the age groups in the sub-Counties. Although the proportion of males (53%) was marginally higher than that of the females (47%), this was not significantly different among and between sub-counties. Due to the numerous comparisons across & within sub-counties during the analysis it was not possible to tabulate the 95%CI.

4.2.4. Child Nutritional Status

Overall, stunting affected 24% of the children, underweight affected 13% of children, while wasting affected 6 % of the children (Fig. 4.14).

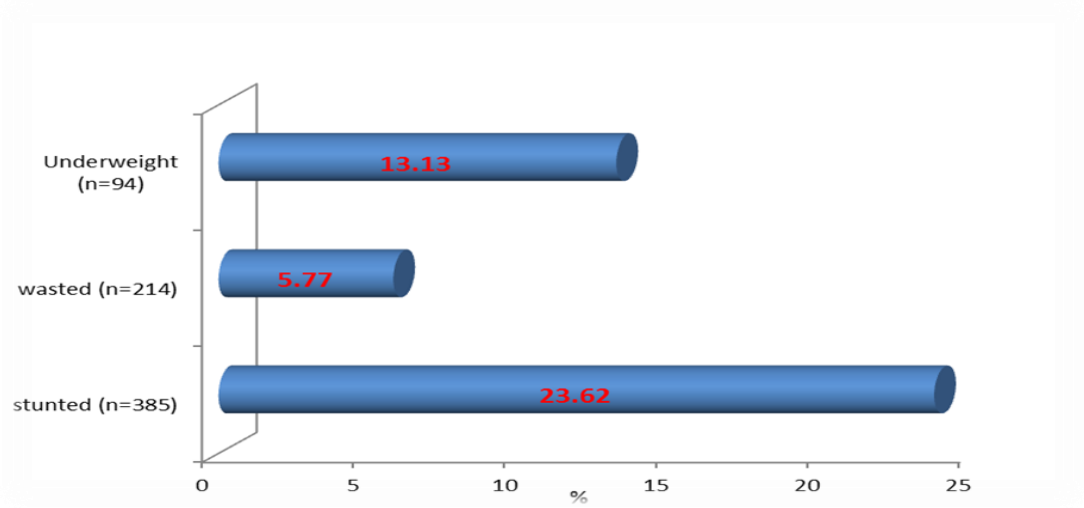

Figure 4.14: Overall nutritional status of children 6-23 months in Western Kenya

Analysis by sub-County revealed that stunted children (moderate & severe) was highest in Bunyala (29.0%), followed by Kimilili (26.1%), and Bungoma North (24.8%) and least in Bungoma East (20.4%). Further analysis using the Insilco soft ware, revealed that there were no significant differences in moderate stunting between sub-Counties but severe stunting was significantly higher in Bungoma North compared to Bungoma East (z=3.10, CI=0.044-0.20, p=0.002), significantly higher in Bunyala compared to Bungoma East (z=3.77, CI=0.091-0.29, p=0.000) and significantly higher in Bunyala compared to Kimilili (z=2.71, CI=0.030-0.19, p=0.006). In wasting, whether moderate or severe, there were no significant differences between sub-Counties (Table 4.8a).

Table 4.8 (a): Distribution of children by nutritional status across sub-Counties

	sub-County							
Nutritional status	**Bungoma North (987)**		**Bungoma East (136)**		**Kimilili (355)**		**Bunyala (152)**	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
Stunted								
Moderate	167	17.0	19	13.8	67	18.7	31	20.5
Severe	77	7.8	9	6.6	26	7.4	13	8.5
Wasted								
Moderate	48	4.9	6	4.6	17	4.9	9	5.7
Severe	19	1.9	3	2.0	10	2.7	1	0.6

There is statistical difference p=0.05); 2- proportion z-test

Disaggregation by gender showed that girls were consistently more stunted and wasted than boys in all sub-Counties.

Table 4.8 (b): Child malnutrition status by gender across sub-Counties

	sub-County							
Nutritional status	**Bungoma North (987)**		**Bungoma East (136)**		**Kimilili (355)**		**Bunyala (152)**	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
Stunted: Girls	119	25.8	18	26.9	53	29.3	21	25.9
Boys	110	21.1	8	11.8	33	19.2	17	23.9
Wasted: Girls	33	7.1	4	6.0	11	6.0	4	4.9
Boys	22	4.2	2	2.9	7	4.1	5	7.0

There is statistical differences p= 0.05; 2-sample proportion z-test

Further analysis revealed that these differences were not significant between sub-Counties and within sub-Counties (Table 4.8b).

4.3. Vitamin A Food intake, Nutritional status and VAD status

This section has made an attempt to address objective 3 thus to determine the relationship between food intake, nutrition status and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

4.3.1. Household Vitamin A Food Consumption Frequency

The HKI vitamin A food consumption frequency score among the children was still way below the threshold indicating Vitamin deficiency among the children aged 6 to 23 months.

Table 4.9: Household vitamin A food consumption frequency among children aged 6-23 months

	Total (days/week) consumed animal VIT A source			HKI Vita A food consumption frequency score		
	mean	Std dev	median	mean	Std dev	median
Overall (n=1630)	1.60	2.34	1.00	3.29	2.64	2.51
By district						
Kimilili (n=355)	1.58	2.35	1.00	3.15	2.66	2.34
Bunyala (n=152)	2.06	2.61	1.00	2.91	2.81	2.16
Bungoma North (n=987)	1.61	2.35	1.00	3.43	2.64	2.65
Bungoma East (n=136)	1.26	1.96	0.50	2.95	2.30	2.32
By wealth status						
Lowest (n=323)	1.81	2.51	1.00	3.50	2.84	2.67
Second (n=333)	1.54	2.32	1.00	3.25	2.64	2.51
Middle (n=299)	1.42	2.18	1.00	3.10	2.45	2.33
Fourth (n=316)	1.58	2.28	1.00	3.25	2.60	2.50
Highest (n=332)	1.68	2.37	1.00	3.41	2.65	2.67
Education of the caretaker						
None (n=59)	1.77	2.15	1.00	3.35	2.31	3.00
Primary (n=1020)	1.65	2.43	1.00	3.34	2.73	2.50
Secondary (n=490)	1.47	2.12	1.00	3.17	2.51	2.50
College/graduate (n=61)	1.54	1.87	1.00	3.23	2.24	2.83
Total days/ week						
Consumed VA from animal						
≤4days per week	1459[a]	89.5[b]				
>4 days per week	171	10.5				
HKI food frequency score						
≤ 6 days per week	1464[a]	89.8[b]				
>6 days per week	166	10.2				

[a] represents number of children [b] is the proportion of children (%)

The mean number of days in a week that the children consumed vitamin A rich foods from animal sources was 1.7 days/week while the HKI frequency score was 3.3 days. Approximately 90% of the children had a HKI food frequency score lower than the minimum threshold of more than 6 days per week. Consumption of vitamin A did not vary with the households' wealth status and with the levels of education of the caregivers (Table 4.9).

4.3.2. Dietary Diversity Indices

a) Household dietary diversity index

Ten food groups were included in the dietary diversity index calculation for households: 1) Starchy staples, 2) Dark green leafy vegetables, 3) Other vitamin A rich fruits and vegetables, 4) Other fruits and vegetables, 5) Organ meat, 6) Meat and fish, 7) Eggs, 8) Legumes, nuts and

seeds, 9) Milk and milk products, 10) Oils and fats (*FAO, 2011*). Each food group was quoted as 0 if not consumed during the past 24hrs and 1 if consumed during the past 24hrs. The dietary diversity index was obtained by summing up the quotes for the 10 food groups. Therefore, the possible range of the dietary diversity index was from 0 to 10. The median value was used to categorize households into two equal groups of dietary diversity: acceptable and below acceptable limits. Bunyala sub-County had the highest proportion of households (81.5%) with diet below acceptable limits, followed by Kimilili (68%), then Bungoma North (67%) and last was Bungoma East (62%) (Fig. 4.15).

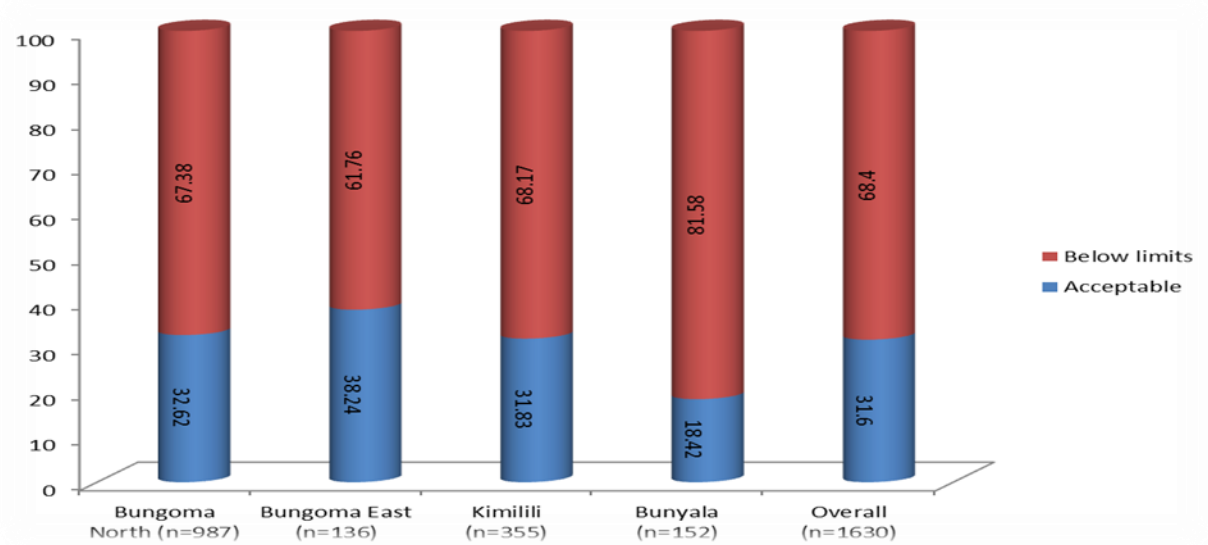

Figure 4.15: Household (%) dietary diversity by sub-Counties

b) Dietary diversity index for children 6-23 months of age3

The dietary diversity scores range was from 1 to 7 for the children depending on the number of different foods the child had consumed 1 day prior to the survey. Generally, the nutrition levels of the children in the survey area as indicated by the minimum dietary diversity and accepted diet were low. Overall, only 47% and 33% of the children had attained the minimum dietary diversity score and acceptable diet respectively. It was also varied significantly across the sub-Counties,

with a range of 51% in Bungoma East and 26% in Bunyala. Similarly, the proportion of children with minimum acceptable diet also varied significantly across the sub-Counties (Fig. 4.16).

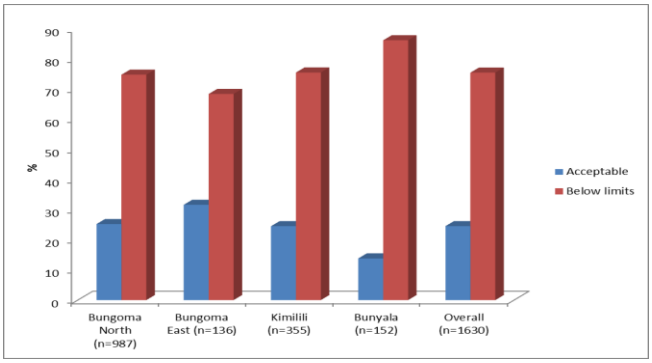

Figure 4.16: Proportions of children's dietary diversity by sub-counties

It was highest in Bungoma East (35%) and least in Bunyala sub-County (17%).

4.4. Association between Vitamin A Deficiency and Potential Predictors in Children in Study Area

4.4.1. Bi-variate Analysis of Potential Predictors of Vitamin A Deficiency

Key potential predictors that have been included; child stunted and wasting, sex, age, age of caretaker, Caretaker educational status, Marital status of care taker, dietary adequacy and diversity, SES of caretaker, health seeking behavior and child care knowledge of caretaker, household size, agriculture as principle activity of caretaker, if the index child had taken VA capsule in the last 1 year prior to survey, Vitamin A and nutrition knowledge and child location (sub-County). A two-stage process to investigate associations between 20 potential predictors and one (1) study outcome –VAD was used. From the results, potential predictors having a bi-variate probability of >0.05 were removed from the pool (Table 4.10a).

Table 4.10(a): Association of VAD with potential predictors in children 6-23 months in study areas

Variable	VAD n=327(20.1%)	p-value	Unadjusted odds ratio (95% CI)
Stunted: No	245(19.7)	0.488	1.1 (0.8-1.5)
Yes	82 (21.3)		
Wasted: No	310 (94.8)	0.432	1.2 (0.6-1.8)
Yes	17 (5.2)		
Child sex: No	163 (20.5)		1.0 (0.7-1.2)
Yes	164 (19.7)	0.682	
Child age: 6-11	115(18.4)		1.2 (1.0-1.3)
12-17	102(19.1)		
18-23	110(23.4)	**0.050***	
Household size: 0-5	156 (19.2)		1.1 (0.9-1.4)
6-10	159 (20.7)		
11-16	12 (24.5)	0.313	
Child dietary: Below Average	245(19.9)		1.0 (0.8-1.4)
Acceptable	82 (20.5)	0.801	
Taken VA capsule in the last 1 year of survey: No	177(18.1)		1.3 (1.0-1.6)
Yes	126(21.9)	**0.044***	
Age of caretaker): < 35	250(76.5)		1.1(0.6-1.3)
36-50	66 (20.2)		
> 50	11 (3.4)	0.791	
Marital status: Married monogamous	256 (19.98)		1.1 (0.9-1.2)
Married polygamous	23 (16.08)		
Single	29 (20.57)		
Other	19 (29.23)	0.296	
Household dietary: Below Average	222(19.9)		1.0 (0.8-1.3)
Acceptable	105(20.4)	0.823	
Health seeking behavior/child care knowledge caretaker:	12 (3.6)		1.0 (0.7-1.2)
No	315 (96.4)		
		0.693	
Yes			
Vitamin A and nutrition knowledge: Lowest tertile	131 (22.7)		0.9 (0.7-1.0)
Second tertile	101 (19.7)		
Highest tertile	95 (17.6)	**0.032***	
Caretaker educational status: None	9 (19.6)		0.9 (0.7-1.1)
Primary	238 (21.0)		
Secondary	73 (17.85)		
College	4 (16.00)		
Graduate	3 (20.00)	0.291	
SES: Poorest	149 (21.05)		0.9 (0.7-1.0)
Middle	97 (21.51)		
Least poor	77 (16.92)	0.111	
Agriculture as principle activity: No	61 (18.7)	0.344	0.9(0.7-1.2)
Yes	266 (81.3)		
District			
Bungoma East	14 (10.3)	Ref	
Bunyala	46 (30.3)	**0.000***	3.8 (2.0-7.3)
Bungoma North	204 (20.7)	**0.005***	2.3 (1.3-4.0)
Kimilili	63 (17.8)	**0.045***	1.9 (1.0-3.5)

*** Correlation is significant at the p<0.05 level (1-tailed)**

4.4.2. Multivariate Analysis of Socio-Demographic Predictors of Vitamin A Deficiency in Children 6-23 Months in Study Area

A multivariate logistic regression analysis for VAD that included the significant predictors from the bi-variate analysis was done (Table 4.10b). Four independent potential predictors of VAD; child's vitamin A capsule intake 1 year before the survey, child's age, caretaker's vitamin A and nutrition knowledge, and the study districts were retained in the analysis.

Table 4.10(b): Multivariate logistic regression analysis for predictors of VAD in children 6-23 months in study area

Variables retained in analysis	No VAD-n=1303 (79.9%)	VAD n=327 (20.1%)	p-value	Adjusted odds ratio (95%CI)
Child taken VA capsule in the last 1 year				
No	803 (81.9)	177 (18.1)	**0.022***	**1.3 (1.1-1.7)**
Yes	449 (78.1)	126 (21.9)	Ref	Ref
Child Age				
6-11	509 (81.6)	115 (18.4)	Ref	Ref
12-17	433 (80.9)	102 (19.1)	0.389	1.1 (0.8-1.6)
18-23	361 (76.7)	110 (23.4)	**0.035***	**1.3 (1.1-1.9)**
Vitamin A and nutrition knowledge score				
Lowest tertile	446 (77.3)	131 (22.7)	**0.027***	**1.4 (1.0-1.9)**
Second tertile	411 (80.3)	101 (19.7)	0.617	1.0 (0.7-1.5)
Highest tertile	446 (82.4)	95 (17.6)	Ref	Ref
Socio Economic Status				
Poorest	559 (79.0)	149 (21.1)	0.088	1.4 (0.9-1.9)
Middle	354 (78.5)	97 (21.5)	0.074	1.3 (0.9-1.8)
Least poor	378 (83.1)	77 (16.9)	Ref	Ref
District				
Bungoma East	122 (89.7)	14 (10.3)	Ref	Ref
Bunyala	106 (69.7)	46 (30.3)	**0.000***	**3.5 (1.7-6.9)**
Bungoma North	783 (79.3)	204 (20.7)	**0.011***	**2.2 (1.2-3.9)**
Kimilili	292 (82.2)	63 (17.8)	**0.045***	**1.9 (1.0-3.7)**

***There is statistical difference p<0.05; Pearson's χ2- test**

In the multivariate analysis, the estimated odds of being VAD for the children who did not take vitamin A capsule within 2 months at the time of the survey was 1.3 times higher compared to children who took Vitamin A capsule, and this is statistically significant (Adjusted odds ratio =1.3, CI=1.1-1.7, p=0.022;) (Table 4.10b). About 18% of the children in the age bracket of 6-11 months were vitamin A deficient as compared to 19% and 23.35% of the children in the 12-17, and 18-23 months age groups respectively. The child's age was a statistically significant predictor to VAD with regards to 18-23 months age group (Adjusted odds ratio=1.3, CI=1.1-1.9, p=0.035).

The odds of having VAD was higher (1.3x) in children aged 18-23 months than those 6-11 and those 12-17months because the 2 latter groups are not different with respect to VAD. The proportion of children (22.70%) whose caretakers were in the lowest tertile of vitamin A and

nutritional knowledge were more likely to develop Vitamin A deficiency compared to children with caretakers in the second (19.73%) and the highest tertiles (19.73%) respectively. The caretaker's Vitamin A and nutritional knowledge has a significant association to VAD (χ^2=0.032) independently from the factors considered in the analysis. In the multivariate analysis, the nutritional and vitamin A knowledge was found to be a risk predictor to VAD with regard to those in the lowest tertile being statistically significant, (Adjusted odds ratio=1.4, CI=1.0-1.9, p=0.027). Mothers in the lowest tertile of vitamin A and nutritional knowledge were 1.4 times more likely to have their children develop VAD (Table 4.10b). The child's location was found to be a risk predictor of VAD in all the sub-Counties, where Bunyala sub-County showed the strongest predictor for a child developing VAD (Adjusted odds ratio=3.5, CI=1.7-6.9, p=0.000), this was followed by Bungoma North (Adjusted odds ratio=2.2, CI=1.2-3.9, p=0.011), then Kimilili (Adjusted odds ratio=1.9, CI=1.0-3.7, p=0.045). This shows that among the four sub-Counties, a child residing in Bunyala had the highest risk of developing VAD and least risk in Bungoma East.

4.5. Knowledge, Perceptions and VAD status

In addressing the objective 4, this section has determined the relationship between knowledge, perceptions and Vitamin A status among children aged 6-23 months in Bungoma and Busia counties of western Kenya.

4.5.1. Knowledge about Vitamin A by Caregivers

Caregivers reporting to have heard about VA were comparable across sub-Counties (Table 4.11). Most caregivers were aware of vitamin A, about of 93% in Bungoma East and a low of 88% in Bunyala. Majority of care takers (>30%) across the sub-Counties had heard of VA over 10 years ago prior to the time of the survey. About 20% across the sub-Counties had heard of VA between

5-10 years ago prior to the time of the survey. The rest of the women in the four sub-Counties had heard about VA at least 5 years prior to the time of the survey.

Table 4.11: Distribution of caregivers by knowledge on vitamin A

	sub-County							
	Bungoma North n=987)		**Bungoma East (n=136)**		**Kimilili n=355)**		**Bunyala n=152)**	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
Proportion reporting to have heard about Vitamin A	911	92.3	127	93.4	320	90.1	135	88.8
Duration information was heard								
Over 10 years ago	372	41.1	45	35.4	118	37.1	45	33.3
5-10 years ago	172	19.3	27	21.3	65	20.4	27	20.0
2-5 years ago	163	18.0	17	13.4	55	17.3	20	14.8
Last year	107	11.8	17	13.4	46	14.5	23	17.0
Just recently	88	**9.7***	21	**16.5***	34	10.7	20	14.8
Proportion reporting Vitamin A is important								
Prevents disease	400	**44.1***	69	**54.3***	141	**44.1***	54	**40.0***
Protects the eyes	67	7.4	10	7.9	34	10.6	5	3.7
Any other correct fact	397	43.8	51	40.2	143	44.7	69	51.1
Proportion reporting correct Vitamin A rich foods								
None correct	162	18.3	24	18.9	62	19.6	24	18.2
1 correct	332	**37.4***	37	**29.1***	119	37.7	63	**47.7***
2 correct	277	31.2	47	37.0	102	32.3	41	31.1
All 3 correct	116	13.1	19	15.0	33	10.4	4	3.0

***There is statistical difference p<0.05) using 2- proportion z-test**

A further analysis (Insilico 2-proportion z-test) among women revealed that there were significantly more women in Bungoma East who had just recently heard of VA compared to Bungoma North and (z=2.42, CI=0.013-0.12, p=0.016), the rest were comparable. The highest proportion of women who correctly recognized that VA is important for disease prevention was in Bungoma East (54%) while the lowest was in Bunyala (40%).

Further, analysis revealed that there were significantly more women in Bungoma East who knew about disease preventive nature of VA compared to Bungoma North (z=2.20, CI=0.013-0.19, p=0.025). Again, there were significantly more women in Bungoma East who knew about the disease preventive nature of VA compared to women in Kimilili (z=2.0, CI=0.003-0.20,

p=0.042) and Bunyala (z=2.40, CI=0.028-0.258, p=0.015) respectively. There was very poor knowledge among the women regarding eye protection nature of VA with only about 10% or less responding correctly. Those mentioning any other correct fact about VA were higher in Bunyala but this did not differ significantly with other sub-counties in the study. Those who were able to mention 1 other correct answer were the majority with 47.7% in Bunyala and 29.1% in Bungoma East where further analysis showed significantly more women in Bunyala being able to give 1 correct answer compared to Bungoma North (z=2.40, CI=0.020-0.19, p=0.015) and Bungoma East (z=3.20, CI=0.073-0.299, p=0.001). Those who were able to give 2 correct answers were comparable across the sub-Counties. 15% of the women in Bungoma East were able to list three foods rich in VA compared to 3% of women in Bunyala and further analysis revealed that there was a significant difference in women able to list 3 foods between Bungoma North and Bunyala (z=3.60, CI=0.046-0.156, p=0.000), between Bungoma East and Bunyala (z=3.60, CI=0.055-0.185, p=0.000) and between Bunyala and Kimilili (z=2.8, CI=0.023-0.299, p=0.005) (Table 4.11). In giving 3 correct answers, caregivers in Bunyala consistently performed poorly.

A comparison was made through KII to qualitatively gauge the general perception about vitamin A. The majority of the health workers (in-charge of health facilities) were not sure about their knowledge of VA and VAD. The participants seemed to have a common voice that VAD was a very rare condition and that they had not experienced it at their places of work. This means that the participants somehow played ignorant of the existent of VAD depicting poor knowledge.

> "….Vitamin A deficiency is a condition in which someone is lacking vitamin A in their body. In pregnant mothers, the signs are blurred vision and night blindness. You don't see well at night. In infants, they almost have the same because if a child doesn't eat vitamin A,

then their vision won't be good; they won't be able to see well. I have not seen any of late, if they are there then they must be very rare…." (Nurse in–charge, Busia County-KII).

"…. It is a state of the body; lacking nutrients from vitamin A. I don't know how to call it in another language! Lacking vitamin A is either due to nutritional deficiencies or due to some disease. You see vitamin A is a small, small, small disease. Knowing its … [signs and symptoms] is not easy! We always treat it but, diagnosing it…, No I don't know! I know that when you lack vitamin A, you will get rickets, in babies and also you will get eyesight problem. No! Vitamin A does not bring rickets, No! Vitamin D is the one causing that. [Nurse in-charge, confuses vitamin A and Vitamin D in babies but later corrects herself]…." (Nurse in – charge, Bungoma County-KII).

Some health workers failed to recognize that VA is a nutrient and emerging voices described it as a set of nutrients. Failure to display good knowledge of VA could be seen among frontline nurses who were unable to identify VAD symptoms in both children and mothers. It appears that there are no routine tests for night blindness and therefore no records could be traced at health facilities. Some respondents used certain world as…. just *a small disease whose symptoms are not known and may be confused with other diseases.*

"….VAD mostly affects children and it's where you will get a child with problems with the skin […..] I have not seen VAD, it's a rare condition." (A Nurse in – charge Busia County)

"....VAD is the lack of Vitamin A in the body and some patients will present with some complications like eye problems and others. Some of them will present with complications [….] the pre-term babies may have other deformities. Infants, they will present with may be

dry skin, also the eyes will be dry, which means there is no lubrication of the cornea.[….]For those who do report night blindness no, we don't have data…." (A Nurse in – charge, Busia County)

"….It is lack of the required level of vitamin A in the body. In pregnant women mothers, we have … anaemia is one of them, blurred vision, I mean poor sight. Infants, we also have anaemia. There is also that eye problem. Jaundice could be one of them. It also affects the growth of the baby. [….] But rare, if they are there, they are few…." (A nurse in –charge, Bungoma County)

4.5.2. Caregivers' Knowledge about Nutrition in the Study Area

Regarding caregivers' knowledge about nutrition on '*what makes a child grow'? ,* a high of 30% in Bungoma East and low of 16% in Kimilili said that '*eating sufficient amounts of* food' makes a child grow. However, further analysis revealed that caregivers who responded '*eating sufficient amounts of food'* were significantly higher in Bungoma East compared to Kimilili (z=3.6, CI=0.065-0.229, p=0.000) and Bungoma North (z=3.1, CI=0.043-0.186, p=0.002) respectively. Eating different kinds of foods in order to grow had a high in Kimilili (65%) and a low in Bungoma East (54%), although caregivers who said '*eating different kinds of foods'* were significantly higher in Kimilili compared to Bungoma East (z=2.3, CI=0.015-0.207, p=0.024); this significant difference was also observed between Bungoma North (higher) and East (z=2.2, CI=0.010-0.184, p=0.029). Caregivers, who thought when 'a *child does not get sick often'* is when they grow, were comparable across the sub-Counties. The ability to identify the three food groups was relatively high and comparable across the sub-Counties with 67% in Bunyala and 80% in Bungoma East. However, a further analysis revealed that significantly more women even

in Bungoma North were able identify food groups compared to Bunyala (z=2.1, CI=0.006-0.156, p=0.034) but significantly more women in Bungoma East (z=2.6, CI=0.032-0.24, p=0.010) were able identify food groups compared to Bunyala. In each sub-County, approximately 40% of the women were able to identify energy-giving foods, with women in Kimilili being more knowledgeable about energy giving foods compared to Bunyala (z=2.0, CI=0.004-0.189, p=0.041) and Bungoma East being more knowledgeable compared to Kimilili (z=2.0, CI=0.002-0.198, p=0.046) (Table 4.8). Bungoma North was more knowledgeable compared to Bunyala (z=2.4, CI=0.019-0.187, p=0.016), Bungoma East was more knowledgeable compared to Bunyala (z=3.4; CI=0.083-0.311, p=0.001) and Bungoma North (z=2.1, CI=0.005-0.183, p=0.038) respectively (Table 4.12).

Regarding body building foods, women from Bungoma North were more knowledgeable compared to those in Bunyala (z=2.2, CI=0.012-0.180, p=0.025), while those from Bungoma East were better than those from Bunyala (z=2.1, CI=0.006-0.230, p=0.039). In this area of knowledge, again Bunyala performed poorly. As for the protective foods, both Bungoma North (z=2.6, CI=0.028-0.196, p=0.009) and East (z=2.0, CI=0.002-0.224, p=0.045) were more knowledgeable compared to Bunyala. In comparing main sources of energy foods, at least 88% of all caregivers, in all sub-counties, recognized cereals, sweetpotatoes and cassava as the main sources of energy-giving foods and this was comparable (Table 4.12). Those who mentioned orange-fleshed sweet potato as an energy source was higher in Bungoma East compared to Kimilili (z=3.5, CI=0.018-0.063, p=0.001), Bunyala (z=2.6, CI=0.010-0.074, p=0.012)) and compared to Bungoma North (z=3.9, CI=0.0180-0.054, p=0.000) respectively.

Table 4.12. Women's knowledge about nutrition

	sub-County							
	Kimilili (355)		**Bunyala (152)**		**Bungoma North (987)**		**Bungoma East (136)**	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
What makes a child grow?								
Eating sufficient amounts of food	55	15.6	34	22.2	183	18.5	41	29.9
Eating different kinds of food	230	64.8	93	61.1	626	63.4	73	53.7
Child does not get sick often	37	10.5	20	13.1	115	11.7	20	14.5
Can identify three food groups, yes	258	72.7	102	67.0	1282	75.1	109	80.4
Energy giving foods	150	42.3	50	32.6	423	42.9	71	52.3
Body-building foods	142	40.0	48	31.7	408	41.3	59	43.5
Protective foods	138	38.9	47	30.8	415	42.0	57	42.1
Main body energy foods								
Cereals, sweet potatoes, cassava	324	91.3	134	88.1	885	89.7	121	89.3
Orange-fleshed sweet potato	1	0.2	0	0.0	6	0.6	6	4.2
Fats (margarines, butter, etc)	4	1.0	3	1.8	12	1.2	1	0.9
Beans, groundnuts	146	41.3	49	32.0	405	41.5	66	48.6
Eggs, meat, milk and fish	87	24.4	60	39.7	234	23.8	28	20.6
Fruits and vegetables	83	22.9	55	36.1	220	22.3	27	19.6
Main body building foods								
Cereals, sweet potatoes, cassava	184	51.7	71	46.6	482	48.8	67	49.5
Orange-fleshed sweet potato	1	0.2	1	0.5	4	0.4	1	0.9
Fats (margarine, butter etc)	12	3.4	4	2.3	15	1.5	4	2.8
Eggs, milk, meat and fish	220	62.0	106	69.9	614	62.2	81	59.8
Fruits and vegetables	122	34.4	72	47.5	376	38.1	59	43.5
Main protective food								
Cereal, sweet potato, cassava	114	32.2	27	17.5	294	29.8	40	29.5
Fats(margarines, butter, etc)	2	0.5	0	0.0	10	1.0	4	2.9
Beans, groundnuts	76	21.4	25	16.6	217	22.0	36	26.7
Eggs, milk, meat and fish	136	38.4	58	38.2	332	33.6	41	30.5
Fruits and vegetables	269	75.7	132	86.6	768	77.8	111	81.4

There is statistical difference p<0.05) using 2- proportion z-test

In this area of knowledge, Bungoma East consistently performed better than all other sub-Counties. As for fats (margarines, butter, etc.), Kimilili caregivers were more knowledgeable about them as source of energy compared to Bunyala (z=2.3, CI=0.002-0.032, p=0.024), all other sub-Counties were comparable. Beans and groundnuts was mentioned as a main energy source by about 40% of the caregivers across the sub-Counties although further analysis revealed that more caregivers in Kimilili mentioned this food group compared to Bunyala (z=2.0, CI=0.04-0.186, p=0.049), more caregivers in Bungoma North mention this food compared to Bunyala

(z=2.3, CI=0.015-0.176, p=0.021) and more caregivers in Bungoma East mentioned this food group as an energy source compared to Bunyala (z=2.9, CI=0.053-0.279, p=0.004). More caregivers in Bunyala thought that eggs, meat, milk and fish were main sources of energy (z=3.5, CI=0.067-0.240, p=0.001) compared to Kimilili (Table. 4.12).

Similarly, more caregivers in Bunyala compared to Bungoma North (z=4.2, CI=0.015-0.176, p=0.0001) thought that these foods were main sources of energy. Compared to Bungoma East, again more caregivers (z=3.5, CI=0.084-0.30, p=0.000) thought that eggs, meat, milk and fish were main sources of energy. Regarding fruits and vegetables more caregivers in Bunyala compared to Kimilili (z-3.1, CI=0.048-0.216, p=0.002) thought these foods are a main source of energy. Again, more caregivers in Bunyala compared to Bungoma North (z=3.7; CI=0.065-0.211; p=0.000) thought these foods are a main source of energy, while more in Bunyala compared to Bungoma East (z=3.1, CI=0.061-0.269, p=0.002) thought these foods are a main source of energy. About 60% of caregivers reported eggs, milk, meat and fish as the main body-building foods, and this was comparable across the sub-Counties. Across sub-Counties caregivers was relatively more knowledgeable about energy giving foods and least knowledgeable on the body building foods. Approximately 80% of the caregivers agreed that fruits and vegetables were the main protective foods (Table 4.12).

4.5.3. Knowledge Scores, Individual characteristics and Awareness about Vitamin A and Vitamin A Deficiency amongst Pre-and Post-Natal Mothers

Caregivers' knowledge about health seeking behavior and child care was associated with age, where older caregivers were significantly more knowledgeable on health seeking behavior and

child care *(χ^2=5.46, df4, p=0.049).* Highest level of formal education attained was strongly associated (*χ^2=24.49, df2, p=0.000*) with knowledge about health seeking behaviors and child care, and nutrition and VA (χ^2=3.27, df2, p=0.000), where caretakers who had attained higher level of formal education were more knowledgeable in the two areas. Caretakers in monogamous marriages were more knowledgeable about health seeking behaviors and child care (*χ^2*=13.93, df6, p=0.030*),* than about nutrition and VA.

Table 4.13. Caregivers' knowledge scores by individual and household characteristics

	Women in the highest quintile of knowledge about health seeking behaviors and child care n=257 (15.77)				**Women in the highest quintile of knowledge about nutrition and vitamin A n=541 (33.77)**			
	n	***%***	***χ2(df)***	***p***	***n***	***%***	***χ2(df)***	***p***
Age (years): < 35	206	80.0	*9.529(4)*	**0.049***	425	78.6		
36-50	43	17.0			101	18.7	*5.462(4)*	*0.243*
> 50	8	3.0			15	2.8		
Highest level of formal education completed		62.0				44.9		
Primary or lower	159	38.0	*24.49(2)*	***0.000****	243	55.1	*3.266(2)*	***0.000****
Higher than primary	98				298			
Marital status								
Married monogamous	193	75.0			438	81.0		
Married polygamous	18	7.0	*13.93(6)*	***0.030****	48	9.0	*6.747(6)*	*0.345*
Single	29	11.0			42	8.0		
Other	17	7.0			13	2.0		
Agric. principal activity: No	188	73.2	*6.826(2)*	***0.033****	408	75.4	*2.992(2)*	*0.224*
Yes	55	21.4			114	21.1		
Household size (members)								
0-5	139	54.1	*4.675(4)*	*0.322*	260	48.1	*8.981(4)*	***0.049****
6-10	109	42.4			269	49.7		
11-16	9	3.5			12	2.2		
HHs wealth quintiles								
Lowest	26	40.8			55	10.2		
second	30	45.2	*26.89(4)*	***0.000***	64	11.8	*3.921(4)*	***0.000****
middle	28	44.9			60	11.1		
fourth	33	52.5			71	13.1		
Highest	33	54.6			70	12.9		

***There is statistical difference at *p*<0.05; Pearson's χ^2 –test**

Caretakers who practiced agriculture as a principal activity were more knowledgeable about health seeking behaviors and child care (**χ^2**=6.826, df2, p=0.033*),* compared to knowledge about nutrition and VA. Caretakers with smaller household sizes were more knowledgeable about

nutrition and vitamin A (χ^2=4.675, df4, p=0.049), whereas women in the highest wealth quintile were more knowledgeable both about nutrition and VA and health seeking behaviors and child care (χ^2=*26.89, df4,* p=*0.000)* (Table 4.13).

FGD discussants displayed some level of limited knowledge on VA. There seemed to be no local name that describes VAD and the respondents exhibited limited awareness of its existence. Even though some of the participants declared having heard about VA/VAD before, especially during schooling, generally the level of awareness appeared low. Many of those who reported to have heard about VAD confused it with *anemia*. This implies that majority did not know the correct signs and symptoms, treatment and prevention of VAD. Despite lack of knowledge about VAD and its control, all of the respondents reported to have taken or allowed their child/children to be given vitamin A capsule (VAC). The component of VA and VAD was only supported by VAC programme which is given during the 9 months of post-natal visits.

> ***[When asked to explain what vitamin A is and its importance, all participants laugh, and respond in unison,]*** "We don't know what the red drug is used for. All we know is that, it is for vitamin A" ….(Busibwabo dispensary Post-natal mothers).
>
> "…. From my side, I just hear children being given vitamin A, but I don't know what it's meant for, maybe you could explain that to me…."(29 year old, mother visiting Matayos Health Center. post-natal clinic)[All other Participants agree with her].
>
> "….We are only told its vitamin A, but we are not told of its function…" (28 year old, Nambale Sub-county hospital, post-natal mother) [Other participants are in agreement with her].

"….We have never asked! We have never asked! [All participants respond in unison] We are always told it's a vaccine! …. (One of the participants, Mahonge dispensary Post-natal mother).

Although previously frontline health workers reported very rare VAD cases where some reported not to have heard experience with VAD at their places of work, mothers on the other hand reported difficulty in seeing at deem light moment during and after their pregnancy. This could be symptoms of VAD which are exhibited among the mothers of children but were not recognizable by the both mothers and health workers due to lack of knowledge.

"….There could be sunshine for example and with this pregnancy, moving from the sun going into the house, you will see darkness. This can take between two and three minutes, it's when you start seeing properly again. [Have you experienced it at night…] I personally have experienced it. At times when coming from the house at night, I am not able to see totally and therefore have to stand like for five minutes, that's when I can start seeing some light…." (29 year old woman, on her 1st trimester visit to Busibwabo Pre-natal clinic-Busia).

"……..It takes me like one minute to see. It affects me a little. [When coming from where there is light, going into the house? Whenever you are expectant or after delivery?] Even now! [Even now? And have you seen the doctor?] No!" …. (22 year old woman visiting Khaoya post-natal clinic-Bungoma).

"…. Mine takes like five minutes! [Your eyes?]Yes! And they are itchy [they only itch, but you can see properly?] No, it takes time! [For you to see properly?] Yes! [And have you informed the doctor?] I visited Webuye (a different health facility), some time back and I

was told to go back, but I did not go back…….” (23 year old woman visiting Khaoya post-natal clinic-Bungoma).

Other proxy indicators of limited knowledge emerged from statements where all the discussants appeared to have described some form of blindness with limited connection to VAD. Regarding knowledge about VAS, participants gave very varied responses and nearly half of the participants in both groups confused VAS with polio vaccine, anti-malarias, and appetizers amongst other preventive and curative services given at clinics. Sixty seven percent of the women interviewed about knowledge on VAS said they were not aware of its importance (Table 4.14).

Table 4.14. Knowledge about VA supplements in the FGDs

Critical quote about Vitamin A supplementation	No. of response	%
“…. helps to protect the body from disease….”	6/48	12.5
“…. It prevents polio….”	4/48	8.3
“…. It helps the child have appetite….”	4/48	8.3
“…. gives him good health…”	3/48	6.3
“…. It’s for preventing the disease…so that the baby is not attacked by night blindness….”	3/48	6.3
“…. It prevents malaria….”	2/48	4.2
“…. It prevents pneumonia….”	1/48	2.1
[All participants laugh, “…. We don’t know what it is used for. All we know is that, it is for vitamin A] ……we are not told what it is….”	32/48	66.7

4.5.4. Contextualized Proximal Nutrition Sensitive Indicators of Knowledge in relation to Vitamin A

In order to understand critical theories behind VAD knowledge an extension of general nutrition knowledge was also evaluated with a focus on three sensitive domains namely: meaning of balanced diet, importance of having a balanced diet during and after a Pregnancy and child feeding practices for children aged 6-23 months in relation to Vitamin A.

Meaning of a balanced diet: Majority of the participants perceived that a balanced diet was one that consisted of all the three main classes of nutrients including carbohydrates, proteins and vitamins. Critical voices focused on macronutrient domains and principles with limited mention of vitamins. This implies that knowledge gap would exist on micronutrient components of diet which justifies limited VAD knowledge. Occasionally some voices mentioned vitamins however, such voices lacked specificity on VAD and related vitamins in the realm of balanced diet.

> "….A balanced diet is making sure you eat body building foods like *Ugali* (local food made from maize flour), beans, beef and also fats. You also feed on vitamin giving foods like fruits and those that protect you from diseases. And not forgetting water, you also make sure you drink some water, and have some energy giving foods also…." (26 year old woman, attending a pre-natal clinic at Busibwabo dispensary-Busia).
>
> "….A balanced diet is feeding you child on different food types containing carbohydrates, vitamins, proteins, fats and oils…." (23 year old woman, attending a pre-natal clinic at Matayos health center-Busia).
>
> "….A balanced diet is one that gives the baby energy, vitamins and proteins like for example eggs, fruits and ugali…" (25 year old woman, attending a post-natal clinic at Matayos health center-Busia).
>
> "….Proteins, carbohydrates, and vitamins…" (22 year old woman attending a post-natal clinic at Mahonge-Bungoma).

Further analysis revealed that there seemed to be poor understanding of which foods belong to which particular nutritional category. Amongst the responses given when asked for carbohydrate giving foods, they mentioned; sugarcane and avocado. When asked for proteins, the participants mentioned fruits, *"mrenda" (local vegetable)*, kales, Avocado, and blue band (margarine) as one

of the protein giving sources of food. This confusion in food and nutrient identification justifies by proxy poor knowledge and awareness of VA and VAD.

> "….Changing diet, if today you take Fish and 'Ugali', tomorrow you will take rice and 'Irish' potatoes…." (23 year old woman, attending a pre-natal clinic at Tongaren Health center-Bungoma).
>
> "…Energy giving foods are, *Ugali*, Sweet potatoes, Sugarcane [other participants laugh at the response] Cassava, Porridge, Avocado…." Proteins include; blue band, fish, milk, eggs. Vitamins include; kales, carrots […]" (Women attending pre-natal clinic at Tongaren Health center-Bungoma).
>
> "…Proteins include; Fruits, beef, Kales, Avocado. Vitamins include; fruits and some greens. Carbohydrates include; *Ugali*, cassava, cooked bananas, sweet potatoes…." (Women attending pre- natal clinic at Khaoya Health center-Bungoma).

4.5.5. Importance of Having a Balanced Diet during and after a Pregnancy

Repeated voices appeared to attest to the fact that participants had some prior knowledge on the importance of having a balanced diet, during and after a pregnancy. Amongst the reasons for having a balanced diet, during and after a pregnancy included: to regain strength and blood lost during delivery, for the mother and baby to have good health, have enough milk for the baby and to improve the baby's immunity. All these reasons somehow relate with vitamin A functions but could only be implied justification of role of nutrition and balanced diet in wellbeing of the mother.

> "…To regain blood lost during delivery! And to gain back strength. I have only that..." (20 year old woman attending post-natal clinic at Busibwabo dispensary-Busia).

"….You have to feed on energy giving foods, and be healthy so as to ensure the baby gets enough milk during breast feeding…." (26 year old woman attending post-natal clinic at Busibwabo dispensary-Busia).

"….An expectant woman should feed well because, since she is expectant, she has a fetus in her tummy and therefore she is supposed to be healthy so that when the day comes to deliver, she will be strong and will regain blood lost during delivery and avoid dizziness every now and then. That's the reason for a pregnant woman feeding on a balanced diet…." (29 year old woman attending post-natal clinic at Matayos Health center-Busia).

"….We feed on a balanced diet, so that the woman giving birth can have strength. Mostly after delivery, we feel weak. So we feed on a balanced diet, so as to regain back our health and also have enough breast milk for the baby…." (29 year old woman attending post-natal clinic at Nambale Sub-county hospital-Busia).

"….So that the mother can have complete immunity and avoid problems for the baby…." (23 year old woman attending post-natal clinic at Khaoya dispensary-Bungoma).

4.5.6. Child Feeding Practices for children aged 6-23 months in relation to Vitamin A

Testing the foods adequacy for their children 6-23months old, women had a mixed level of aptitude in responding to the qualitative descriptions of attitudes towards dietary and child feeding practices. None of the women mentioned breastmilk as an important food that they feed to their children yet breast milk is an important source of VA. This reflected limited knowledge on provision of Vitamin A especially at critical age of weaning where continued breast feeding is required. The knowledge of appropriate weaning somehow demonstrated existent a mechanical feeding pattern which only occurs by default.

"…. I give my child porridge from maize flour, water, soft vegetables……eeeh ….I don't know how to call in English or Kiswahili but locally it is called mrenda". {Women respond in unison}. (21 year old woman attending post-natal clinic at Khaoya dispensary-Bungoma).

"….for me I also give porridge and ugali from cassava……then ugali from cassava and vegetable or fish soup because at this age he cannot chew the fish or the vegetables ". (26 year old woman attending post-natal clinic at Nambale Sub-county hospital-Busia).

….most of use give porridge from cassava or maize because that is what easy to get and cook…… {Women respond in unison}. Other foods that are recommended to us such as pumpkin, sweetpotato are expensive and sometimes off season……some of us do not know that are fed to children of this age. (29 year old woman attending post-natal clinic at Matayos Health center-Busia)

Some common beliefs and perceptions emerged as restrictive in provision of Vitamin A rich foods during weaning. Women mentioned various foods that are available seasonally but found it difficult give to their children for various perceived reasons associated with common beliefs. *Mango* which is a rich source of Vitamin A was perceived as the theory behind *frequent bowel movement* and *common cold* demonstrating high level of belief strength among the caregivers with restrictive forces.

…. Most of us do not give our children mangoes because it causes frequent bowel movements and there is a change in the colour of her stool……{Women laugh and respond in unison!!}. …..one woman……it makes my child have 'homa'…..eeeh what is this called in English….aaah! I don't know….. (Women attending pre- natal clinic at Nambale Sub-county – Busia).

CHAPTER FIVE

DISCUSSION

5.1. Introduction

This chapter discusses study results in the light of VAD prevalence and geospatial distribution of VAD prevalence, Socio-Demographic Characteristics and VAD Status, Food intake, Nutritional status and VAD status, Knowledge, Perceptions and VAD status regarding children among children 6-23 months.

5.1.1 VAD prevalence and geospatial distribution of VAD prevalence among children 6-59 years

This study has shown that in western Kenya, vitamin A deficiency (VAD) prevalence (20.1%) is a public health concern. According to World Health Organization (WHO) whose cut-offs for community VAD are 2-9%-mild, 10-19% is moderate while ≥20% (WHO, 2009). This magnitude of prevalence in the study area requires public health intervention among these children aged 6-23 months. These findings are comparable with the neighboring province of Nyanza where VAD prevalence is about 23% among children 6-59 months (Ruth *et al.*, 2009), but sharply contrast the national figure of 62.1% (Mwaniki *et al.*, 2000). According to world Health Organization (WHO, 1995) categorization, Bunyala (30.3%) and Bungoma North (20.7%) were severely affected by VAD; Kimilili (17.8%) was moderate to severe, while Bungoma East (10.3%) was moderate to mild. In terms of location, children in Bunyala and Bungoma North were most affected by high proportions of VAD, with children in Bunyala having a 3.5 odds ratio of developing VAD followed by Bungoma North 2.2 and then Kimili 1.9.

This study has shown that the prevalence of VAD in Western Kenya is not evenly distributed but forms clusters that are distributed at various places in the study area. These findings are in line with those of WHO (1995) which found that the occurrence of forms VAD is not evenly distributed but forms clusters (WHO, 1995). Overall, there are hot spots of VAD for children aged 6-23 months, with the prevalence being alarmingly high (>20%) in certain sub-locations in Bungoma such as Kibisi, Kabuyefwe, Soysambu, Sitabicha & Mabakalo, while in Busia such sub-locations were Magombe West, Magombe Central, Ruambwa, Budalangi and Mudembi. Clustering is likely to reflect a convergence of several risk factors that lead to depletion of VA stores in the surrounding child population (WHO, 1995). For this reason, severely sub clinically deficient populations of children up to 5 years of age, based on the distribution of the serum retinol levels, are considered to be as much at risk of severe morbidity and mortality as those populations experiencing clinical deficiency (WHO, 1995). Furthermore, moderately sub clinically affected populations such as Tongaren, Mituwa, Makhonge, Nabikoto, Ndalu, Sirakaru, Milima and Mihuu, are also likely to be at risk because according WHO (1995) moderate levels of VAD can quickly turn severe depending on child environmental and health condition.

The fact that VAD distribution is uneven means that there are factors specific to areas that are influencing this difference. The current study found that spatially, there were clustering of VAD in the study area which were influenced by i) average travel time to various places, ii) distance to health centers, iii) distance to towns and iv) length of food crop growing season. These findings are in line with those of Kazembe et al (2006) who found that the physical location of a child can affect his/her health though several means and can further influence the success of interventions in many ways. Furtherrmore, WHO (1995) found that clustering of VAD is related to ecological

factors and poorly developed infrastructure. This means that the target population cannot be easily reached and accessing health facilities for VAD services and other sources of VA have been affected and may be the reason the VACs coverage is very low in Western Kenya. Furthermore, this could also hamper distribute vitamin A-containing foods from excess to deficient areas because vitamin A-rich foods tend to be quite perishable (WHO, 1995). Hostile environments such as arid, infertile land, or the periodicity of excessive rain and humidity, in part determine the variety and amount of foods rich in vitamin A-activity that can be grown, and the duration of their availability.

5.1.2 Socio-Demographic Characteristics and VAD Status

Taking VAC in the last 1 year preceding the survey was an important predictor for VAD. This predictor is a pointer to the failure to reach the recommended VAC coverage and that VAD could be responsible for the high mortality rate that is present in Western Kenya among under fives as has been found by Black et al, (2008). Despite National efforts by Kenya government make VA supplements accessible children through its National Food and Nutrition Security Policy (GoK, 2012), Western Kenya has the lowest VA supplementation coverage (19.8%) in the country with a persistent VAD problem. Additionally, western Kenya has the second highest under-five mortality rate of 121/1,000 live births (KDHS, 2010).

The child's age was found to be a significant predictor of VAD with children aged 18-23 months more vulnerable to VAD than those aged 6-17. Children 6-17 months are more frequently on breast milk compared to 18-23 months old ones. Because breast milk is unadulterated and provides retinol in a readily absorbable form, this age group is less likely to experience factors that precipitate VAD. Furthermore, the mother's antibodies in breast milk provide immunity to

disease. Neonates are currently not given VA supplements because studies have shown no justification in neonatal VA supplementation as a public health intervention in developing countries such as Kenya for reducing infant mortality and morbidity (Gogia, 2009). Even though clinical VAD rarely occurs as long as a child is receiving breast milk, depletion of an infant's body stores, leading to sub-clinical VAD and consequent health risk, may occur by six months of age when maternal VA status is inadequate and thus breast milk VA is low (Underwood, 1994).

Highest level of formal education attained was strongly associated with knowledge about 1) health seeking behaviors and child care, and 2) nutrition and vitamin A. Furthermore, caretaker,s knowledge about vitamin A and nutrition was an important predictor for child VAD. Mothers in the lowest tertile of knowledge on VA and nutrition were 1.4 times more likely to have their children develop VAD compared to those in the highest tertile. These findings are in agreement with those of KDHS, (2010), where the educational level of the mother was positively correlated with consumption of VA-rich foods.

The educational attainment of women has numerous positive impacts on the quality of care they themselves receive during pregnancy and post-partum and on the quality of care for their children after they are born, ranging from duration of breastfeeding to health care seeking during illnesses (Ruel et al., 2013). Under-educated, impoverished women tend to follow traditional ideas and practices, and are less confident in engaging in social interactions where more modern concepts and practices are promoted. Due to under-education, they are less likely to learn from educational materials typically displayed at health centers and used in health-related community educational activities, including those concerned with appropriate child care and feeding practices (WHO, 1995).

5.1.3 Food intake, Nutritional status and VAD status

Household VA consumption frequency (HKI), Household Dietary Diversity Score (HDDS), Individual Dietary Diversity Score (IDDS) for children, and child feeding practices in the study area were considered. The value of a diverse diet has over time been recognized and is highly recommended since it is strongly and positively associated with nutrient adequacy (Jayawardena et al., 2013). In the HKI measurement, a community is considered to have a VAD problem if: the mean frequency of consumption of animal sources of VA is 4 days/week or less; or the mean frequency of total consumption of animal and plant sources of VA (weighted by the food sources) is 6 days/week or less (HKI, 1993). The study established that the mean number of days in a week that the children consumed vitamin A rich foods from animal sources was only 1.7 days/week against a recommended 4 days/week or more, while the HKI frequency score was 3.3 days against a recommended 6 days/week or more.

Approximately 90% of the children had a HKI food frequency score lower than the minimum threshold of more than 6 days per week. Children younger than 6 months are supposed to be exclusively breastfed. However, results from this study reveal that children were given complementary foods earlier than 6 months. Most mothers/caretakers in the study reported porridge as the first complementary food they gave to the children and this was composed primarily of cereals with little diversity even within the cereals (mainly maize).

In Kenya, 1.8 million children are classified as chronically malnourished with poor breastfeeding and infant feeding practices contributing to more than 10,000 deaths per year (GOK, 2008a). Furthermore, these results are in agreement with those of WHO which found that the diet of a newly weaned child frequently has very little VA and that until a child has begun receiving a

diversified family diet, the post weaning period is one of great vulnerability to VAD (WHO, 1995). It is, therefore, important to enhance diversity in complementary foods, especially among this age of children who are entirely dependent on complementary foods for their nutrient an intake including VA. With regards to dietary diversity (HDDS & IDDS), only 47% and 33% of the children had attained the minimum dietary diversity score and acceptable diet respectively.

Attainment of the minimum dietary diversity among these children was associated with age of the child, thus a significantly higher proportion of children aged 12- 23 months had attained the minimum dietary diversity compared to that of those aged 6-11 months. Arimond and Ruel (2004) showed that the interaction between dietary diversity and child age group showed that attainment of the minimum dietary diversity was most strongly associated with HAZ (stunting) among older children in some countries (e.g., Peru), whereas the opposite was true in Rwanda, where the strongest association was among children 6–11 months old.

Despite evidence from other studies showing associations between HAZ with DDS, (Arimond and Ruel 2004; Sawadogo et al. 2006; Ekesa et al. 2008) no significant relationships were found in this study. This is further supported by another recent study in Kenya which also found no significant relationship between DDS and HAZ (Nungo et al. 2012). This study found that a child's attainment of the minimum dietary diversity was positively associated with the household wealth levels. This is line with other studies that have shown that an increase in dietary diversity is associated with socio-economic status and household food security (Arimond and Ruel 2004; Hoddinot and Yohannes, 2002; Hatloy *et al*., 2000). Families with greater incomes and resources tend to have more diverse diets, but they are also likely to have better access to healthcare, and better environmental conditions.

5.1.4. Knowledge, Perceptions and VAD status

This study has shown that despite the presence of VAD there were low levels of awareness about VAD, VAS, and importance of good nutrition among the communities in Western Kenya. Generally, level of awareness and knowledge about VA and VAD amongst community members was low. These findings were similar to those of Kamau et al, (2012) who found that at Mbagathi District Hospital in Nairobi province, caretakers did not understand the rationale for VAS. The health workers whose expertise included nursing, clinical officer, Assistant Clinical officers, and nutritionists were not able to articulate issues on VA and VAD. They were aware of VAC and even administered it to the mothers and children at the health facilities and during immunization activities. Interestingly, they were not able to correctly describe VA and VAD and could therefore not suspect the deficiency in both children and mothers. Their responses showed that VAD is just a minor disease whose symptoms they do not know clearly and may be confused for other diseases. There were no routine tests at the health facilities for night blindness and therefore no records of its presence or absence.

Although all caregivers were females who had attained at least primary level education, and were thus expected to have knowledge, positive attitudes and practices related to vitamin A, this was not the case as seen in the low level of awareness and poor knowledge about VAD, VAS, and importance of good nutrition. This contrasts findings by Kamau et al (2012) who found that education of mothers was positively correlated with the use of VAS for themselves and their children. Further, participants gave very varied responses and nearly half of the participants confused VAS with polio vaccine, anti-malaria tablets, and appetizers amongst other vaccines.

The fact that mothers allowed themselves and their children to be given VAS during scheduled clinic visits and immunization days showed that most mothers valued VAS. However, the responses given by the mothers about awareness on the child VAS schedules, VA given to mothers and when and why it is given to mothers, indicate that mothers did not understand the rationale for VAS. They consequently followed what they were told by health workers as a routine and this may explain why after 9 months post natal, some mothers would only attend VAS services when convenient. Mothers did not know the correct signs and symptoms, cure and prevention of VAD.

Some also stated that they had never heard about VAD at all despite clinic attendance. These findings are in line with those of Birungi and Onyango-Ouma, (2006), whose study on acceptability and sustainability of the focused ANC package in Kenya showed sub-optimal nutrition counseling with only one third of the women attending ANC clinics for the first time receiving nutritional counseling. Although educational sessions were recommended as part of the ANC service provision, a study in rural Uganda found that ineffective organization of this service was a major impediment to increasing maternal knowledge (Conrad et al, 2012). Additionally, in a cross-sectional survey conducted in western Kenya only 14% of the women participating in the study attended a health talk at the ANC clinic and the health topics covered during these visits were found to be limited in scope (Van Eijk et al, 2006). Moreover, in rural Tanzania, delivery of health information, including nutrition counseling, at the ANC clinics was noted to be among the least likely components of ANC to be effectively implemented (Magoma et al, 2011). This information indicates persistent gaps in effective counseling, specifically in nutrition topics, provided through ANC clinics and this is not surprising because: 1) the HKI food frequency (HKI, 1993) score lower than the minimum threshold of more than 6 days per

week has been observed in approximately 90% of the children in western Kenya (Ouedraogo et al, 2012); 2) the average household dietary diversity score for women in western Kenya was less than five, a level previously demonstrated to correlate with micronutrient inadequacy (Kennedy et al, 2007). Furthermore, a cross-sectional study in rural western Kenya, found that pregnant women avoided certain foods due to various attitudes and reasons such as not wanting large babies, heart burns and stomach upsets (Ouedraogo et al, 2012).

Although this study was not designed specifically to assess night blindness among mothers, 4% of mothers who participated in this study reported having difficulty seeing in deem light during and after pregnancy, the description of which could be night blindness but which was not accorded the needed attention by both mothers and the health workers. The women thought that this is a normal experience during or after pregnancy and did not suspect that it might be night blindness. The extended postpartum risk among night blind women during pregnancy is "dormant"; that is, women carry their risk without remaining night blind (Rolf et al, 2007), necessitating the history to relate to a woman's most recent pregnancy. A study in Nepal, demonstrated that women who became night blind during pregnancy had a higher risk of morbidity, anemia, malnutrition, and infant mortality and could themselves die during pregnancy and at first one to two years postpartum than those who did not (Krueger, 1998, Christian, et al, 2000, Christian, et al, 2001 and Christian, 2002). The study found that there were no routine tests at the health facilities for night blindness and therefore no records of its presence or absence. Finding night blind women during pregnancy, typically through a simple but specific history, can identify high-risk women who are likely to suffer consequences of vitamin A deficiency (Rolf et al, 2007). There were no local names for night blindness. This is not surprising since the

participants did not know signs and symptoms of VAD. In order to effectively control VAD more work needs to be done to identify common, specific terms for night blindness and to incorporate the assessment and treatment of night blindness into primary antenatal and postnatal care (Rolf et al, 2007).

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

This section presents a summary of the study, conclusions, recommendations and suggested areas for further studies.

6.1 Summary

Vitamin A deficiency among children 6-23 months in Western Kenya is a public health problem with a VAD prevalence of >20%, considered as severe by WHO.

Vitamin A deficiency in Western Kenya is unevenly distributed in the population and forms clusters where predictors for these VAD clusters have been identified as length of food crop growing season, distances to towns and health facilities.

Demographic factors that predict VAD among this age of infants in Western have been identified as child age with children 18-23 months being most at risk, child location with a child in Busia and parts of Bungoma North being at most risk, whether a child had taken VACs in the last 1 year or not and mothers' knowledge on VA and nutrition.

The communities in Western Kenya have poor knowledge, low awareness of VA, VAD and general nutrition for children 6-23 months.

6.2 Conclusions

This study has shown that in western Kenya, VAD prevalence is a public health concern among children 6-23 months in Bungoma and Busia counties of western Kenya. The study has further established that the prevalence of VAD in Western Kenya is not evenly distributed but forms clusters distributed at various places and is influenced by travel time to

various places, distance to health centers, distance to towns and length of crop growing season.

Taking VAC in the last 1 year preceding the survey is an important predictor for VAD among children aged 6-23 months in Bungoma and Busia counties of western Kenya. The child's age is a significant predictor of VAD. Highest level of formal education attained was strongly associated with knowledge about 1) health seeking behaviors and child care, and 2) nutrition and vitamin A. Furthermore, caretakers' knowledge about vitamin A and nutrition was an important predictor for child VAD. Mothers in the lowest quintile of knowledge on VA and nutrition were more likely to have their children develop VAD compared to those in the highest quintile.

The mean number of days in a week that the children in the study area consume vitamin A rich foods from animal sources is only 1.7 days/week against a recommended 4 days/week or more, while the HKI frequency score is 3.3 days against a recommended 6 days/week or more. Approximately 90% of the children have a HKI food frequency score lower than the minimum threshold of more than 6 days per week. This is further confirmed by child-feeding practices where the average age at which complementary foods are introduced to children is less than 5 months against a recommended age of 6 months and this is comparable across the study area. Porridge is the first complementary food given to the children and is composed primarily of cereals. Attainment of the minimum dietary diversity among these children is associated with age of the child, thus a significantly higher proportion of children aged 12-23 months attained the minimum dietary diversity compared to those aged 6-11 months. There was no association between DDS and nutritional status but an association was found between a child's attainments of the minimum dietary diversity and household wealth levels.

Although VAD is prevalent in the study area, majority of the people in the community have low awareness. There are knowledge gaps at household, community and facility level. Some health providers (KIIs) display low understanding of the consequences of VAD. Likewise, mothers have low understanding and wariness level of vitamin A sources.

6.3 Recommendations

1. These findings require varying intervention approaches according to circumstances that are influenced by child location which is in line with the current call for nutrition-specific and nutrition-sensitive interventions and programs that target VA and VAD.
2. There is need to educate caretakers on the introduction of complementary foods taking into account dietary diversity as a way of improving VA intake because this apparently is introduced earlier and is low in VA.
3. There is need for health education for healthcare providers so that they can more effectively communicate this information to mothers and caregivers in an effort to prevent, control and eliminate efforts VAD.

6.4 Areas for Further Study

1. There is need to undertake studies that identify short duration crops, that can be grown severally in a year, that are adaptable to this area particularly in Busia County in order to improve access to foods that are rich in VA and suitable for children 6-23 months.
2. There is need to undertake research that identifies how health and other forms of infrastructure can be improved particularly in Busia County in order to improve access to health facilities (VAC distribution), main towns, and markets (access to sources of VA foods) for children 6-23 months.

3. There is need to undertake research that identifies specific educational strategies and materials on VA that are suited to Western Kenya and which target mothers/caretakers of children 6-23 months.

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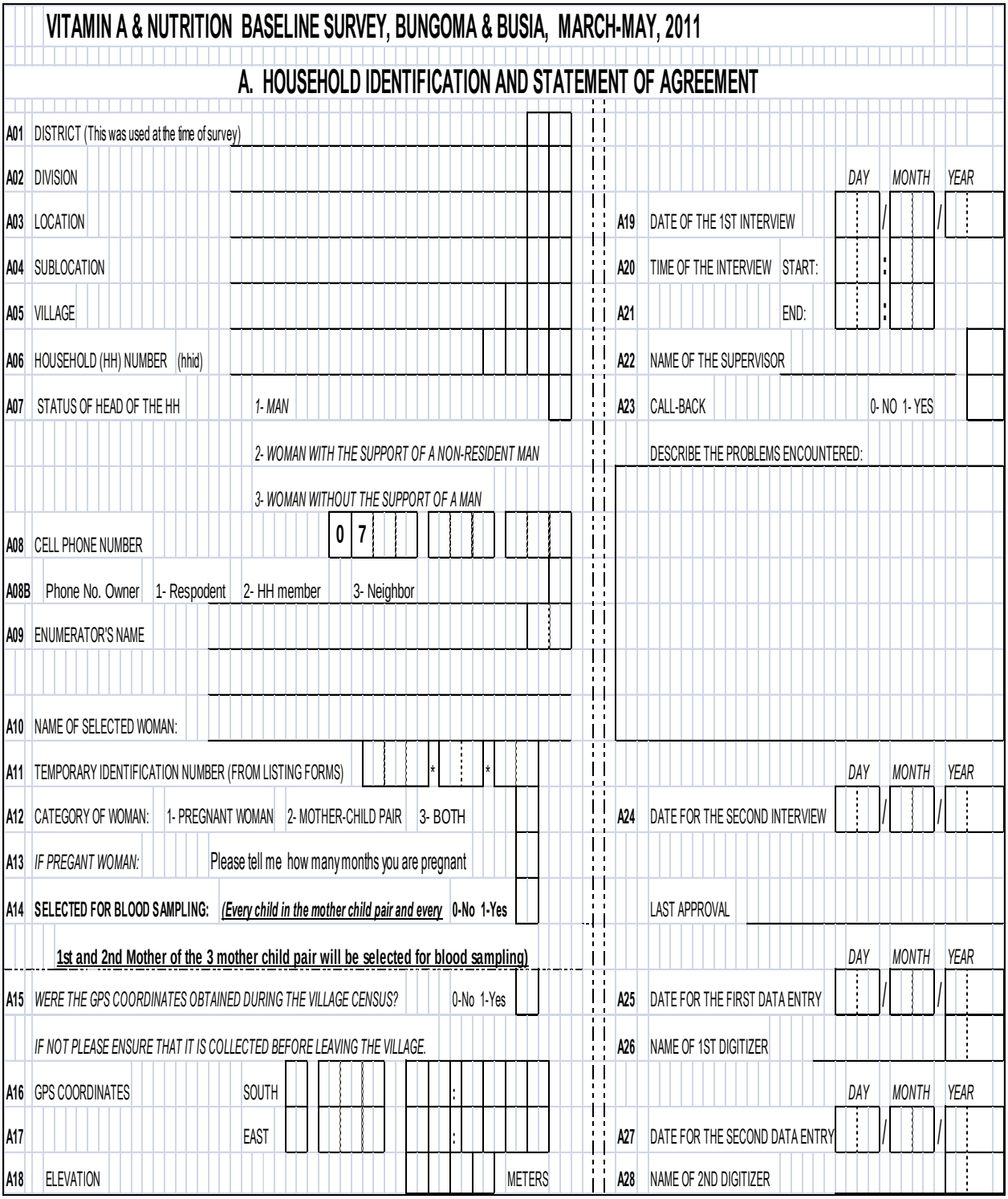
APPENDIX

APPENDIX. I. Quantitative Questionnaire



VITAMIN A & NUTRITION BASELINE SURVEY, BUNGOMA & BUSIA, MARCH-MAY, 2011

A. HOUSEHOLD IDENTIFICATION AND STATEMENT OF AGREEMENT

A01 DISTRICT (This was used at the time of survey)

A02 DIVISION

A03 LOCATION

A04 SUBLOCATION

A05 VILLAGE

A06 HOUSEHOLD (HH) NUMBER (hhid)

A07 STATUS OF HEAD OF THE HH 1- MAN

2- WOMAN WITH THE SUPPORT OF A NON-RESIDENT MAN

3- WOMAN WITHOUT THE SUPPORT OF A MAN

A08 CELL PHONE NUMBER 0 7

A08B Phone No. Owner 1- Respodent 2- HH member 3- Neighbor

A09 ENUMERATOR'S NAME

A10 NAME OF SELECTED WOMAN:

A11 TEMPORARY IDENTIFICATION NUMBER (FROM LISTING FORMS) * *

A12 CATEGORY OF WOMAN: 1- PREGNANT WOMAN 2- MOTHER-CHILD PAIR 3- BOTH

A13 IF PREGANT WOMAN: Please tell me how many months you are pregnant

A14 SELECTED FOR BLOOD SAMPLING: (Every child in the mother child pair and every 0-No 1-Yes

1st and 2nd Mother of the 3 mother child pair will be selected for blood sampling)

A15 WERE THE GPS COORDINATES OBTAINED DURING THE VILLAGE CENSUS? 0-No 1-Yes

IF NOT PLEASE ENSURE THAT IT IS COLLECTED BEFORE LEAVING THE VILLAGE.

A16 GPS COORDINATES SOUTH :

A17 EAST :

A18 ELEVATION METERS

A19 DATE OF THE 1ST INTERVIEW DAY / MONTH / YEAR

A20 TIME OF THE INTERVIEW START: :

A21 END: :

A22 NAME OF THE SUPERVISOR

A23 CALL-BACK 0- NO 1- YES

DESCRIBE THE PROBLEMS ENCOUNTERED:

A24 DATE FOR THE SECOND INTERVIEW DAY / MONTH / YEAR

LAST APPROVAL

A25 DATE FOR THE FIRST DATA ENTRY DAY / MONTH / YEAR

A26 NAME OF 1ST DIGITIZER

A27 DATE FOR THE SECOND DATA ENTRY DAY / MONTH / YEAR

A28 NAME OF 2ND DIGITIZER

B. HOUSEHOLD MEMBERS WITH AN AGE EQUAL TO OR ABOVE 60 MONTHS

VILL: | | | | HHID: | | | |

I would like to ask you questions about each member of your household. We will start with those members over five years.

List the names of everyone considered to be a member of this household who have lived here at least 3 months during 2011.

(For this table 99 is not a valid code)

rshead

01- head	05- Step child	11- parent in law
02- Spouse	06- Parent	12- Son/Daughter in law
03- son/daughter	07- brother/sister	13- Worker
04- grandchild	09- nephew/niece	14- Other relative
	10- Brother/sister in-law	15- No relation

No.	First and Middle name	Surname	Sex	Relationship with the head of the HH *see codes*	Year born	How many months in the last 12 months has this person been living at home	is ... currently enrolled in formal schooling	Highest level of formal education completed *(codes below)*	Marital Status 1- Single 2-Monogamously Married 3- Marital Union 4- Polygamous 5- Divorced or Separated 6- Widowed	Is currently involved in growing sweet-potatoes? 0- No 1- Yes	Is agriculture his/her principle or secondary activity 0- Not applicable 1- Principal 2- Secondary	**Since the Beginning of 2010, has this person:** Sold agricultural or livestock products? **0- No 1- Yes**	Undertaken salaried employment? **0- No 1- Yes**	Done casual labour? **0- No 1- Yes**	Been involved in some other form of self-employment (e.g. fishing, wood cutting, masonry)? **0- No 1- Yes**
			1-M 0-F				0- No 1- Yes								
IDNO	**First**	**Middle**	**Last**	**Sex**	**rshead**	**yrborn**	**mhome**	**school**	**educ**	**mstatus**	**growsp**	**agract**	**soldagr**	**salary**	**cslabor**	**selfemploy**

Education levels (educ)

0=pre school				8= old form 1	9= old form 2	10= old form 3	11= old form 4	
1= std 1	3= std 3	5= std 5	7= std 7	9= new form 1	11= new form 3	12= old form 5	15= college 1	17= college 3
2= std 2	4= sts 4	6= std 6	8= std 8	10= new form 2	12= new form 4	13= old form 6	16= college 2	19= graduate

C. DEMOGRAPHIC OF MEMBERS OF HOUSEHOLD WHO ARE LESS TO 60 MONTHS OF AGE (5 YEARS) VILL: HHID:

Now, I am going to ask you about the children in your household that are under five years of age. Please get the health card for children you have in this age group.

(Use 99=N/A)

Child Ident. Number	First and Middle Name	Surname	Sex 1-M 0- F	Date of Birth DAY	MONTH	YEAR 88- Does not know	AGE (in months)	Has a health card ? 0- No 1- Yes	If Yes: How many registered visits	Child's mother Name	ID No. from (Sec.B) 87-non-resident 88-Dead	If caregiver not mother IDNO of main caregiver	Child's father: Name	ID No. from (Sec.B) 87-non-resident 88-Dead	If father not resident IDNO of male caregiver
chd	**First**	**Middle**	**Surname**	**chsex**	**C01**	**C02**	**C03**	**C04**	**C05**	**C06**	**C07**	**C08**	**C09**	**C10**	**C11**	**C12**

D. HOUSEHOLD LEVEL DIETARY DIVERSITY AND YOUNG CHILD DIET DIVERSITY

Now we will ask you questions about the type of foods you ate in your household yesterday. *If there is a **child 6-23 months of age** in the household, record his/her name here. If there is more than one, choose the oldest.*

Name: ID Number:

Yesterday, did your household consume at least a tablespoon (15 gm minimum) per person of any of the following kinds of food?

First ask the question for the whole household for a category of food. Then if there is a reference child, ask: **Did *(name of reference child) consume this type of food?***

		Household 0-No 1-Yes	Reference Child 0-No 1-Yes			Household 0-No 1-Yes	Reference Child 0-No 1-Yes
D01	Any starchy staple, like maize, cassava, cooking banana, sweetpotato			**D07**	Any other kind of fish, meat or poultry, like beef, chicken, or pork		
D02	A type of sweetpotato that is orange inside			**D08**	Any dark green leafy vegetables		
D03	Any legumes or nuts, like beans, groundnuts, seeds, soybean			**D09**	Any vegetables that are orange inside, like pumpkin or carrot		
D04	Any dairy products like milk, youghurt or cheese			**D10**	Any fruits that are orange inside, like mango or papaya		
D05	Any organ meat like liver or heart			**D11**	Any other kind of fruits or vegetables		
D06	Any eggs			**D12**	Any source of fat, like cooking oil, coconut milk, or butter		

E. WOMEN'S KNOWLEDGE ABOUT NUTRITION & VITAMIN A VILL: ___ HHID: ___

Now I am going to ask you some questions regarding your opinions about the kinds of foods you eat. ***(Write down the response.)***

E01 What makes a child grow? *Does the answer mention:* **E01A** Eating sufficient amounts of foods? 0- No 1- Yes 8- Don't know

E01B Eating lots of different kinds of foods? 0- No 1- Yes 8- Don't know

E01C Child does not get sick often? 0- No 1- Yes 8- Don't know

E02 Have you ever heard of Vitamin A? 0- No 1- Yes ___ **E03** *if yes,* When did you first hear of vitamin A? *if remembers year record year:* Year: ___

If E02=0, skip to E04 1- Over 10 years ago 2- Over 5 years ago, but less then 10 3- 2-5 years ago 4- last 5- just recently 8- can't remember 99-NA ___

E04 Why is Vitamin A important for us? *Does the answer mention that it:* **E04A** Prevents disease? ___ **E04B** Protects the eyes? ___ **E04C** Any other correct fact? ___

0- No 1- Yes 8- Don't know

E05 Please give me 3 examples of foods rich in Vitamin A ___ ___ ___

Refer to the code list *Determine the number of foods that are correct:* ___

E06 Can you tell me the three key food groups? 0-No 1-Yes ___ *Does the answer mention:* **E06A** Energy-giving foods? ___ **E06B** Body-building foods? ___ **E06C Protective** foods? ___

0- No 1-Yes 8- Don't know

E07 What are the main sources of energy? *Does the answer mention:* **E07A** Cereals (maize, millet, sorghum, ..), sweetpotatoes, cassava? **E07D** Beans, groundnuts? 0- No 1-Yes 8- Don't know

E07B Orange-fleshed sweetpotato (OFSP)? **E07E** Eggs, milk, meat and fish?

E07C Fat (margarines, vegetable oils, butter, etc)? **E07F** Fruits and vegetables?

E8 What are the main body building foods?? *Does the answer mention:* **E08A** Cereals (maize, millet, sorghum, ..), sweetpotatoes, cassava? **E08D** Beans, groundnuts?

E08B Orange-fleshed sweetpotato (OFSP)? **E08E** Eggs, milk, meat and fish?

E08C Fat (margarines, vegetable oils, butter, etc)? **E08F** Fruits and vegetables?

E9 What are the main protective foods?? *Does the answer mention:* **E09A** Cereals (maize, millet, sorghum, ..), sweetpotatoes, cassava? **E09D** Beans, groundnuts?

E09B Orange-fleshed sweetpotato (OFSP)? **E09E** Eggs, milk, meat and fish?

E09C Fat (margarines, vegetable oils, butter, etc)? **E09F** Fruits and vegetables?

E. WOMEN'S KNOWLEDGE ABOUT NUTRITION & VITAMIN A , cont.

VILL: HHID:

Does the answer mention: **E10A** Hold the baby and ensure baby's skin touches mother's skin **E10B** Breastfeed the baby **E10C** Mother should take a Vitamin A capsule

E11 When a baby is born, is it good or bad to give the first milk (the colostrum)? ..... 0- Bad 1- Good 8- Don't know

E12 What do nurses mean when they use the term *exclusive breastfeeding* ?

Correct? 0- No 1- Partially 2- Completely

E13A At what age should a baby be given water for the first t..... **E19B** *indicate the units using codes: 1-days 2- weeks 3-months 4- years*

E14A At what age should a baby be given other foods such as porridge for the first..... **E20B** *indicate the units using codes: 1-days 2- weeks 3-months 4- years*

E15A At what age should a baby be given sweetpotato for the first..... **E21B** *indicate the units using codes: 1-days 2- weeks 3-months 4- years*

E16A If the mother and the child have no special problems, a mother should breastfeed her child until wh..... **E22B** *indicate the units using codes: 1-days 2- weeks 3-months 4- years*

E17A How many times should a breastfed child 6-8 months old be fed porridge or other foods per day? 88- don't know

E18A How many times should a 1 year old breast fed child be fed?

F. HEALTH AND NUTRITION PRACTICE

VILL: HHID:

G01	Are their any traditions that prohibit certain foods being eaten either by pregnant women or women who are breastfeeding?	0- No 1- Yes 8- Don't remember									
G02	*if yes,* List the foods that pregnant women are not supposed to eat.	**G02A**		**G02B**		**G02C**					
G03	*if Yes,* List the foods breastfeeding women are not suppost to eat.	**G03A**		**G03B**		**G03C**					
G04	Indicate with a "1" if the child received the vaccines, 0 if did not receive, and a "2" if the mother says the child received but there is no card.										
	BCG	DPT1	DPT2	DPT3	OPV0	OPV1	OPV2	OPV3	Measles	Date of Measles vaccination: day mon yr	
G05A	Has the child received a vitamin A capsule within the last year?	0- No 1- Yes 8- Don't remember	**G05B**	Date of most recent capsule: day mon yr							
G06	How long after birth did you put (*name*) to the breast?	1- immediately 2- within the first hour 3- after the first hour, but within the first day	4- after the first day	8- Don't remember							
G07A	How old was this child when you gave him/her the first porridge or other solid food?	months	**G07B**	What was this first food?							
		0- No 1- Yes									
G08A	During the past two weeks, has (*name*) ever been ill with?	Fever?	**G08B**	a cough?	**G08C**	diarrhea?	**G08D**	other illness?			
G09A	Since he/she was born, has he/she ever surfered from a serious illness that required hospitalization?	0- No 1- Yes	**G09B**	And from measle	0- No 1- Yes	**G09C**	*if yes,* at what age (months)				

G. FREQUENCY OF CONSUMPTION OF VITAMIN A RICH FOODS DURING PAST 7 DAYS

VILL: HHID

Now we have a few more questions regarding your child (*name*) and how often he has eaten certain foods during the past week.

We are also interested in learning if you ate those foods as well.

H01 Is the *reference child* still breastfeeding? 0- No 1- Yes .....

H02 *If not:* At what age did the child stop breast feeding? 88- don't know Months

[88- don't know]

H03 How many times yesterday did the child receive food? .....

H04 *If the child is NOT breastfeeding:* How many times yesterday did the child receive milk from a cow, goat, or from a package? .....

Explain to the participant that you want the number of DAYS, not the number of times.

During the past 7 days, how many days did the *child* eat *(name of the food)* ?

Meaning, how many days, starting with the last day *(specify the day)* , did the child eat *(food)* remembering that if the child, for instance, ate the food at lunch and at dinner on the same day, that just counts as 1 day.

NUMBER OF DAYS THE FOOD WAS CONSUMED OVER THE PAST 7 DAYS

Num.	NAME OF THE FOOD	CHILD ID	MOTHER'S ID
		H05	**H06**
1	Cassava - fresh or flour		
2	Maize		
3	Whole chillies		
4	Dark green leaves (of all kinds)		
5	Cows milk/goats milk/powdered/condensed		
6	Carrots		
7	Ripe mango		
8	Pumpkin		
9	Sukumawiki (kale)		
10	Ripe papaya		
11	Stiff porridge of sorghum/millet/maize		
12	Rice		
13	Pumpkin or other seeds		
14	White flesh sweet potato		
15	Eggs with yolk		
16	Small fish (omena) FRESH (with intact liver)		
17	Small fish (omena) DRIED (with intact liver)		
18	Small fish (omena) SOUP ONLY		
19	Groundnut or cashew nut		

NUMBER OF DAYS THE FOOD WAS CONSUMED OVER THE PAST 7 DAYS

Num.	NAME OF THE FOOD	CHILD ID	MOTHER'S ID
		H05	**H06**
20	Orange-flesh sweet potato (OFSP)		
21	Chicken		
22	Pumpkin leaves (Sebebe)		
23	Liver - from any animal		
24	Sweet potato leaves		
25	Meat from cow/pig/sheep/rabbit/rat		
26	Butter		
27	Beans (all kinds)		
28	Wheat/biscuits/cookies/bread		
29	Cod liver oil		
30	Food fried in oil or with oil		
31	Amarantha leaves (Terere/Msicha)		
32	Vitamin A fortified margarine (BLUEBAND) or oil added		
33	Prawn/crab		
34	Coconut milk		
35	Yellow-flesh sweet potato		
36	Cerelac (fortified packaged cereal)		
37	LACTOGEN		
38	Any other cereal		
39	Blood added as an ingredient (Mutura)		

H07 *FOR THE **CHILD** IF CONSUMED ANY TYPE OF SWEETPOTATO:*

On a typical day, how much sweetpotato does (name) eat during the entire day?

H07A Number of roots **H07B** Size: 1-Very Small 2-Small 3-Medium 4- Large

H08 *FOR THE **MOTHER** IF CONSUMED ANY TYPE OF SWEETPOTATO:*

On a day when you eat sweetpotato, how much do YOU typically eat during the entire day?

H08A Number of roots **H08B Size:** 1-Very Small 2-Small 3-Medium 4- Large

H09 *If consumed OFSP* , was it available from (1- Your field 2- the market 3- Other 9- N/A) ? .....

H10 Specify other _____

H. HOUSEHOLD ASSETS

VILL: HHID

M01 At present, how much/many of the following does this household own that are usable/repairable?

(Instructions: For value per unit, ask how much they would pay for the asset if they have to buy it in its current state)

Asset	Qty	Value per unit (Kshs)	If value per unit is unknown ask for total value	Owner 0- Woman 1- Man 2- Both	Asset	Qty	Value per unit (Kshs)	If value per unit is unknown ask for total value	Owner 0- Woman 1- Man
M01	M02	M03	M04	M05	M01	M02	M03	M04	M05
1- Storage facility for crop					18- Saw				
2- Water tank					19- Spray pump (back pack)				
3- Radio/ cassette player					20- Motorized water pump				
4- TV					21- Mechanical water pump				
5- Telephone/Mobile					22- Drip irrigation equip.				
6- Solar panels					23- Other irrigation equip.				
7- Gas cooker					24- Cart				
8- Bicycle					25- Plough				
9- Wheelbarrow					26- Harrow, tiller, ridger, weeder				
10- Milking equipment					27- Motor cycle				
11- Chaff cutter					28- Car/truck				
12- Sewing/knitting machine					29- Tractor				
13- Borehole or well					30- Generator				
14- Posho mill					31- Watering can				
15- Sheller					32- Axes				
16- Other agro-processing equip.					33- Watch				
17- Weighing machine					34- Cows				
					35- Sheeps				
					36- Goats				

I. ANTHROPOMETRY & BLOOD SAMPLING

VILL: HHID

INSTRUCTIONS: **P01** DATE OF MEASURE / / **P02** MEASURER: **P03** ASSISTANT:

Weigh all children between 6 TO 23 months old. The child should be undressed when being weighed

Measure the length of children aged between 4 to 23 months old and the height of children thought to be older than 24 months. TIME :

(If the child's age is unknown, measure its length (laying down), if it is less than 85 cm, register it, and if it is greater than or equal to 85 cm, measure the child's height. Measure the heightand weight of the mother or equivalent caregiver

1. REFERENCE CHILD: (INFORMATION FROM THE PREVIOUS QUESTIONNAIRE)

MEM	ID INDIV	Child's Name	Sex	Date of Birth	Age (in	Is he/she	**Blood sampling**
			1-M		completed	a twin?	**P33** IDNO of person taking sample
			2- F	88- don't know	months)		0-No 1- Yes
						0- No	**P34** Blood sampling for child needed?
				Day Month Year		1- Yes	**P35** Blood sampling for child obtained?
P04	**P05**	**P06**	**P07**	**P08** **P09** **P10**	**P11**	**P12**	**P36** Blood sampling for woman needed?
				/ /			**P37** Blood sampling for woman obtained?

SUPERVISOR:

2. INFORMATION AND HEIGHT OF MOTHER OR PRIMARY CAREGIVER **WOMEN:** WEIGHT (0,1 kg) Mother's clothes

MEM	ID INDIV	NAME	Is she	*If yes:*	Has she taken her	1 Measurement	2 Measurement	1- Light weight	Child's clothes	Child's WEIGHT
			pregnant	How	iron sulfate pill within	Mother Alone	Child	(<0,5 kg)	0- Undressed	within normal limits
			0- No	many	the last 2 weeks			2- Medium weight	1- Underwear	0- No
			1- Yes	months?	0- No 1- Yes			(0,5-1,5 kgs)	2- Light clothes	1- Yes
P13	**P14**	**P15**	**P16**	**P17**	**P18**	**P19**	**P20**	**P21**	**P22**	**P23**
						.	.			

3. CHILD'S LENGTH ***SUPERVISOR:*** ***SUPERVISOR:*** ***Method Used***

HEIGHT (0,1 CM) OR LENGTH		1-Length	Is the height or length	*If there is a measurement outside of*
1 Measurement	2 Measurement	2-Height	of the child within	normal limits, re-estimate date of birth
			normal limits	Re-estimated date of birth
			0- No 1- Yes	DAY MONTH YEAR
P26	**P27**	**P28**	**P29**	**P30** **P31** **P32**
.	.			/ /

APPENDIX. II. Qualitative Questionnaire

A. Key informant Interview guide administered to the KIIs at the MCH clinic

1. From your own point of view, what is VAD?
2. Do you know of any signs of VAD? (In pregnant mothers, Infants)
3. Are there pregnant women who complain of difficulty seeing at night, especially those in their 3rd trimester? [If there are any reported cases, ask for the records book to get the magnitude of the problem]
4. Are those having difficulty seeing at night, from specific areas of the community? [Confirm their location from the records book]
5. What do you think are the main factors contributing to VAD in these areas?
6. How can this problem be addressed?
7. Which other nutritional diseases are common in this community? (Probe for the disease and its prevalence from the disease and disease prevalence book – Look for their Geographical location No. 9)
8. What are their causes?
9. Are these nutritional diseases, specific to certain areas of the community? [Ask for documentation if any]

B. Focus group discussion guide administered to mothers pre and post natal [6– 23 months]

1. What foods did you mostly take while you were pregnant? (Wakati wa ujamzito wako, ni vyakula zipi ulipenda kuvikula sana sana? Na baada ya kujifungua?) **What kinds of food should you have during and after pregnancy? (Ni Vyakula vyaaina gani unafaa kula wakati na baada ya ujauzito wako?)**
2. What kinds of food [**should]** did you/do you feed to your baby from 6-23 months? [NB. Exclusive breastfeeding for 1st 6 months and after 6 – 23 months](Ni vyakula gani wewe humlisha mtoto wako wa miezi 6-23 sana sana)
3. From your own point of view, what is a balanced diet? (Kwa maoni yenu, je mwajua maana ya lishe bora ama kwa lugha ya Kimombo, balanced diet?)
4. What is the importance of having a balanced diet after pregnancy? (Ni nini Umuhumu wa kupata lishe bora baada ya kujifungua?)
5. Which foods are readily available in this community? (Ni vyakula gani zinapatikana zaidi huku kwenu?)
6. From your own point of view, what is VAD? (Kwa maoni yenu, je mwaifahamu ukosefu wa vitamin A?)
7. Do you know of any signs of VAD? (Probe for signs in pregnant mothers, Infants) (Kwa akina mama, ni nini inaonyesha ukosefu wa vitamin A? Na kwa watoto?)
8. What do you think are the main factors contributing to VAD in these areas? (Kwa maoni yenu, ni nini chanzo cha ukosefu wa vitamin A mwilini?)
9. How can this problem be addressed? (Ni nini suluhisho wa hii shida?)

APPENDIX.III. Informed Consent Form-English Version

Mother/Guardian Written Own Consent and Consent for her Child

We are here today to ask you and your child to participate in a research study. This study will help us understand what your child is currently eating and if your child is growing well. It will also let us understand what crops you grow and what foods you are eating in your household and how healthy you are. This is because we are working closely with your local health center to improve its services for women with very young children and for women who are expecting a new child. When I say we, I am representing organizations that work in health and in agriculture because we are interested in improving the use of the foods you already grow so that you eat better. We are interested in sweet potato in particular because some of the new varieties of sweet potato are very rich in vitamins essential for making you healthy.

The districts of Bungoma North, Bungoma East, Kimilili, and Bunyala are part of this project. Your child has the right age to qualify for this survey and we would very much like for you and your child to agree to participate. Your help will enable us to assist your country and even those outside of your country to provide better services on how to help mothers themselves to eat well and feed their children better. We want to explain what agreeing to participate in this survey means.

First, you as the person most responsible for caring for the child will be given a date and time on which we will ask you to come to a central location where you will find other women with young children and the team conducting the survey. You will spend about 2 hours with the team answering questions. You will be interviewed by yourself and others will not be able to hear your answers. Second, they will measure your weight and the height *and* the weight and length of the child. We will give you these results immediately. If we find your child is not growing well his or her health is at serious risk due to poor growth and/or illness, we will give you a piece of paper referring the child for immediate treatment at the nearest health center. Third, we may also ask to prick the fingers of both you and your child to obtain about 5 drops of blood each which we will put on a paper. This will be about as painful as a test for malaria with a small prick. This person doing this is well trained and we do not expect any side effects from this test. This small blood sample will be stored and analyzed at the malaria laboratory at KEMRI. We will use it to find out the level of vitamin A, a very important vitamin for good health. We will not be using this blood to determine any other condition. We will not be presenting or using your name or your child's name in any way when we analyze or publish the results. You will not receive the results for you or your child for this test. This is because we are interested in finding out whether there is

a problem with not having enough Vitamin A in the diet within your entire community so that we can work to improve the situation with your local health facilities and agricultural services.

We do not expect there to be any risk to you for participating. However, in the unlikely event that you will get an infection from the finger prick, a project staff member will take you to the health facility and cover the cost of your treatment. Also, we know traveling to the interview site can cost money and we will provide you with 100 KSh to cover your transport costs to and from the interview site. You will receive this at the site the day of the interview.

This project is due to last 2 years but we expect your local health service to be permanently improved as a result of this project. You will benefit from this project if you use the improved services at your local health center. This is the first survey to be conducted in your village. The survey information will be kept by the research team for at least 5 years. The blood sample will not be kept once the analysis for the study is completed. The team will use this information to see how the situation in your community improves after 2 years. However, we again assure you that your personal information and that for your child will not be shared with others outside of the research team nor published. We are reporting results for the community or district as a whole.

Please feel free to ask us any questions. Your signature on this form means that you understand what we have said and that you agree to participate in the study along with your child. Your decision for you and your child to participate is voluntary, and you may withdraw from the study at any time without penalty or loss of access to the health center.

If you join the study, but you have questions later or problems due to taking part in the survey, please contact person leading this study, Mary Anyanngo Oyunga & Dr. Fred Grant, CIP Office, Bungoma; Tel: 0721710038 (email: oyungam2010@gmail.com). We will also giving you the contact information for the secretary of the Kenya National Ethical Review committee (Phone: 020-2722541) if you have any questions about your rights as a study participant.

Woman's First Name: _____ Last Name: _____

Child's First Name: _____ Last Name: _____

Mother or Guardian's statement and Signature:

( ) The above study has been explained to me. The consent form has been read to me, and my questions have been answered to my satisfaction. I understand taking part is voluntary. **I agree** for me and my child to take part in this study. I have received a copy of this form.

Signature:_____ Date____/____/2011

Or if the mother or guardian cannot read: Participant's thumbprint

and Witness' signature: _____ Date____/_____/2011

If present, signature of child's father: _____ Date___/____/2011

If woman (mother) is unmarried and under 18 years, the signature of her father or mother.

Signature of parent: _____ Mother or Father: _____

Name of enumerator: _____

Signature of enumerator: _____ Date____/_____/2011

APPENDIX.IV. Informed Consent Form-Luhyia Version

EFOMU YE KAMAFUKILISIANO KA MAYI OMUKHULU

Khuliano luno khumusaba khuba mumukanda kwe bumenyelesi.Bumenyelesi buno bunakhuyeta khuelewa sina nisiyo mubialanga nende khulia khubela khukholanga ekasi alala nende e hospitali eli simbi nanywe khuyeta huduma khubamayi be bana batiti nende bamayi bali asiro.Nembola ndi efwe nemelele kumukanda kukhola ekasi ye afia yefwe nende bulimi khubele khwenya khuendeleza burumikhi bwe biakhulia nibio mubialanga nio mulie bulayi . Khulinende aja ye kamapwoni khubele kamapwoni malala kamakeni kali nende chivitamini chingali chiyeta kimibili kibe nende afya endayi.

Bumenyelesi buno buli mu chi districti cha Bungoma North,Bungoma East,Kimilili nende Bunyala.Sirekere sienywe siabukulilwe khu masomo kano nende bamanyelesi khurumikhila chingila chiekhumanya mbu buli sirekere mudistrict siabukulwe mungila khulondekhana nende enamba ye babandu bamenyelimo.

Ewe onyala khusanga mubumenyelesi buno ne khwakhekombile sana ofukilile khubamo. Sikila nisiokhwenya khumanya sichakhuyeta sibala siefwe nende bibala bibindi khutasa khumanya bibiakhulia bia afia nende huduma ya afia.

Khwenya khukhwichusie khu surveyi yino.

Lwebweni khuna khuwa e tare nende chisa che khukhwicha abundu nio ocha khunyola babasio nende bakhosia e surveyi. Esurvey yino ekhabukule chisa chibili. Banakhureba kamarebo khulundekhana enju yoo,nisiobialanga nende nisiolichanga.Bakhureba weng'ene khurusiakho babandi aambi. Banapima busiro nende buleyi bwoo ne bakhuwa kamachibu chisa echo. Noli asiro asi we kimiezi 5 Khunapukula kamafuki kamatone 5 khukhwama khulwala khure khukaratasi.Onaulila burafu bukekhe nga ne khupima malaria.Obukula kamafuki kano ali omusomi mu kasi eyo ne sekhutarajia eshida yosiyosi tawe.

Kamafuki kano kakhabikhwe ne khupimwa musipimilo sia KEMRI. Khukharumile khumanya kiwango ya vitamin A, evitamin ya muhimu khu maisha kefwe. Se khurumikhila kamafuki ako khupima sisindu sisindi tawe. Sekhukharumikhile lisina lio aundu wosi tawe. Ne sokhanyole kamachibu ke khupimwa kamafuki tawe.Sikila aaja eli khumanya kiwango ya vitamin mu district yenywe yaba bali khuli ne shida ye khuloba khuba nende vitamin yolana mubiakhulia nio mbo khurekebishe khubiira chihospitali nende akirikacha.

Sekhutarajia eshida yosiyosi tawe,lakini sikila wenyekhana transpoti khucha msituo sie khupimwa,chisilingi mia moja bachakhuwelesia msituo sia surveyi.Kumradi kuno kulabukula kimiaka kibili. Mulanyola bukhala khurumikhila situo siefwe sia afya.

Eyino eli esurvey yebweni khukholekha musirekere sienywe. Esurvey echakhubikha kamachibu khumiaka kirano. Bakharumikhile kamachibu khumanya nga mulaba nemuchilile kimiaka kibili kikichao.Nekhali khukalukhilamo mbo nikomulakhubolela mbao omundu okundi khumanya tawe. Khukharusie sa e ripoti ye sirekere nende e district yosi kijumla.

Mwakhasimile mube balekhule khureba kamareba.Esignature yoho khu fomu yino yokesia mbo mwaelewile niko khubolile lundi mwafukilile khushirikiana khu masomo kano. Buamusi bwe khushirika buli bwo mundu omwene,ne oli omulekhule khururamo chisa chosichosi bila efaini.Lundi oli omulekhule khuchilila khucha muhosipitali yoho.

Nowingila mubusomi buno,mala obe nende kamareba namwe e shida khulondekhana khuba khwoo mu survey yino,nosima bolela omwimelesi we kumukanda kuno, Mary Anyanngo Oyunga-Ogubi & Dr. Fred Grant, CIP Office, Bungoma; Tel: 0721710038 (email: oyungam2010@gmail.com). Nende enamba ya secretary wa Kenya National Ethical Review Committee (020-2722541) niba oli nende kamareba khulondekhana nende khushirika khwoo.

Lisina liebweni lio omushirika ---------- Lisina Limalilisi ----------

Liba lio omushirika

Kamasomo kano bafafanuliwe.Efomu ye kamafukilisiano basomele,ne bachilibe kamarebo kase mubwichufu. Namanyile ndi khuusika khuli khusamwene.Nafukilile khu usika mu busomi buno. Nanyolile a fomu yino.

Esikinecha ---------- Date ----------/----------/2011

Namwe lulwala(okhanyala khuandika tawe)

Omushaidi ---------- Date ----------/----------/2011

Esikinecha ye Omusecha Nalioo ----------Date----------/----------/2011

Nali omukhana oli asi we kimika 18, esikinecha ya baba namwe mayi.

Esikinecha yo omusasi ----------Date----------/----------/2011

Lisina lio omukarani ----------

Esikinecha yo omukarani ----------Date----------/----------2011

APPENDIX.V. Sources of GIS Data

GIS DATA	DESCRIPTION	COODINATE SYSTEM	SOURCE
Kenya Poverty 1999.shp	-Contains information on population that is poor, poverty gap, poverty rate, poverty gap in the year 1999 by locations across the Country -Polygon feature class	Geographic Coordinate System	ILRI and Central Bureau of Statistics, Ministry of Planning and national Development, Kenya
Length of Growing Period.shp	-This map was originally in Idrisi format and was called Kprlgp. - It was published by FAO in its "Predictions of cattle density, cultivation levels and farming systems in Kenya" report of 1998 - These ecological zones were produced by combining 11 images namely the mean, and minimum of the NDVI, Channel 4 temperature and CCD	Geographic Coordinate System	Food and Agriculture Organization of the United Nations
Elevation - Meters	-Coverage represents a digital elevation model of Kenya based on the 1:250,000 contour Map. -File type is Grid	Geographic Coordinate System	Done by Russ Kruska and Jeff Worden of the International Livestock Research Institute, ILRI
Slope-Degrees	-Derived from Elevation Data -Coverage represents a digital elevation model of Kenya based on the 1:250,000 contour Map. -File type is Grid	Geographic Coordinate System	-Main source Files; Done by Russ Kruska and Jeff Worden of the International Livestock Research Institute, ILRI
Kenya Rivers.shp	- This coverage shows the rivers of Kenya done by Japan International Cooperation Agency (JICA) - Hydrographic	Geographic Coordinate System	Japan International Cooperation Agency (JICA), National Water Master Plan, Kenya
West Kenya Roads.shp	This coverage shows the road networks in Western province including a small section extending into the eastern part of Uganda and part of Nyanza province up to the Northern part of lake Victoria area.	Geographic Coordinate System	International Livestock Research Institute (ILRI)
Kenya Towns.shp	The coverage shows the towns and urban centers in Kenya derived from the Kenya topographic sheets of scale, 1:250,000 for Northern Kenya and 1:50,000 for the rest of Kenya. There are approximately 1620 owns and urban centers captured in this layer.	Geographic Coordinate System	Digitized by International Livestock Research Institute, ILRI
Kenyan River Basins	The coverage shows the river basins of Kenya as defined by Japanese International Co-operation Agency (JICA), National Water Master Plan, Kenya	Geographic Coordinate System	Digital created by JICA, National Water Master Plan, Kenya
Kenyan Health Centres.shp	-Welcome Trust collaborative group, TALA Research Group, Ministry of Health and Centre for Tropical. - This is a coverage showing health service providers for Kenya compiled by Kenya Medical Research Institute (KEMRI) medicine. -It shows the relative location of health service providers for Kenya categorized by type and supporting agency.	Geographic Coordinate System	KEMRI/Wellcome Trust Collaborative Programme, TALA Research Group, Department of Zoology, University of Oxford, Ministry of Health and Centre for Tropical Medicine
Geology.shp			

APPENDIX. VI. Study Ethical Approval

KENYA MEDICAL RESEARCH INSTITUTE

P.O. Box 54840-00200, NAIROBI, Kenya
Tel (254) (020) 2722541, 2713349, 0722-205901, 0733-400003; Fax: (254) (020) 2720030
E-ms: : director@kemri.org info@kemri.org Website:www.kemri.org

KEMRI/RES/7/3/1 **October 22, 2012**

TO: **DR. JAN LOW (PRINCIPAL INVESTIGATOR – mama SASHA STUDY)**
INTERNATIONAL POTATO CENTRE,
ILRI OLD CAMPUS, OLD NAIVASHA ROAD,
P. O. BOX 25171-00603,
NAIROBI

Dear Madam,

RE: **NON-SSC PROTOCOL No. 282 (*REQUEST FOR ANNUAL RENEWAL AND PROTOCOL DEVIATION*): UNDERSTANDING CURRENT SWEET POTATO UTILIZATION AND NUTRITIONAL STATUS OF GROUPS VULNERABLE TO VITAMIN A DEFICIENCY IN WESTERN KENYA: A BASELINE ASSESSMENT**

Thank you for the continuing review report for the period **27 July 2012** to **24 September 2013.**

This is to inform you that during the 220th meeting of the KEMRI/ERC held on 22nd October 2013, the Committee **conducted the annual review and approved** the above referenced application for another year.

This approval is valid from today **October 22, 2013** through to **21st October 2014**. Please note that authorization to conduct this study will automatically expire on **21st October 2014**. If you plan to continue with data collection or analysis beyond this date please submit an application for continuing approval to the **ERC** secretariat by **September 9, 2014.**

You are required to submit any amendments to this protocol and other information pertinent to human participation in this study to the SSC and ERC for review prior to initiation.

Yours faithfully,

EAB

DR. ELIZABETH BUKUSI,
ACTING SECRETARY,
KEMRI/ETHICS REVIEW COMMITTEE

APPENDIX. VII. Map of study area