DIETARY, SOCIO-ECONOMIC AND DEMOGRAPHIC FACTORS INFLUENCING SERUM ZINC LEVELS OF PREGNANT WOMEN AT NAIVASHA LEVEL 4 HOSPITAL NAKURU COUNTY, KENYA

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DECLARATION

‘‘This thesis is my original work and has not been presented for a degree in any other University.’’

Signature ……………………… Date …………………

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Supervisors: We confirm that the work reported in this thesis was carried out by the candidate under our supervision and has been submitted for examination with our approval as university supervisors.

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DEDICATION

I dedicate this work to my family and the Kenyan girl child, to inspire you to work hard for a healthy generation.

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DEFINITION OF TERMS

Dietary diversity- This is the qualitative measure of food consumption that reflects household access to a variety of foods, and is also a proxy for nutrient adequacy of the diet of individuals (Swindale and Bilinsky, 2006 and FAO, 2011).

Dietary diversity score- The total sum of the different food groups consumed by the study participants (Swindale and Bilinsky, 2006 and FAO, 2011).

Women dietary diversity score: It is a reflection of the probability of micronutrient adequacy of the diet and the food groups included in the score are tailored towards this purpose. While twelve groups are included in the house hold dietary diversity, nine food groups are included in women dietary diversity with the micronutrients intakes in consideration (FAO, 2011).

Operational definitions of terms

Dietary factors – These are the factors related to dietary intake of zinc and other nutrients. They include dietary zinc intake, dietary diversity and food consumption practices during pregnancy.

Socio-economic Status - defined by proxy indicators and ownership of properties e.g. source of income, occupation and type of housing.

Demographic factors- These are the factors associated with the demographic characteristics of the study participants. They include parity, age, education level and marital status.

Food consumption practices - These are the practices related to food intake, food choice, food preparation and cooking methods of the study participants.

LIST OF ABBREVIATIONS AND ACRONYMS

AAS	Atomic Absorption Spectrophotometer
ANC	Antenatal Clinic
FAO	Food and Agriculture Organization of the United Nations
FNB	Food and Nutrition Board
GoK	Government of Kenya
HIV	Human Immunodeficiency Virus
IOM	Institute of Medicine
IZiCNG	International Zinc Nutrition Consultative Group
KDHS	Kenya Demographic and Health Survey
KEMRI	Kenya Medical Research Institute
KNBS	Kenya National Bureau of Statistics
LBW	Low Birth Weight
LMP	Last Menstrual Period
MCH	Maternal Child Health
MoH	Ministry of Health
P: Z	Phytate to Zinc Ratio
RDA	Recommended Daily Allowance
SEM	Standard error of mean
SPSS	Statistical Package for Social Sciences
SSA	Sub-Sahara Africa
UNICEF	United Nations Children’s Fund
WHO	World Health Organization

ZD	Zinc Deficiency
Zn	Zinc

ABSTRACT

Zinc is an essential micronutrient for human health. Its numerous structural and biochemical functions at the cellular and sub cellular level makes it very important during pregnancy. Maternal serum Zn levels at the time of conception and in pregnancy plays a major role in maternal and child health. It is an important determinant of foetal growth and development. Despite availability of data to demonstrate widespread micronutrient deficiency in pregnancy, minimal studies have examined the status of zinc among pregnant women. Hence the present study was undertaken. The objectives of the study were to determine serum zinc levels of pregnant women and to establish dietary, socio-economic and demographic factors influencing serum zinc levels of pregnant women in Naivasha. To achieve this, a cross sectional analytical study design was conducted amongst 172 pregnant women attending antenatal clinic (ANC) at Naivasha level 4 hospital. A systematic random sampling was applied to obtain the sample size. Dietary intake was assessed using 24-hr dietary recall and Food Frequency Questionnaire method. Serum zinc levels were analyzed by atomic absorption spectrophotometer (AAS). Quantitative data obtained was analyzed using SPSS computer software .Means, SEM and ANOVA were used for continuous variables. Regression analysis was applied on categorical factors influencing serum zinc levels and a p value of < 0.05 statistical significant at 95% confidence level was used. The study found a mean serum zinc level of 66 μg/dl ($\pm$ 14 SD) ranging between 39 to 123 μg/dl, with a prevalence of 66.9%. About 75.0% of the participants were in low socio-economic class. Dietary zinc intake was not significantly associated with ZD, but women consuming Vitamin C below the recommended dietary allowance had 2.62-fold risk (95% CI: 0.55 – 12.37) of becoming ZD. Parity was significantly associated with ZD (AOR=3.65; 95% CI: 1.27 – 10.49; p=0.016. The study therefore concludes that the high prevalence of zinc deficiency is of public health concern in the area, which could be due to high consumption of cereals, carbohydrates and legumes which are high in zinc inhibitors. This may be addressed through a combination of short, medium and long term strategies which includes adoption of traditional household food processing techniques such as fermentation, sprouting and germination to increase absorbable rate of dietary zinc from plant foods, economic empowerment and livelihood promotion among women.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Pregnancy is the state of carrying a developing embryo or foetus within the female body. It lasts for about nine months from the date of the woman's last menstrual period (LMP). It is conventionally divided into three trimesters, each roughly three months long. Proper nutrition at the time of conception and during the entire pregnancy is very important (Williamson, 2006). Physiological changes and increased metabolic demands to meet fetal requirements for growth and development make gestation a critical, nutritionally responsive period of life for both mother and fetus (Christian, 2010).

Worldwide, zinc deficiency is estimated to affect one third of the world's population with estimates ranging from 4% to 73% across sub-Sahara Africa (SSA). The International Zinc Nutrition Consultative Group (IZiNCG) indicates that zinc (Zn) deficiency is significant in developing countries. This is attributed to poor dietary intake and socioeconomic status, among many other factors (IZiNCG, 2004). Zinc deficiency is responsible for approximately 16% of infections of the lower respiratory tract KNBS/ICF (2010); 18% of malaria and 10% of diarrheal diseases, and in 2002, 1.4% of deaths world-wide were attributed to zinc deficiency as cited in (Were etal., 2009). In rural Shaanxi, China, semi quantitative food frequency questionnaire data revealed inadequate intakes of zinc (91%), in pregnant women. In peri-urban Mexico, prevalence of zinc and folate deficiency in the third trimester was 34% and 19%, respectively (Christian, 2010).

An estimated 34.6% of the Sub-Saharan African population is at risk for zinc deficiency, according to Wuehler, Peerson and Brown (2005). In rural Southern Ethiopia low plasma zinc concentrations was documented to be 72%, given their low dietary zinc intake (Abebe *et.al*. 2007). Two studies conducted in Kenya between the year 2002 and 2008, revealed a 50% prevalence rate of zinc deficiency among women of child bearing age and pregnancy was said to further exacerbates the risk (GOK/UNICEF, 2008; GOK/UNICEF, 2002). According to the Kenya 1999 National Micronutrient Survey Report, high risks for zinc deficiency occurred in about half of the children, women and men. Nutritional demands during pregnancy and lactation predispose women to developing zinc deficiency. Due to expansion in plasma volume, serum zinc concentration declines in concert with serum albumin during pregnancy. From cross-sectional studies of maternal zinc status and clinical observations, possible consequences of maternal zinc deficiency on pregnancy outcome like low birth weight and congenital malformations have been observed (IZiNGC, 2009).

Zinc deficiency during the early stages of pregnancy is associated with foetal neurological malformations and growth retardation. Deficiency in later stages of pregnancy negatively affects neuronal growth. It may also be associated with impaired brain function and behavioral abnormalities (Mahomed, Bhutta and

Middleton, 2007). The effects of Zn deficiency on protein metabolism have been well documented in animal studies (Obled, and Coudray, 2007). In human studies, reports have noted low serum zinc levels to be linked with abnormalities during child delivery such as miscarriage, prolonged labour and delivery. This leads to complications such as high risk of stillbirths, retarded foetal growth, postpartum hemorrhage, pregnancy-induced hypertension, preterm labour and post-term pregnancies (KNBS/ICF, 2010; Mahomed, Bhutta and Middleton, 2007).

Zinc deficiency in pregnancy may also lead to, lowered immunity of both the mother and the infant, low mental development of the infant, and increased risk of infection (KNBS/ICF, 2010). There is therefore a need to understand the dietary, socio-economic and demographic factors influencing serum Zn levels during pregnancy. This will help to improve maternal health and reduce the maternal mortality ratio in order to achieve the fifth millennium goal (WHO, 2008).

1.2 Problem statement and justification

More than two decades ago, maternal nutritional factors may have accounted for more than 50% of the etiology of low birth weight (LBW) in developing countries (Christian, 2010). The overall nutritional status of the mother during pregnancy is a significant contributor to both maternal and prenatal mortality and morbidity (Williamson, 2006; Saskia, *et al*., 2003**).** The risk of low dietary intake of absorbable zinc and consequent zinc deficiency is a widespread problem globally. It affects between 1/3 and 1/2 of the world’s population (KNBS/ICF, 2010). Women of reproductive age in developing countries are highly vulnerable to nutritional deficiencies, including that of zinc (Chandyo, *et al*., 2009). Many nutritional programmes have been established globally to prevent iron-deficiency anaemia during pregnancy, in terms of research and dietary supplementation (Aminisani, *et al*., 2009). However, in the case of zinc, less research has been done in Kenya, although it is very important for maternal and infant survival.

There are minimal studies done in Africa particularly in Kenya to determine serum zinc levels and factors influencing serum zinc levels in pregnancy and more so hospital based studies are minimal from the Kenyan pregnant women population. Quantitative estimates of the population at risk of inadequate zinc intake and specific information on the prevalence of deficiency in particular settings like during pregnancy are still lacking in the country. This lack of information has been a major limiting factor in developing programs to reduce the rate of zinc deficiency (KNBS/ICF, 2010). Good nutrition during pregnancy to provide the recommended dietary Zn is necessary in order to make any significant impact on morbidity and mortality. Optimum zinc levels during pregnancy have a beneficial influence to the mother and on subsequent birth outcomes. Information obtained from this study will contribute to a better understanding of factors influencing zinc levels among pregnant women at Naivasha level 4 hospital.

1.3 Purpose of the study

The aim of the study was to assess dietary, socio economic and demographic factors affecting serum zinc levels of pregnant women at Naivasha level 4 hospital.

1.4 Research objectives

The study was guided by five objectives;

1. To determine socio economic and demographic factors influencing serum zinc levels during pregnancy.

2. To determine serum zinc levels of pregnant women attending antenatal clinic (ANC) at Naivasha level 4 hospital.

3. To determine morbidity patterns and health seeking behavior among pregnant women attending antenatal clinic (ANC) at Naivasha level 4 hospital.

4. To determine dietary zinc intake, food consumption patterns and related practices among pregnant women in Naivasha.

5. To establish relationship between factors (dietary, socio-economic, demographic and morbidity patterns) and serum zinc levels during pregnancy.

1.4 Hypotheses

H_{o1}: There is no significant relationship between dietary factors and serum zinc levels during pregnancy.

H_{o2}: There is no significant relationship between socio-economic factors and serum zinc levels during pregnancy.

H_{o3}: There is no significant relationship between socio-demographic factors and serum zinc levels during pregnancy.

H_{o4}: There is no significant relationship between morbidity patterns, health seeking behavior and serum zinc levels during pregnancy.

1.5 Significance of the study

The study generated information on dietary, socio-economic and demographic factors influencing serum Zn levels among pregnant women. This may be useful in formulating policies on food fortification to address micronutrient deficiency and maternal child nutrition and healthcare education. The findings from the study may contribute to knowledge on maternal and child healthcare. The knowledge may be useful in the Ministry of Health (MoH), and any organization intending to design interventions to improve maternal and child health (MCH) in guiding their intervention programmes, in Kenya and worldwide.

1.6 Limitation of the study

Due to limited data available on zinc status among Kenyan pregnant women, data collected was compared to data available on Kenyan women of reproductive age, and regional data that is available.

1.7 Delimitations

The study assessed zinc levels, among pregnant women in Naivasha and results can only be generalized to other areas with similar characteristics.

1.8 Conceptual framework

The study was guided by a conceptual framework (Fig 1.1) by the author, adopted and modified from UNICEF conceptual framework on malnutrition (UNICEF, 1998). It illustrates the interrelation of various factors that have an influence on serum Zn levels during pregnancy. Socio-economic and demographic factors Christiana *et.al* (2010); influences food availability which may affect dietary diversity in turn influencing dietary Zn intake. Other factors, such as food consumption practices (food choice, food preparation and cooking methods) KNBS/ICF, 2010), Williamson (2006), GOK/UNICEF (2002) affects dietary zinc intake and zinc bioavailability, hence affecting serum zinc levels.

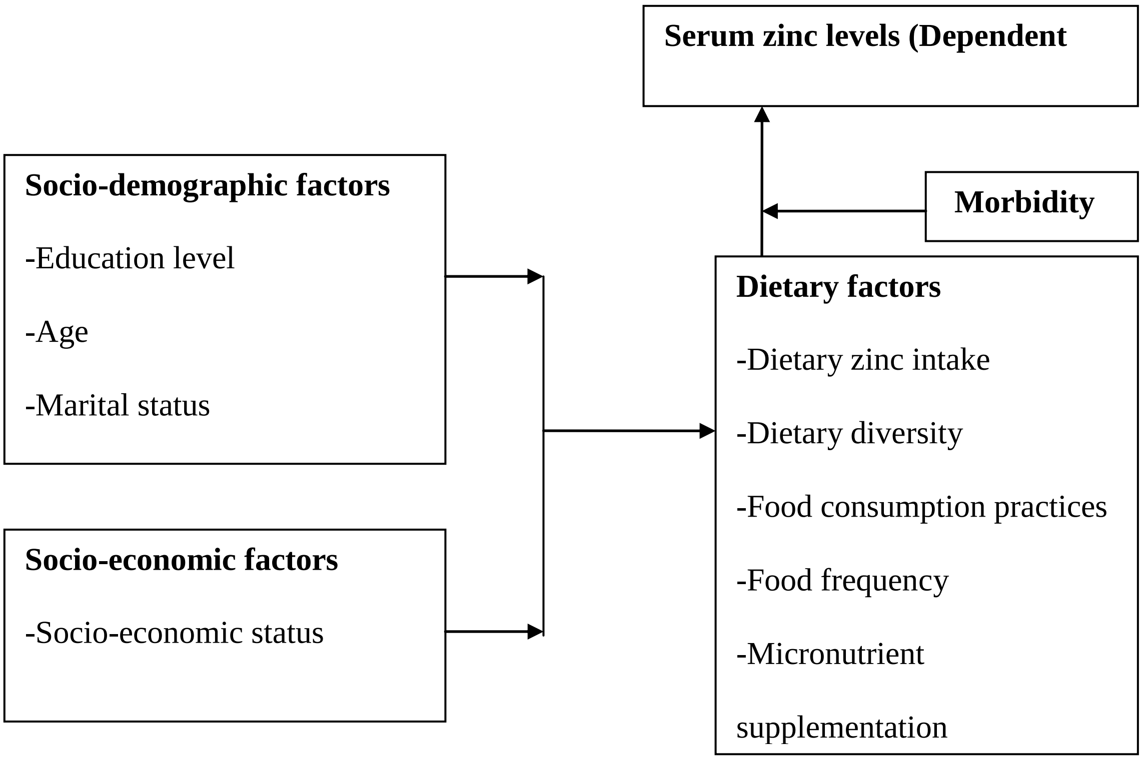

Figure 1.1: Conceptual framework on factors affecting serum zinc levels during pregnancy.

Source: Author, adopted and modified from UNICEF conceptual framework on malnutrition, 1998.

CHAPTER TWO

LITERATURE REVIEW

2. Introduction

Zinc is a dietary trace element which is essential for biochemical and physiologic functions. Its requirements during pregnancy are especially high and believed to be important because it is essential for growth and development of the foetus and maternal tissue accretion. This chapter reviews literature on serum zinc levels in pregnancy, and factors influencing maternal serum zinc.

2.1 Serum zinc levels in pregnancy

Low serum zinc levels during pregnancy have been related to adverse effects on both maternal health and pregnancy outcome (Christian, 2010; Williamson, 2006 and Saskia *et al*., 2003). However, its prevalence is still unknown in most populations. A study conducted among healthy reproductive women of Bhaktapur Nepal in 2009, showed a high prevalence of zinc deficiency in women of reproductive age. This was associated with an increased risk of infections and poor pregnancy outcomes (Chandyo, *et al*, 2009). In Australia, a review of 17 trials which involved over 9000 women and their babies concluded that zinc supplementation had a small effect on reducing preterm births but it did not help in prevention of low birth weight babies. The findings from the review therefore recommended ways to improve women's overall nutritional status, particularly in low-income areas, which would do more to improve the health of mothers and babies than supplementing pregnant women with zinc (Mahomed, Bhutta and Middleton, 2007).

Worldwide, zinc deficiency is an important public health problem that affects approximately 2 billion people who do not ingest adequate amounts of zinc (IZiNCG, 2009). In Kenya information on zinc status among pregnant women is minimal and therefore, this study tries to identify the prevalence of zinc deficiency among Kenyan pregnant women especially in a hospital set up population.

2.2 Consequences of poor serum zinc status in pregnancy

Pregnancy is associated with physiologic changes that result in increased plasma volume and red blood cells, and decreased concentrations of circulating nutrient-binding proteins and micronutrients. There is an increased demand for zinc and its deficiency could affect delivery and outcomes of pregnancy. Zinc can neutralize free radicals and may reduce or even help prevent some of the damage they cause during the pregnancy (Hanachi, Golkho and Norrozi, 2007). In many developing countries, these physiologic changes can be aggravated by under nutrition, leading to micronutrient deficiency states such as zinc deficiency. In pregnant women, moderate to severe deficiencies of zinc have been shown to increase risk of low birth weight, pregnancy complications and birth defects (Seshadri, 2001).

Maternal zinc deficiency may be an added threat to poor women in developing countries. These women are most likely to be carrying a small foetus, and they are unable to withstand prolonged labour and delivery. They may have the least access to assisted or operative delivery as treatment for prolonged labor and delivery. They are also likely to have the least access to health care for proper treatment of maternal and perinatal morbidity during the puerperium (Caulfield, *et.al*., 1998).

Observational studies in human populations have produced strong associations between poor maternal zinc status and various indicators of poor pregnancy outcome (Caulfield,*et.al*., 1998). Association between maternal zinc status and neonatal cognitive outcome in humans and animals suggests that adequate zinc intake during pregnancy and lactation is necessary to ensure proper brain development (Chowanadisai, Kelleher and Lönnerdal, 2005). From the literature there is enough evidence of consequences of zinc deficiency among pregnant women globally and regionally. This study therefore establishes the prevalence of zinc in pregnancy so that the necessary interventions are put in place to avert the health problems associated with zinc deficiency.

2.3. Maternal nutritional status

Maternal nutritional status is an important determinant of prenatal and neonatal well-being. Its importance is well documented on how it enhances foetal growth and birth outcomes. It is a modifiable risk factor of public health importance in the effort to prevent adverse birth outcomes, particularly among developing/low-income populations (Williamson, 2006 and Bu-Saad and Fraser, 2010).

2.4 Factors influencing serum zinc levels during pregnancy

Various factors have an influence on serum zinc levels during pregnancy. The present reviewed literature on dietary, socio-economic and demographic factors that have been documented to have any effects on serum zinc levels during pregnancy.

2.4.1 Dietary zinc intake and daily requirements in pregnancy

The decline in plasma zinc and plasma albumin is a normal physiologic adjustment during pregnancy and has been well documented (Williamson, 2006). The mechanisms may include placental zinc uptake needed for foetal growth, response to hormonal changes causing redistribution of circulating zinc in maternal tissues, hem dilution, or a combination of these (Williamson, 2006). A normal weight gain of 10 to 12 kilos in pregnancy requires an increased need for zinc accumulation of 300 to 360 mg (IZiNCG, 2007). The zinc content in food is parallel to that of protein and energy intake, but its bioavailability is reduced when protein content is low, when phytate and fiber content is high, and when there is competition with other micronutrients such as, increased amounts of calcium, copper, iron, tin, heavy metals, or chelating drugs (IZiNCG, 2009). There is considerable evidence that a high percentage of women worldwide consume diets inadequate in zinc and an estimated 82% of pregnant women worldwide have low usual intakes of zinc that are inadequate to meet the normative needs of pregnancy (Pathak, *et al*, 2008 ; Gibson and Huddle, 1998). In developing countries, the prevalence is likely to be higher. (Haide and Bhutta, 2006; Caulfield, *et al*., 1998).

Chronic inadequate dietary intake of zinc is the most likely cause of zinc deficiency. Hence, estimating the adequacy of zinc intakes through quantitative dietary intake surveys is useful to evaluate the risk of zinc deficiency in populations (IZiNCG, 2009). The worldwide prevalence of dietary zinc deficiency is believed to be approximately 20.5% (Wuehler, Peerson and Brown, 2005). A high prevalence of zinc deficiency was documented among women of reproductive age in Bhaktapur, Nepal in 2009. From the findings of the study, food that contributed most to the intake of zinc also contributed substantially to the intake of phytate, which seemed to have a negative impact on zinc status (Chandyo, *et al*, 2009). Inadequate dietary intake of bio-available forms of zinc is the most likely cause of zinc deficiency. Plant-based diets consumed in many developing countries are often based on unrefined cereals and legumes. These foods contain a high content of phytate, a substance that significantly inhibits the body's absorption of zinc by binding with zinc and rendering it unavailable. Other diets based on starchy roots or tubers have low total zinc content (IZiNCG, 2009). This study tends to establish and estimate the dietary zinc intakes among pregnant women in Naivasha.

2.4.2 Dietary diversity, zinc sources, bio availability and zinc deficiency

Zinc occurs in a wide variety of food sources. Although its bioavailability is highly variable it is found in highest concentrations in meat, fish and shellfish, and lesser amounts in eggs and dairy products. Relatively high content of zinc in dietary plant sources is found in nuts, pumpkin and watermelon seeds, legumes and whole grain cereals. Zinc content is lower in tubers, refined cereals, fruits, and vegetables. (IZiNCG, 2009 and Samman, 2002). Animal proteins increase zinc bio availability as a whole except for the milk casein which makes up 80% of the proteins in cow's milk, but has a modest inhibitory effect on zinc absorption (Lönnerdal, 2000).

In many parts of the world, consumption of animal products, such as shellfish and red meat which contain substantial amounts of zinc in readily absorbable form, is minimal due to their high cost and limited supply. The more widely available whole grain cereals and legumes are highly consumed. These foods contain zinc but are less absorbed efficiently because the zinc uptake by the intestine is inhibited by other components of these foods, notably fibre and phytate (IZiNCG, 2009).

Strategies to diversify or modify the diet aim at enhancing the access to, and utilization of foods with a high content of absorbable zinc by the target population. These strategies can involve changes in food production practices, food selection patterns, and traditional household methods for preparing and processing indigenous foods (IZiNCG, 2009). The utilization of zinc depends on the overall composition of the diet (FAO/WHO, 2001). The diversification and modification of diets can enhance availability and utilization of foods with a high content of absorbable zinc, iron and folate throughout the year.

Several strategies such as soaking, fermenting, germination and sprouting exist to either increase the total dietary zinc content or to alter the level of zinc absorption from household diets and thus improve zinc bioavailability, even in subsistence farming settings (IZiNCG, 2009). This study tried to establish the diversification of diets among pregnant women in Naivasha, and established the individual dietary diversity score (IDDS) of the women.

2.4.3 Food consumption patterns and related practices

Zinc assimilation mainly depends on its amount in the food and presence of substances stimulating or suppressing its absorption (Lönnerdal, 2000). Phytic acid (inositol hexaphosphate) and phytic acids salts are the strongest inhibitor of zinc absorption. They are found in highest amounts in wheat, beans nuts and are less in fruits and vegetables. This is because they attach zinc irreversibly in the intestines. (IZiNCG, 2009; (Lönnerdal, 2000).

Quantities of zinc and phytate and their molar proportion in the food are stable and adequate indexes of zinc bio availability (IZiNCG, 2009). Diets with phytate/ zinc molar ratio > 15 are low bio availability with zinc absorption of 15%. A cereal-based diet with low intake of animal proteins is in this category (IZiNCG, 2009; (Lönnerdal, 2000). Diets with phytate/ zinc molar ratio between 5 and 15 are of moderate bio available with 30% of zinc absorption. They include mixed diets and lacto- ovo- vegetation diets. Diets with molar ratio < 5 are of high zinc absorption level with 50% zinc absorption, and they include refined diets with low amounts of fiber and animal protein being the main sources of energy (IZiNCG, 2009; (Lönnerdal, 2000).

Zinc availability is also influenced by food preparation methods. A loss of up to 89% zinc was found in canned vegetables, while white bread contained 77% less zinc than brown (Schroeder, 1971). Likewise, zinc content is reduced by milling of grains, but extrusion cooking can increase zinc availability by reducing phytate levels (Southon, Fairweather-Tait, and Hazel1, 1988).

In many developing countries, rural diets are based predominantly on cereals or starchy roots and tubers. Diets based on starchy roots and tubers typically have low zinc content while those based on unrefined cereals and legumes contain high levels of phytate-a plant component that inhibits the body's absorption of zinc (IZiNCG, 2009). The daylong consumption of a maize diet with a typical high-phytic acid content and a high molar ratio of phytic acid to zinc are associated with a low fractional absorption of zinc. A low phytic acid intake and a low molar ratio of phytic acid to zinc are associated with a substantially and significantly greater fractional absorption of this micronutrient (Lönnerdal, 2000).

2.4.4 Socio-economic and demographic factors

There is a likelihood of widespread zinc deficiency in low-income countries where diets are composed primarily of cereals and legumes which contain phytate that inhibit zinc absorption (IZiNCG, 2009; Walingo, 2009). This is because of the underlying social and economic problems present in low-income populations. They include poverty, poor quality food supply, lack of nutritional education and high exposure to pathogens because of poor sanitation and hygiene. These problems compound and contribute to the health problems brought on by zinc deficiency, and for this reason, clear identification of nutritional zinc deficiency and its causes in specific populations is becoming a priority for public health planners (IZiNCG, 2009; WHO, 2008).

Pregnancy increases zinc requirements by 3 mg/d (FNB/IOM, 2000). This increment is often difficult to attain in women living in resource-poor environments. Access to foods rich in bio available zinc may be limited, and dietary staples readily available and highly consumed, often contain phytates, which inhibit zinc absorption (Lannotti, et al., 2008).

According to a community based cross-sectional study conducted in Rural Sidama zone, Southern Ethiopia in January and February 2011 among 700 pregnant women, maternal age was negatively associated to zinc status, while maternal education was positively associated to zinc status, (Gebremedhin, Enquselassie, and Umeta, 2011). In contrast; a study conducted in Tehran, Iran in 2007 among pregnant women, showed no significant association of the socio-demographic factors with the rate of zinc status. The majority of women in the study did not have any source of income, indicating that maternal education and household wealth index is not associated to zinc status. (Hanachi, Golkho and Norrozi, 2007). This study assessed various socio economic and socio-demographic factors to establish the ones that were significantly associated with zinc status among pregnant women in Naivasha.

2.5 Summary of literature review

Understanding of dietary, socio-economic, and demographic factors that may adversely affect zinc absorption will be critical to preventing and treating zinc deficiency in human populations, especially during pregnancy. Consequently, pregnancy is a physiological state with increased zinc requirements. Zinc deficiency during pregnancy therefore, has long-lasting effects on the well-being of the mother and the fetus, and may further influence the health of the baby at a later age.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The study was designed to establish the dietary, socio-economic and demographic factors influencing serum zinc levels of pregnant women at Naivasha level 4 Hospital in Nakuru County. This chapter presents the study design, study variables, location, target population, sample size determination and sampling techniques, data analysis and presentation.

3.1 Research design

A cross-sectional analytical study design was adopted (Katzenellenbogen, *et. al*, 2002). The study design ensured that the results and findings presented were based on data collected at one point in time. It is also analytical because inferential statistics involved compared various characteristics of the study population (Katzenellenbogen, *et al.*, 2002).

3.2 Variables

Dependent variable: Serum zinc levels were the main dependent variable in this study.

Independent variables: They included, dietary factors (dietary Zn intake, dietary diversity, food consumption patterns and related practices). Socio-economic factors (source of income, occupation and type of housing. Demographic factors age, parity, stage of the pregnancy in trimester, marital status and education level. Morbidity pattern and health seeking behavior, among pregnant women in Naivasha.

3.3 Study location

The study was carried out at Naivasha level 4 hospital in Naivasha town, Nakuru County. The hospital was purposively sampled, because the majority of the people in Naivasha and its environs seek healthcare services from the hospital. The District has five administrative divisions, and Naivasha division is the most densely populated. This is as a result of high influx of workers both skilled and unskilled in the flower farms along Lake Naivasha, possibly making it a low socio-economic area (Office of the Prime minister/Ministry of state for planning, 2009).

3.4 Target population

The study targeted pregnant women attending ANC clinic at Naivasha level 4 hospital.

3.4.1 Inclusion criteria

The study included pregnant women, who were visiting the hospital in the first, second and third trimesters, and only those who gave their consent to participate in the study. Women, who had been residents of Naivasha division for at least six months at the time of study, were also eligible for inclusion in the study.

3.4.2 Exclusion criteria

Pregnant women who met the inclusion criteria, but suffering from cancer, diabetes, Hypertension, HIV positive and who willingly disclosed this information were excluded from the study. Those who were residence for less than six months at the time of study and non residence of Naivasha division were not included.

3.5 Sample size determination

A population size of 700 pregnant women visiting ANC at the hospital per month was estimated. An attendance of twelve months was obtained from the hospital's records office then the total divided by twelve and an estimate of 700 per month was obtained. The sample size therefore targeted 172 women as calculated using a formula by (Israel, 1992).

$$n = \frac{z^2_{1-\alpha/2} pq}{d^2}$$

Table 3.1: Sample size determination table

Value	
n	The desired sample size
$z_{1-\alpha/2}$	The standard normal deviate at 95% confidence level (1.96)
p	The proportion of the target population estimated to have characteristic being measured
q	1-p
α	The level of statistical significance set (0.05)
d	Absolute precision (margin of error) (0.065)

Prevalence rate of 50% was used to estimate the proportion of zinc deficiency in pregnancy (GOK/UNICEF, 2008 and GOK/UNICEF, 2002).

$$n = \frac{(1.96)^2 (0.5)(0.5)}{0.065)^2} = 227$$

Finite population correction was done to produce a sample proportional to the population therefore the sample size was calculated as;

$$n = \frac{n}{1 + \frac{(n-1)}{N}}$$

N=Target population size

$$N = \frac{384}{1 + \frac{(384-1)}{700}} = 172$$

3.6 Sampling techniques

Naivasha level 4 Hospital was purposively sampled because it is a public health institution and therefore the costs are subsidized by government making it affordable to the majority of the population. A predetermined sample size of 172 was systematically randomly sampled. An average attendance to the ANC was estimated to be 700 per month. The clinic was at the time of study run five days per week, and therefore 35 women were expected to visit the clinic per day. Hence A sampling interval of 4 was used to select 9 respondents every week day. The researcher wrote numbers (1, 2, 3 and 4) on four pieces of papers, randomly selecting one number to be the 1st study subject every day. The rest (8) were selected systematically taking every 4th woman. This process was repeated daily for approximately 26 working days consecutively between 8.00 am and 1.00 pm until the required sample size of 172 pregnant women was obtained. The ANC at the time of study operated up to 1.00pm and blood samples for zinc analysis had to be collected latest 1.00 pm, every day.

3.7 Data collection instruments

Quantitative data were collected using an interviewer administered questionnaire (Appendix I), two 24 hour food recall, and a one time seven day food frequency. Qualitative data were collected through four focus group discussion (FGDs) which were guided by an FGD guide (Appendix II). Each FGD session had 8-12 pregnant women. A biochemical test was done to determine serum zinc levels of the study subjects. Secondary data were used to get information on morbidity pattern of the women and zinc and phytates content of various food groups.

3.7.1 Questionnaire

A structured interviewer administered questionnaire with both closed-ended and open-ended questions, developed by the researcher was used. This collected information on socio-economic and demographic factors (age, marital status, education level, parity income and occupation). Morbidity data were also collected with a confirmation from the medical records in the mother's card for health assessments of the study participants.

3.7.2 24-hour Food recall and food frequency (FFQ)

Two 24-hour food recalls were used to establish food consumption practices such as food choice, food preparation and cooking methods (IZiNCG, 2009; Gibson and Ferguson, 2008). The subjects were required to recall all they had ingested from morning till evening during the previous 24 hours prior to the date of interview. The amounts were indicated in household units and measures, like cups, mugs, plates and spoons which were later translated to metric measurements. This was administered twice at the subjects' home, to ensure validity. A one seven days FFQ was used to establish dietary zinc intake and dietary diversity of the study subjects (IZiNCG, 2009 and FAO, 2011).

3.7.3 Focus group discussion (FGD)

A focus group discussion (FGD) guide was used during discussions that were held four times after all respondents had been interviewed. The participants in FGDs were not among those interviewed in the study. This was done to elicit qualitative data that gave an in-depth understanding and provided complementary information to the quantitative findings.

3.7.4 Blood sample collection, serum extraction and zinc level determination

A 3mls venous non fasting blood sample was drawn from each subject's arm using a 5mls syringe and stainless steel disposable needles, to determine serum zinc levels. This was done by a qualified laboratory technician at the hospital's laboratory. The blood sample was put in a red cup vacutainer. All samples were labeled with the secret code, time and date of sampling at room temperature (Gibson, 1993 and Gibson, 1990). This information was transferred to the biochemical sheet. Blood samples were then centrifuged within 30 minutes from the time taken, at 2500 revolutions per minute for ten minutes. Visibly haemolysed samples were discarded and not included for analysis (Gibson, 1993).

Serum blood was extracted using a pipette into well labeled screw-top cryogenic vials with both date and secret analysis codes indicated. They were then wrapped with aluminum foil, to protect against light degradation. Four cryogenic vials were then wrapped together with a plastic rubber band and later stored in liquid nitrogen frozen at -70^{0}c awaiting transportation to Kenya Medical Research Institute (KEMRI) laboratories in Nairobi for further analysis (Gibson, 1993). Necessary precautions were taken to ensure that a dust and light free environment was observed throughout the blood sample collection and serum blood separation, as zinc is highly affected by dust and light (IZiNCG, 2009).

Atomic absorption spectrophotometer (AAS) Shimadzu AA-2000 series (Burtis and Ashwood, 2001) was used to analyze zinc status of the participants. To get zinc values, blank solution was made by adding 10 mls of the sodium stock solution into the volumetric flask through a pipette to make up 100 mls. A pipette was used to get 0.25mls of serum into a plastic tube containing 4.75mls of de-ionized water. The samples were then put into a vortex for 30 seconds and let to settle for two minutes before being aspirated into the AAS. The blank was then aspirated, analyzed and read directly from the screen (IZiNCG, 2009). In the present study, zinc deficiency (ZD) was defined as serum zinc level of < 66µg/dl for all the three trimesters (Pathak *et al*, 2008 and IZiNCG, 2007).

3.8 Pre-testing of Research instruments

The study questionnaire was pre-tested for accuracy and clarity at Gilgil level 4 hospital an area with similar characteristics as the target population, on 10% of targeted sample and 17 respondents were therefore interviewed. The procedures used in pre-testing were similar to those used during the actual study. After pre-testing the instruments, questions and instructions not clear to the respondents were modified and reconstructed. This ensured clarity of the questions to the respondents, enhancing validity of data collected (Fisher, John and John, 1983).

3.8.1 Validity of the instruments

Content validity of the study questionnaire was established by using competent experts in the field of maternal child nutrition. They were requested to assess the relevance of the content used in the questionnaire, and give their recommendations. On examining the questionnaire, they individually provided feedbacks which were later used to make the final study questionnaire.

3.8.2 Reliability of data collected

The research team comprised of the researcher and two research assistants of post secondary education level. The research assistants were recruited and trained on research techniques and were given instructions on how to exactly perform the interview. During data collection, they were always under supervision of the researcher. This ensured reliability of the data (Fisher, John and John, 1983).

3.9 Data Collection Techniques

The researcher and the research assistants reported at the ANC at 8.00am every weekday. Respondents meeting the inclusion criteria were identified with the help of the hospital staff. These were sampled and recruited only when they signed an informed and written consent. They were also informed on the objectives of the study, the benefits and risks involved in participating in the study. They were then briefed on how to respond to the questionnaire. The researcher and the research assistants administered the socio-economic and demographic questionnaire and FFQ to the women on a face-to-face interview at the hospital. This was done in a private room provided by the hospital, to ensure confidentiality among the participants and from interference from the hospital staff and those who did not participate in the study. This also ensured confidentiality among the participants. The interview took between 30 and 45 minutes with one respondent, and another 10 minutes at the laboratory for blood sample collection. The women were later given appointments to be visited at home for the first 24-hr food recall which was carried out at the respondents' home. Each woman was given a secret code and details of how to reach their homes were recorded. The second 24-hour recall was carried out at least four days later, for all the respondents at their respective homes.

Four FGDs were held immediately after the sample size was attained, and the first group of women was purposively sampled by the researcher. They had to meet the inclusion criteria but were not among the 172 women in the study sample, in order not to introduce biasness to the study. Discussions lasted between 30-50 minutes conducted by three people. They were all moderated by the researcher, who lead the discussions, kept the conversation flowing, took a few notes and kept track of time. The recorder took some notes and operated the tape recorder, while the observer handled the environmental conditions, observed and made notes on body language, non-verbal communication and responded to unexpected interruptions. All FGD sessions were held at the Hospital's conference room, with just the participants, moderator, recorder and observer present. Information collected was treated confidential. The tape recordings were later transcribed, coded and triangulated with quantitative data from the questionnaire.

3.10 Data analysis and presentation

Completed questionnaires were checked daily for accuracy in responses recording, and edited before entry into the computer. Data entry, screening and analysis of all other data apart from 24-hour recall data, were carried out using the SPSS computer software version 12.0.1. The 24-hour dietary recall data, recorded food sizes and ingredients were converted to their respective equivalent grams. This was entered and analyzed using the NutriSurvey software to obtain the amounts of nutrients consumed by the study subjects. The actual amounts of nutrients were converted into percentages and grams of recommended daily allowance (RDA) for the nutrients energy, protein, dietary fiber, vitamin C, calcium, magnesium, iron and zinc. This was based on the recommendations found in the NutriSurvey software and the RDA from the USA. The data were then exported to the SPSS software for further analysis.

Descriptive analysis was done using mean, frequency, percentage and SEM, to describe quantitative data such as the study population and zinc levels of the study subjects. ANOVA and regression analysis was used to compare means for serum zinc levels, and to establish dietary, socio-economic and demographic characteristics influencing serum zinc levels during pregnancy as shown in the data analysis matrix (Table3.2). Qualitative data from FGDs were transcribed, coded then triangulated with quantitative data from the questionnaire. A p-value of <0.05 was used as the criterion for statistical significance.

Table 3.2: Data analysis matrix

Objectives	**Dependant variable**	**Independent variable**	**Nature of variable**	**Method of data collection**	**Statistical test**
To determine demographic and socio-economic factors influencing serum zinc levels during pregnancy	Serum zinc levels	-Age -Marital status -Education level -SES	Continuous Categorical	Blood analysis	Linear regression
To determine serum zinc levels of pregnant women	Serum zinc levels		Continuous	Blood analysis	Means, SEM and ANOVA
To determine morbidity patterns and health seeking behavior among pregnant women in Naivasha		Secondary data	categorical	Blood analysis	Means, SEM and ANOVA
To determine dietary zinc intakes, food consumption patterns and related practices among pregnant women in Naivasha		Dietary Zn intake, diversity and food consumption	Categorical	FFQ, 24 hr recall FGD	Linear regression
To establish the relationship between the factors influencing serum zinc levels during pregnancy	Serum zinc levels	-Age -Marital status -Education level -SES Dietary zinc intake, diversity and food consumption	Continuous Categorical	Blood analysis FFQ, 24 hr recall FGD	Linear regression

3.11 Logistical and ethical considerations

A research permit was obtained from graduate school of Kenyatta University and National Council for Science and Technology (NCST) (Appendix VII). Ethical clearance was given by Kenyatta National Hospital Ethical and Research Committee (Appendix VIII). Informed written and signed consent was taken from all respondents and parents/ guardians of respondents below 18 years of age also gave consent to their daughters' participation in the study. All information given by the respondents was treated confidential. Needle safety procedures were in line with world Health Organization (WHO) standards.

CHAPTER FOUR

RESULTS AND FINDINGS

4.0 Introduction

This study was designed to establish dietary, socio-economic and demographic factors influencing serum zinc levels of pregnant women at Naivasha level 4 hospital in Nakuru county. A total of 172 pregnant women visiting the hospital participated in the study. Their background information, health assessment as well as food and nutrition assessments were done. Dietary data were established by two 24-hour recall and one FFQ. All weights of foods consumed by the subjects were converted from household measures into grams and then into values of energy, protein, iron, zinc dietary fiber, calcium vitamin C, and magnesium. Women's health assessment and demographic characteristics were analyzed using and descriptive statistics (mean, standard deviations, frequencies and percentages). Serum zinc levels were determined by atomic absorption spectrophotometer. Results and findings of the study are presented in various sections of this chapter.

4.1 Background characteristics of the study participants

4.1.1 Socio-demographic characteristics of the study population

Mean age of the participants were 24 $\pm$ (4 SD) ranging between 16 to 40 years. There were relatively younger women in the age-group (20-29) making nearly half of the study population. About half of the population (48.8%) was aged between 20 and 24 years while 27.9% was between the ages of 25-29 whereas a small proportion 12.8 of women aged 30 and above was represented in the study population.

Parity has been identified as one of the most factor influencing serum zinc levels among pregnant women. In the present study, women were asked to give the number of pregnancy they had at the time of interview. The results revealed a greater majority of the participants (82.0%) had a parity of 1. The mean parity of the study population was 1 + (1 SD) ranging between 0 and 4pregnancies. This could have been probably due to a young population presented by the study participants. A greater majority (90.1%) reported to have ever been married, constituted by 86.0% currently married and 4.1% separated (Table 4.1).

Table 4.1 Selected socio-demographic characteristics of the study participants.

Variables	n=172	%
Age in years		
<20 years	18	10.5
20 - 24 years	84	48.8
25 - 29 years	48	27.9
≥30 years	22	12.8
Parity		
≤1	141	82.0
2	20	11.6
≥3	11	6.2
Period of pregnancy in trimester		
1st trimester (0-12 weeks)	3	1.7
2nd trimester (13-28 weeks)	33	19.2
3rd trimester (29-40 weeks)	136	79.1
Marital status		
Married	148	86.0
Single	17	9.9
Separated	7	4.1
Education level		
No formal education	4	2.3
Primary	71	41.3
Secondary	77	44.8
Post secondary	20	11.6

The level of education in this study varied from non formal and post secondary education, with 43.6% of the participant attaining at most primary education constituted by 2.3% non formal, and 41.3% primary education (Table 4.1).

4.1.2 Occupational status of the study population

Occupation is an important determinant of the level of income. It is an important factor that determines the purchasing power of food sources with high zinc bio availability. A relatively small proportion of the study participants (17.4%) had formal/regular jobs with 18.6% having salaried employment as the main source of income (Table 4.2).

A small proportion (2.9%) did not have any form of employment as they were either students or unemployed and another 4.1% relying on their parents as the main source of income. This was probably due to a high youthful representation in the study population who were likely to have no employment. There were also a high number of women who were housewives (48.3%) and (47.1%) reported that they depended on their husbands as their source of income (Table 4.2).

Analysis of the husband's occupation reveals that 44.6% of them had formal or regular job with a small proportion (0.7%) not employed (Table 4.2). This finding revealed a high dependency ratio in the study area, which collaborates with a development report from the District (Naivasha District development plan 2008-2012, 2009).

Table 4.2: Source of income among the study participants

Variables	n=172	%
Respondents occupation		
Casual worker	19	11.0
Housewife	83	48.3
Formal/regular job	30	17.4
Self-employed	35	20.3
Student	2	1.2
Unemployed	3	1.7
Respondents main source of income		
Salaried job	32	18.6
Husband	81	47.1
Self employed	33	19.2
Casual income	19	11.0
Parent	7	4.1
Spouse's occupation		
Casual worker	42	28.4
Formal/regular job	66	44.6
Self employed	39	26.4
Unemployed	1	0.7
Not applicable	24	

4.1.3 Housing characteristics of study population

The housing characteristics of the study population were established as a proxy indicator of their socio-economic status. These included the house ownership, number of rooms and the amount of money spent on paying rent. Majority of the participants (85.1%) resided in rental houses. Out of 143 participants residing in rental houses 91.9% paid 4000 Kenya shillings per month with 61.5% spending less than 2000 Kenya shillings on rent per month. Out of all the 172 participants 81.4% resided in 1 – 2 roomed houses with 51.2% residing in a single roomed house (Table 4.3).

Table 4.3: Wealth assessment among the study participants

Variables	**n=172**	**%**
Type of house		
Rental house	143	85.1
Own house	25	14.9
Monthly rent payment		
<2000	83	61.5
2000-4000	41	30.4
≥4000	11	8.2
Number of rooms in the house		
1	88	51.2
2	52	30.2
≥3	32	18.6
Estimated monthly earnings		
≤5000	56	40.9
6000-10000	53	38.7
>10000	28	20.5
Amount spent per week on food		
≤500	8	4.7
600-1000	39	22.7
1100-1400	73	42.4
≥1500	52	30.3
Wealth index		
First quintile	71	41.3
Second quintile	58	33.7
Third quintile	25	14.5
Fourth quintile	18	10.5

4.1.4 Socio-economic characteristics of the study participants

Analysis of wealth index of the study population was performed using principle component analysis. This is a background characteristic which was used as a proxy for the long-term standard of living of the household. This was based on data from the participants' ownership of a house, dwelling characteristics, occupation and other characteristics that relate to a household's socioeconomic status. The index was then constructed by assigning these assets with a weight (factor score) generated through principal component analysis. The resulting asset scores were standardised in relation to a standard normal distribution, with a mean of zero and a standard deviation of one (KNBS/ICF, 2010). The values were classified into four categories namely First, Second, Third, and Forth quintiles as the individual indices fell into one of the four quadrants (KNBS/ICF, 2010). According to the Kenya Demographic Health Survey 2008-09, majority of the participants in this study (75.0%) were in low socio-economic class constituted by 41.3% in low and 33.7% in moderately low socio-economic class (Table 4.3).

4.1.5 Household food expenditure

The total household's monthly expenditure is a good indicator of the household's income and purchasing power. A household with a high monthly income is likely to be one with more income than one with lower income as shown by the result of this study. The estimated monthly earnings in 137 households where the estimates were given revealed very low incomes. Approximately (41.0%) of the households earned less than 5000 Kenya shillings per month. Weekly expenditure on food revealed that more than a quarter (27.4%) spent at most 1000 Kenya Shillings (Table 4.3).

4.2 Health assessment among the study participants

More than one-quarter of the participants (29.7%) suffered an illness in the current pregnancy period. Out of those who were sick, the most commonly reported illnesses were malaria (15.7%), headache (13.7%), typhoid (11.8%), and cold and flu (19.5%). Other specific illnesses accounted for less than 10%. Of those who suffered an illness, close to three-quarter of them (72.5%) received treatment for the illness. A relatively small proportion of the participants (14.0%) reported to be ill on the day of interview, and of these half (58.3%) indicating that the sickness negatively affected their appetite. Among those affected, 78.6% had decreased appetite (Table 4.4).

Table 4.4: Morbidity history among the study participants

Variables	n=172	%
Sickness during pregnancy period		
Sick	51	29.7
Not sick	121	70.3
Types of illness*		
Malaria	8	15.7
Headache	7	13.7
Cold and flu	10	19.5
Typhoid	6	11.8
Other illnesses	21	41.15
Type of treatment/medications given*		
Anti-malaria	8	15.7
Painkillers	14	27.5
Other treatments	11	22.0

*Multiple responses allowed

Health and dietary risks associated with nutritional status of pregnant women were also assessed, since it is a reflection of how one eats. The study participants gave the association in relation to some of the nutrition problems related to poor nutritional status. These were dizziness, cases of LBW babies, and a mother is susceptible to sickness and lack of enough energy throughout the pregnancy and during delivery. Complications experienced by pregnant women during pregnancy and delivery could be avoided if only they ate the right foods during pregnancy. The complications given were miscarriage, pre-mature labour, constipation, underweight and premature babies. A mother with poor nutritional status such as anaemia, or other micronutrient deficiencies has a greater risk of obstructed labour, of having a baby with low birth weight, mortality due to postpartum haemorrhage, and maternal and child morbidity (KNBS/ICF, 2010).

4.3 Dietary intake, food consumption patterns and related practices (food choice, preparation and cooking methods) of the study population

4.3.1 Consumption patterns of selected macro and micronutrients of the study participants

Mean energy intake was 2286 kilocalories (± 753 SD) ranging from 898 to 4888 kilocalories with more than a half (63.4%) of the participants consuming below the recommended dietary requirement (RDA) of 2550 kilocalories (FAO/ WHO, 2001). Mean protein intake was 65g (± 27 SD) ranging from 22 to 166 g. Consumption of protein below recommended daily allowance was observed in 31.4% of all the participants. Mean dietary fiber intake was 55g (± 21 SD) ranging from 11 to 124g. Consumption of dietary fiber below recommended daily of25g (FAO/WHO, 2001) allowance was observed in 5.8% of all the participants. Mean Vitamin C consumption was 297mg (± 454 SD) ranging from 10 to 4147 mg. Consumption of Vitamin C below recommended daily allowance of 85mg (FAO/WHO, 2001) was observed in 7.0% of all the participants. Mean calcium intake was 658mg (± 290 SD) ranging from 189 to 1634 mg, which was below recommended daily allowance 1000mg FAO/WHO, 2001) observed in a higher proportion of the study participants (87.8%). Mean magnesium intake was 711 mg (± 287 SD) ranging from 151 to 1558 mg, which was higher than the recommended daily requirement of 350mg (FAO/WHO, 2001). Consumption of magnesium below recommended daily allowance was observed in 7.6% of all the participants. Mean Iron intake was 21 mg (± 12 SD) ranging from 5 to 65 mg. Consumption of Iron below recommended daily allowance was observed in 72.7% of all the participants. Mean Zinc intake was 14mg

(+ 7 SD) ranging from 2 to 38 mg. Consumption of Zinc below recommended daily allowance was observed in 33.1% of all the participants

Table 4.5: Consumption of selected macro and micronutrients of study participants

Nutrients N=172	RDA	Mean	SD	Median	Minimum	Maximum
Energy (kcal)	2550	2286	753	2211	898	4888
Protein (g)	50	65	27	60	22	166
Dietary fiber (g)	25	55	21	51	11	124
Vitamin C (mg)	85	297	454	206	10	4147
Calcium (mg)	1000	658	290	615	189	1634
Magnesium (mg)	350	711	287	643	151	1558
Iron (mg)	27	21	12	19	5	65
Zinc (mg)*	13/11	14	7	13	2	38

*13mg used for participants aged <18 years and 11mg used for participants aged >18 years.

SD= Standard Deviation

RDA= Recommended daily allowance (and FAO/WHO, 2001)

4.3.2 Dietary diversity of the study participants

Data collected form food frequency questionnaire were analysed to calculate the dietary diversity score of individual study respondent (FAO, 2011). Individual dietary diversity score/household dietary diversity score (IDDS/HDDS had no much difference from Women's dietary diversity score (WDDS), upon tabulation of each. IDDS/HDDS were calculated based on food groups proposed by FANTA (Swindale and Bilinsky, 2006). WDDS were calculated based on food groups proposed by (FAO, 2011). The mean DDS was 7.9 SD + 1.2 ranging from 4 to 10 for the HDDS/IDDS. Mean WDDS of the study participants was 7.2 SD + 1.1 ranging from 4 to 9. There was a small proportion (7.56 %) of the study participants with a medium DDS (4-5 food groups) and the highest percentage (92.44%) of them having a high DDS (≥ 6 food groups). None of the study participant had a low dietary diversity score (≤ 3 food groups) (Swindale and Bilinsky, 2006, FAO, 2011). Most of the study participants were found to have high intakes of macro and micronutrients since they had a high DDS (≥ 6 food groups) compared to those who had a medium DDS (4-5 food groups). The highest consumed food groups by the study participants were milk and milk products (100%), Legumes, nuts and seeds (98.8%), eggs (97.1%), meat and fish (95.3%) and organ meat (95.3%) (Figure 4.1).

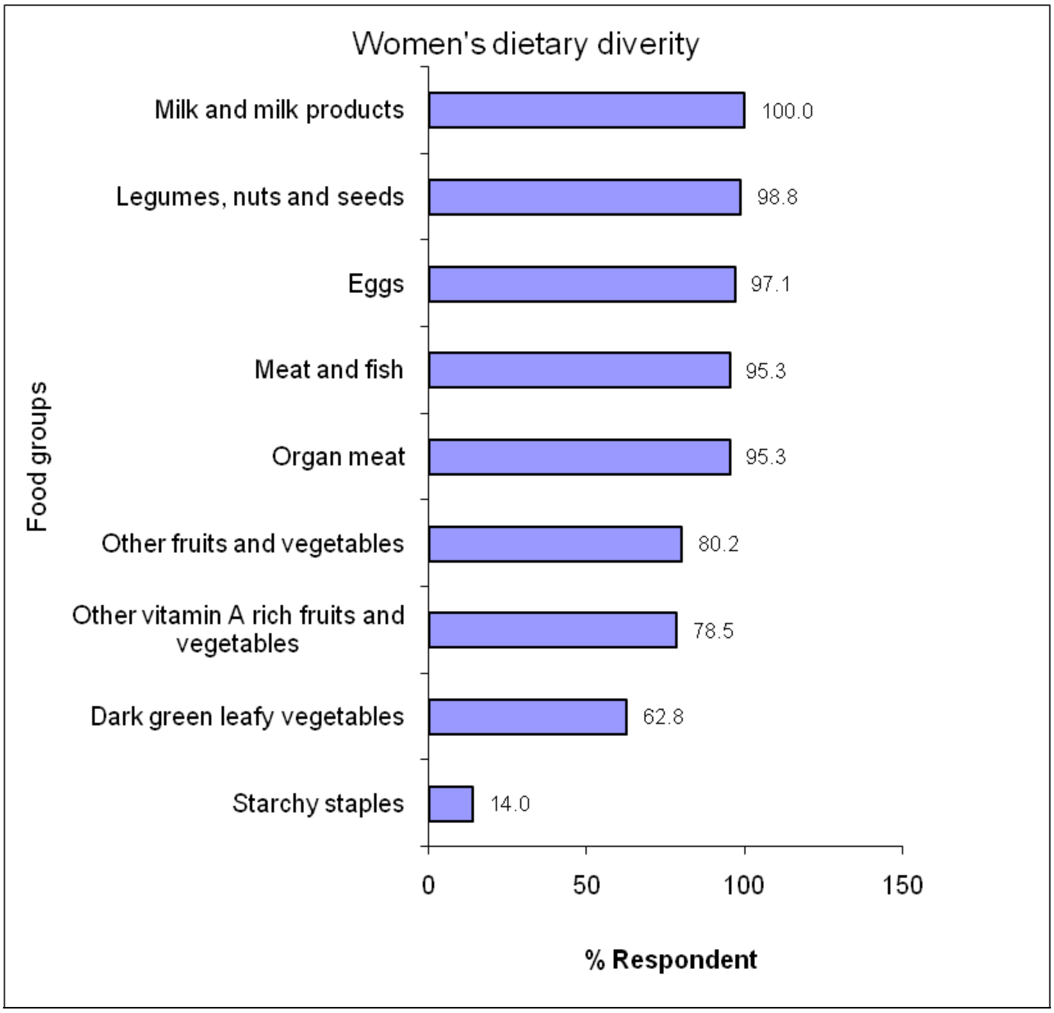

Figure 4.1: Dietary diversity of the study participants

4.3.3 Food practices (food choice, preparation and cooking methods of the study population

Food choice during pregnancy is very crucial in determining maternal nutritional status. Cravings were reported by the study participants as the most determining factor in their choice of food during pregnancy, particularly during first and second trimesters. According to them, cravings determined what they ate regardless of their nutrients content. Availability of resources was another most determining factor in food choice. Money availability determined what one would eat regardless of its nutritional value. Though nutritional knowledge was found to have a determining factor in food choice during pregnancy, the study participants were found to be incapable of choosing their food according to what they had been advised, due to lack of enough resources. *"We are advised to eat foods rich in iron and other micronutrients but if you don't have enough money to buy these foods like liver or meat, you will end up buying kales or beans which are cheap"* (Naivasha discussant February, 2012). Fatty foods or any fried food was avoided by the study participants particularly in the first trimester and this affected their consumption pattern as they would eat less than usual if they had to. Spices, fermented foods and drinks were avoided by the study participants as they increased heart burn episodes as the pregnancy advances.

4.4 Serum zinc levels among the participants

The mean serum Zinc concentration amongst pregnant women in the present study was 66 µg (± 14 SD). The value ranged from 39 to 123 µg. The study revealed a high prevalence of zinc deficiency (66.9%) amongst pregnant women in Naivasha (Figure 4.2).

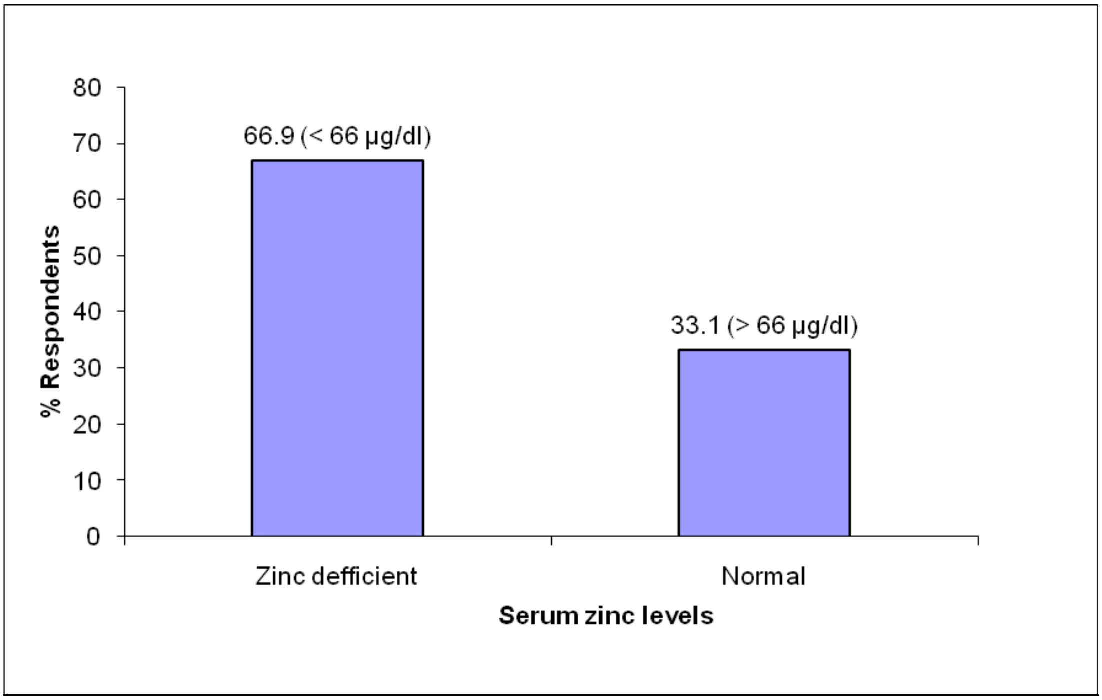

Figure 4.2: Serum zinc levels of the study participants

5. 0 Relationship of serum Zinc levels other characteristics of the study participants

Analysis of Zinc deficiency was done with respect to three thematic areas namely, (1) Socio-demographic and socio-economic characteristics, (2) Health assessments, and (3) Food and nutrition availability.

5.1 Serum Zinc levels in relation to selected socio-demographic and socio-economic characteristics of the study participants

Out of five demographic factors that were assessed, only one was significantly associated with serum zinc levels. Parity indicated a negative association with serum zinc levels among the study population. A high proportion (83.9%) of the study participants with multi parity were zinc deficient compared to those with null parity (58.8%). There was a significant association between multi parity and zinc deficiency (OR=3.65; 95% CI: 1.27 – 10.49; p=0.016) compared to null parity. A participant with multi parity was 3.65 times more likely to be zinc deficient compared to one with null parity.

While parity was the only socio-demographic factor that showed a statistical difference with serum zinc levels among the pregnant women in the study area, others socio-demographic factors were not significantly associated with serum zinc levels of the study participants at a p-value <0.5. Maternal age was negatively associated with serum zinc levels of the study population, while maternal education was positively associated with serum zinc levels of the study population. A high proportion (72.0%) of participants with no-formal/primary were zinc deficient compared to those with Post secondary education (50.0%). Low literacy level was not significantly associated with zinc deficiency at a p- value of < 0.05 (OR=2.57; 95% CI: 0.94 – 7.07; p=0.067), but a participant with low literacy level was 2.57 times more likely to be zinc deficient compared to one with post secondary education (Table 4.6).

On analysis of the relationship between serum zinc levels and socio-economic status, the results revealed that there was no significant association between socio-economic status and serum zinc levels among the study participants (Table 4.6).

Table 4.6: serum zinc levels in relation to selected socio-demographic and socio-economic characteristics of the study participants

Variables	Zinc deficient (<66 µg/dl) (n=115) n	%	Normal (>66 µg/dl) (n=57) n	%	Odds Ratio	95% CI Lower	Upper	p value
Age in years								
<20 years	9	50.0	9	50.0	Reference			
20 - 24 years	55	65.5	29	34.5	1.90	0.68	5.30	0.222
25 - 29 years	34	70.8	14	29.2	2.43	0.80	7.40	0.119
30 years and above	17	77.3	5	22.7	3.40	0.87	13.24	0.078
Parity								
0	47	58.8	33	41.3	Reference			
1	42	68.9	19	31.1	1.55	0.77	3.13	0.219
2 or more	26	83.9	5	16.1	3.65*	1.27	10.49	**0.016***
Education level								
None/Primary	54	72.0	21	28.0	2.57	0.94	7.07	0.067
Secondary	51	66.2	26	33.8	1.96	0.72	5.31	0.185
Post secondary	10	50.0	10	50.0	Reference			
Wealth index								
First quintile	46	64.8	25	35.2	0.92	0.31	2.75	0.88
Second quintile	43	74.1	15	25.9	1.43	0.46	4.49	0.54
Third quintile	14	56.0	11	44.0	0.64	0.18	2.24	0.48
Fourth quintile	12	66.7	6	33.3	Reference			

UD Undefined, i.e. the odds ratio is infinitely large or small

*Significant association at 95% confidence level (<0.05 P-value)

4.5.2 Serum zinc levels in relation to morbidity patterns and health seeking behaviour of the study participants

There was no significant association between serum zinc levels and morbidity patterns and health seeking behaviour among the study participants. However, sickness at the time of interview was negatively associated with serum zinc levels (p=0.065). A participant who was sick at the time of interview was 2.79 times (95% CI: 0.91 – 8.59) more likely to be zinc deficient compared to one who was not sick (Table 4.7).

Table 4.7: Serum zinc levels in relation to selected health assessments

Variables	Zinc deficient (<66 µg/dl) (n=115) n	%	Normal (>66 µg/dl) (n=57) n	%	Odds Ratio	95% CI Lower	Upper	p value
Suffered illness during pregnancy period								
Sick	35	68.6	16	31.4	1.12	0.56	2.26	0.749
Not sick	80	66.1	41	33.9	Reference			
Treatment for the illness								
Treated	26	70.3	11	29.7	1.31	0.36	4.82	0.681
Not treated	9	64.3	5	35.7	Reference			
Sickness at the time of interview								
Sick	20	83.3	4	16.7	2.79	0.91	8.59	0.065
Not sick	95	64.2	53	35.8	Reference			
If sick, affected appetite								
Affected	12	85.7	2	14.3	1.50	0.17	12.94	0.711
Did not	8	80.0	2	20.0	Reference			

*Significant association at 95% confidence level (<0.1 P-value)

4.5.3 Serum zinc levels in relation to dietary zinc intake, food consumption patterns of the study participants

There was no statistical association between dietary zinc intake and serum zinc levels among the study participants. However, a participant consuming vitamin C below the recommended daily allowance had a 2.62-fold risk (95% CI: 0.55 – 12.37) of becoming zinc deficient (Table 4.8).

Table 4.8: Serum zinc levels in relation to consumption of selected macro and micronutrients

Variables	Zinc deficient (<66 µg/dl) (n=115) n	%	Normal (>66 µg/dl) (n=57) n	%	Odds ratio	95% CI Lower	Upper	p value
Energy (kcal)								
Below RDA	71	65.1	38	34.9	0.81	0.41	`1.57	0.528
RDA or higher	44	69.8	19	30.2	Reference			
Protein (g)								
Below RDA	36	66.7	18	33.3	0.99	0.50	1.96	0.971
RDA or higher	79	66.9	39	33.1	Reference			
Dietary fiber (g)								
Below RDA	6	60.0	4	40.0	0.73	0.20	2.70	0.635
RDA or higher	109	67.3	53	32.7	Reference			
Vitamin C (mg)								
Below RDA	10	83.3	2	16.7	2.62	0.55	12.37	0.209
RDA or higher	105	65.6	55	34.4	Reference			
Calcium (mg)								
Below RDA	102	67.5	49	32.5	1.28	0.50	3.29	0.607
RDA or higher	13	61.9	8	38.1	Reference			
Magnesium (mg)								
Below RDA	9	69.2	4	30.8	1.13	0.33	3.82	0.850
RDA or higher	106	66.7	53	33.3	Reference			
Iron (mg)								
Below RDA	82	65.6	43	34.4	0.81	0.39	1.67	0.567
RDA or higher	33	70.2	14	29.8	Reference			
Zinc (mg)								
Below RDA	35	61.4	22	38.6	0.70	0.36	1.35	0.284
RDA or higher	80	69.6	35	30.4	Reference			

4.5.3.1: Serum zinc levels in relation to percentage of recommended daily allowances of energy, protein and zinc

Consumption of dietary zinc, energy and protein in relation to the percentage of RDA was also assessed in relation to serum zinc levels. The results revealed that more than a half of the study participants were consuming more than a 100% of the RDA for zinc (68.9%), energy (69.8%) and protein (66.9%) respectively. However there was no association of serum zinc levels in relation to the consumption of dietary zinc, energy and protein at <50%, 50-100% and at >100% of the RDAs of the respective nutrients (Table 4.9).

Table 4.9: Serum zinc levels in relation to percentage of RDA consumption of selected macro and micronutrients

	Deficient (<66 µg/dl) (n=115)		Normal (>66 µg/dl) (n=57)		Odds	95% CI		
Variables	**n**	**%**	**n**	**%**	**ratio**	**Lower**	**Upper**	**p value**
Zinc intake (%)								
<50	7	53.8	6	46.2	0.53	0.16	1.69	0.282
50 - 100	35	66.0	18	34.0	0.88	0.44	1.77	0.719
>100	73	68.9	33	31.1	Reference			
Energy intake (%)								
<50	8	61.5	5	38.5	0.69	0.20	2.39	0.559
50 - 100	63	65.6	33	34.4	0.82	0.42	1.63	0.580
>100	44	69.8	19	30.2	Reference			
Protein intake (%)								
<50	2	66.7	1	33.3	0.99	0.09	11.23	0.992
50 - 100	34	66.7	17	33.3	0.99	0.49	1.98	0.971
>100	79	66.9	39	33.1	Reference			

Nonetheless, participants who consumed dietary zinc of above 100% of RDA had a higher prevalence of zinc deficiency (68.9%), compared to participants consuming dietary zinc less than 50% of RDA (53.8%). Consumption of dietary zinc at between 50-100% of RDA had 66% zinc deficiency prevalence (Figure 4.3).

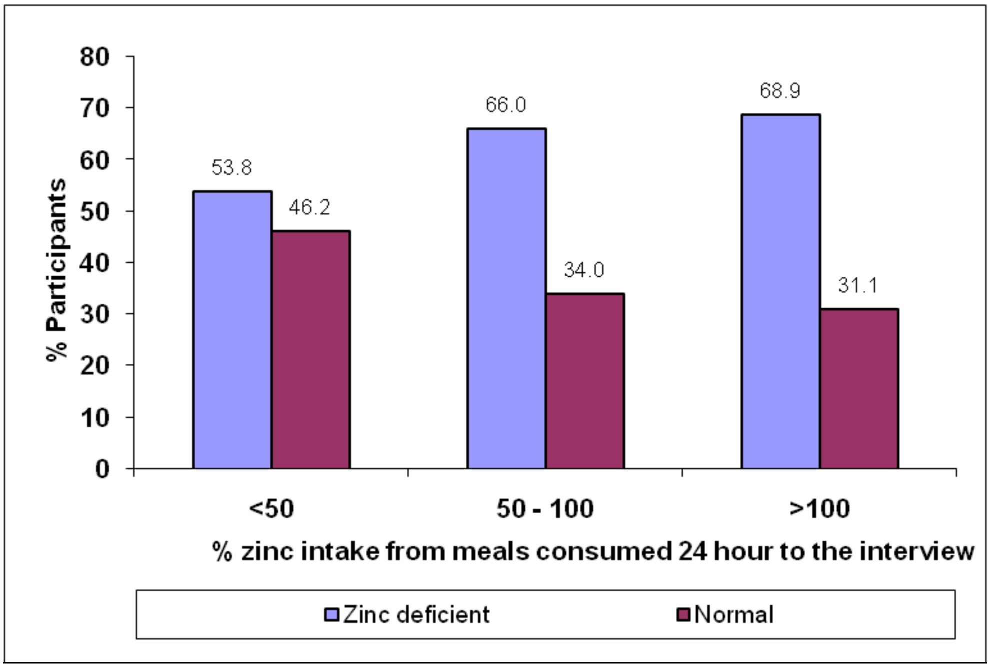

Figure 4.3: Serum zinc levels in relation to percentage dietary zinc intake from, meals consumed 24 hours to the interview

4.6 Predictors of serum zinc deficiency

Multivariate analysis was performed to identify predictor(s) of zinc deficiency among study participants. Four factors associated with Zinc deficiency at p<0.1 during bivariate analysis were considered for multivariate analysis. They include; (1) Age (2) Parity (3) Education level and (4) Sickness at the time of interview. Upon fitting the factors using Binary logistic regression and specifying *'backward conditional'* method with removal at P<0.05, four iterations were performed. The first iteration yielded the estimates as shown by the full model. The final iteration (fourth) yielded the estimates as shown by the reduced model. One predictor was retained in the final analysis as shown in. The analysis revealed that parity was a predictor of zinc deficiency (Table 4.10).

Table 4.10: Predictor(s) of zinc deficiency among pregnant women

		95% CI		
Predictors	**AOR**	**Lower**	**Upper**	**p value**
Full model				
Age in years				
<20 years	Reference			
20 - 24 years	2.56	0.81	8.12	0.111
25 - 29 years	2.37	0.63	8.91	0.200
30 years and above	2.89	0.55	15.09	0.209
Parity				
0	Reference			
1	1.36	0.58	3.19	0.487
2 or more	2.82	0.77	10.37	0.119
Education level				
None/Primary	2.95	0.91	9.54	0.071
Secondary	2.25	0.77	6.64	0.140
Post secondary	Reference			
Sickness at the time of interview				
sick	3.33	0.98	11.29	0.053
Not sick	Reference			
Reduced model				
Parity				
0	Reference			
1	1.55	0.77	3.13	0.219
2 or more	3.65	1.27	10.49	**0.016***

*Significant association at 95% confidence level (P-value 0.05)

CHAPTER FIVE

DISCUSSION

5.0 Prevalence of zinc deficiency

According to the International Zinc nutrition Consultative Group (IZiNCG), the risk of zinc deficiency (ZD) is of public health concern when the prevalence of low serum zinc concentrations is greater than 20% (IZiNCG, 2009). In this study the prevalence of ZD is prone to seasonality bias as the study is cross-sectional. The study was carried out in January and February which are locally considered as transitional months to household food insufficiency. The food is considered sufficient at this time, from the October and December short rains though not a lot. If it had been conducted in food insecurity prone months (March to May), a higher prevalence would have been expected. The study therefore signals the public health significance of ZD in the area.

Two studies conducted by the government of Kenya have attempted to determine prevalence of zinc deficiency among women in Kenya. One was conducted among the Kenyan population in 2008 and women of reproductive age were among the study participants. The other one was the routinely National Micronutrient Survey (NMIS) conducted by the Kenya Medical Research Institute (KEMRI) on the Kenyan population in 1999. They both recorded a prevalence of 50% amongst women of reproductive age, with pregnancy further exacerbating the risk (GOK, 2008; GOK/UNICEF, 2002). The present study reported severe deficiency situation compared to the two studies. The variation could be explained by the time gap, seasonal difference in data collection and the study target group. Further, the two studies may have underestimated the problem as they included all women of reproductive age, unlike the present study which targeted pregnant women. Different cut-offs of serum zinc levels that were used could also be a causative factor on the variations.

Similar prevalences of zinc deficiency have been reported among pregnant Ethiopian and Indian women (Abebe *et.al*, 2007 and Pathak, *et.al*, 2008). However, another study conducted in the neighbouring Ethiopia reported a lower serum zinc levels amongst pregnant women as compared to this study (52.4 (+/-9.9) µg/dl (Gebremedhin, Enquselassie and Umeta, 2011).

5.2 Socio-demographic and socio-economic characteristics of the study population

This study presented a youthful population, and the finding was slightly higher from 41% reported by the 2008-09 KDHS (KNBS/ICF, 2010). There is an implication of a large youthful population in the study area with a majority of them being below 30 years as evidenced by this study, supporting a report given by the District development plan which gave a youthful population with 74 % of the population being below 30 years (Naivasha District development plan 2008-2012, 2009). Maternal age was negatively associated to zinc status. The study finding agrees with the understanding that serum zinc level reaches its peak during adolescence and young adulthood, and then declines (Gibson, 1990). Other studies also reported more or less parallel finding (Gebremedhin, Enquselassie, and Umeta, 2011; Ugwuja, *et. al.*, 2010; Salimi, *et. al.*, 2004).

Following the youthful representation of the study participants, majority of them had a single or null parity. The biological expectation on parity is that serum zinc levels decreases with an increase with parity (IZiNCG, 2009). The study finding witnessed an association between parity and zinc status. This finding supports the knowledge that repeated pregnancies deplete maternal zinc stores. Other previous studies conducted in Ethiopia, Nigeria and USA also gave similar findings (Gebremedhin, Enquselassie, and Umeta, 2011; Ugwuja, *et. al.*, 2010; Neggers, *et. al*, 1996).

Education is a key determinant of the lifestyle and status enjoyed by an individual in the society (KNBS/ICF, 2010). This study witnessed a positive association between maternal education and zinc status. This could be the case as it is documented that educational attainment has a strong effect on health and eating behaviours and attitudes of an individual (KNBS/ICF,2010). However, two recent studies in Nigeria did not show any definite trend on the effect of maternal education on maternal zinc status (Ugwuja, *et. al*, 2011; Ugwuja, *et. al*, 2010). Nonetheless, this finding collaborate finding of a study on Ethiopian pregnant women (Gebremedhin, Enquselassie, and Umeta, 2011). The study finding hence indicates that higher education level might have contributed to superior zinc status through enhancing good nutritional awareness and practice prior to and during pregnancy.

A higher and medium socio-economic status enhances maternal zinc status (Ugwuja, *et. al.*, 2010; Hayati and Rirnbawa, 2002). However, in this study, household wealth index was not associated to zinc status, although majority of the study participants (75%) were low socio-economic class according to the KDHS 2008-09 (KNBS/ICF, 2010). This is in line with the same report that a greater proportion of currently employed women is lower in represented age group and increases up to forty years (KNBS/ICF, 2010).

5.3 Dietary zinc intake among the pregnant women

Proper nutrition evidenced by proper nutrient intake, plays a crucial role in influencing foetal growth and birth outcomes. It is a modifiable risk factor of public health importance in the effort to prevent adverse birth outcomes (Abu-Saad and Fraser, 2010). Proper maternal nutrition is an important determinant of health of the mother and that of the baby. Poor dietary intake increases complications experienced during pregnancy and delivery. Malnutrition in women results in reduced productivity, an increased susceptibility to infections, slow recovery from illness, and heightened risks of adverse pregnancy outcomes (KNBS/ICF, 2010).

Studies have shown that insufficient dietary zinc intake is one of the main contributing factors in the development of zinc deficiency. Zinc deficiency is documented to be significant in developing countries and this has been attributed to low dietary zinc intake. Most of the diets consumed are mostly plants diets (cereals and legumes) which have low zinc bio availability, as compared to animal diets which have high zinc bio availability (IZiNCG, 2004). Serum zinc reflects the usual zinc intake of an individual over a few weeks or months (Hess, *et.al*, 2007). Dietary intake has remained a useful indicator in assessment of zinc deficiency among populations (IZiNCG, 2009). Positive association between dietary zinc intake and serum zinc levels was expected. However, the findings did not reveal an association between dietary zinc and serum zinc levels among the study population. A recent study done among the Kenyan population attributed ZD to a high level of cereals and legumes which have a high level of zinc inhibitors (Walingo, 2009).

Findings from other studies have documented low zinc status with low dietary zinc intake (IZiNGC, 2009; Abebe *et.al*, 2007). In this study, zinc deficiency was possibly due to high consumption of cereals, carbohydrates, starches and legumes which are high in zinc inhibitors. These food sources have been documented to be of low zinc bioavailability, than animal sources such as organ meat, beef, pork, poultry, fish and shellfish which are of high zinc bioavailability (Samman, 2002). Similar findings have been reported in other studies among pregnant women in developing world (Pathak *et al*, 2008).

The study finding revealed a high dependency on consumption of cereals, starches, carbohydrates and legumes which provided considerable amounts of energy and dietary zinc to the participants. This relatively high intra-person variability in consumption of a combination of zinc dense foods with very high level of phytate intake could result in a weaker association between zinc intakes or the P: Z molar ratio with serum zinc. Such diets contains higher amount of phytates and dietary fiber which are known to cause poor zinc absorption (Chandyo, *et.al*, 2009; Pathak *et al*, 2008; Lönnerdal, 2000). This could be a major contributing factor for a high prevalence of zinc deficiency in this study population.

Results from this study showed that porridge and *ugali* were prepared from mixed flours which contain phytates, while according to the food frequencies beef and other organ meats were rarely eaten. These two reasons could have been responsible for the high prevalence of zinc deficiency among the study population. This is because high levels of dietary zinc are concentrated in animal products, nuts and seeds, and little quantities in vegetables and fruits. Meat has the highest concentration of bio available zinc (Chandyo, *et.al*, 2009; Walingo, 2009). In this study, it was consumed by half of the women but not on a regular basis.

Experimental studies have shown that utilization of dietary zinc could be markedly different depending upon the source of the dietary protein (Lönnerdal, 2000 and IZiNCG, 2007). Zinc in diets containing proteins from animal sources (meat, fish, milk and eggs), have been found generally to be of high availability and well absorbed. Whereas those from plant products notably those from cereals and legumes are poorly absorbed. One factor that is of major importance in giving rise to low zinc availability from cereals and legumes based diets is phytic acid (inositol hexaphosphate) and its salts, known as phytates. They attach it irreversibly in the intestines. The highest amounts are found in wheat, beans and nuts, less in fruits and vegetables and a few tubers. This is what makes them non-reliant sources of zinc, despite the fact that dietary zinc concentration is relatively high in these foods (Lönnerdal, 2000 and IZiNCG, 2004).

Studies have established that animal proteins increases zinc bio availability as a whole. The highest concentrations of zinc are found in oysters, followed by mammals' and poultry's meat and organs, fish, shellfish, and in a less extend in eggs, milk and dairy products (Lönnerdal, 2000, and IZiNCG, 2007).

Fibers are known to inhibit zinc absorption but several studies have shown that this is due to the fact that plants containing fibres contain large contents of phytates as well (Lönnerdal, 2000; IZiNCG, 2007 and IZiNCG, 2004;). This is because of the high intakes of fiber present in vegetables, which may be problematic as availability of zinc may be compromised by the high content of phytates, present in vegetables (Lönnerdal, 2000).

Reduced dietary intake of foods rich high bio available zinc has serious effects on the nutrition and health of pregnant women. According to IZiNCG this is the case in many developing countries, where most diets are predominately based on these foods which have low zinc content (IZiNCG, 2009). This high intake of diets with high-phytic acid content and a high molar ratio of phytic acid to zinc are associated with a low fractional absorption of zinc and studies have associated it with significantly greater fractional absorption of this micronutrient (Adams, *et al.*, 2002). This consumption of dietary plants sources could have compromised the absorbable zinc as its availability in this food sources is lower compared to animal food sources (Samman, 2002). Food consumption practices like fermentation which was not popular with the study participants, could have probably caused high zinc deficiency prevalence, despite the fact that dietary zinc consumption was adequate. This could have compromised the absorbable dietary zinc as fermentation as a food technique is believed to increase bio availability of zinc from plant foods (IZiNCG, 2009). Another notable factor that could have led to the prevalence is the high consumption of cow's milk which is composed of 80% casein protein that has been found to have inhibitory effect to zinc absorption (Lönnerdal, 2000).

The present study revealed a higher prevalence of zinc deficiency amongst study participants who consumed dietary zinc at between 50% and 100% and at above 100% of RDA as compared to those who consumed less than 50% dietary zinc of RDA. This finding conquered with the fact that fractional absorption of zinc (i.e., the percentage of dietary zinc intake that is absorbed) decreases with increasing zinc intake. The total amount of absorbed zinc (TAZ) increases in relation to the amount of zinc consumed until it approaches an area of little variation, at higher levels of zinc intake (Hess and Brown, 2009). The implication of a low dietary zinc intake is that, it exposes an individual to zinc deficiency (IZiNCG, 2009). Over consumption of dietary zinc on the other hand also predisposes one to development of zinc deficiency due to the decreased fractional absorption of zinc percentage of dietary zinc which decreases as one increases dietary zinc intake (Hess and Brown, 2009).

Studies have shown that inadequate dietary zinc intake is one of the main contributing factors in the development of zinc deficiency. However, the results of this study suggest that other factors may be more critical than dietary zinc intake in the development of zinc deficiency among pregnant women, especially from developing countries. These other factors include socio-demographic factors (parity, maternal age, education level), and morbidity patterns and health seeking behaviour, more specifically sickness during pregnancy.

The findings of this study, clearly indicates a high prevalence of zinc deficiency in the study area. This signals a public health concern in the area which needs to be addressed. The results are fairly consistent with the findings from other studies in developing countries (Gebremedhin, Enquselassie, and Umeta, 2011; Chandyo, et. al., 2009 and Pathak, et. al., 2008). The study hence confirms significantly higher prevalence of zinc deficiency among pregnant women, and parity is the main associated factor. This high prevalence of ZD clearly indicates that the study population and probably other pregnant women in urban areas may be vulnerable to risks of birth outcomes associated to ZD.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 Summary of the research findings

The study presented the findings of a study focusing on the dietary, socio-economic and demographic factors influencing serum zinc levels of pregnant women at Naivasha level 4 Hospital, Nakuru County. The study purposed to establish dietary, socio-economic and demographic factors that influence serum zinc levels among these women. The study adopted a cross-sectional analytical study design in achieving its stipulated objectives. A sample size of 172 pregnant women of reproductive age (15-49), residing at Naivasha division at the time of interview were included and there data on dietary, socio-economic and demographic were collected.

All data were analyzed using SPSS computer software version 12.0.1. Descriptive analysis was done using mean, frequency, percentage and SEM. ANOVA. Regression analysis was used to compare means for serum zinc levels, and to establish dietary, socio-economic and demographic characteristics influencing serum zinc levels during pregnancy. A p value of < 0.05 statistical significance was used. Results were presented using tables, figures and graphs.

6.1 Implications of the Findings

The findings from the present study revealed a high prevalence of zinc deficiency (66.9%). Dietary zinc intake was not significantly associated with serum zinc levels of the participants, as other studies have showed (Pathak *et al*., 2008). This high prevalence of zinc deficiency among the study participants could possibly be explained by the explained variables in the food consumption patterns and related practices other than the dietary intake.

While parity was a significant predictor of serum zinc levels among the study population, other factors were seen to be risk factors to zinc deficiency during the bivariate analysis. These are maternal age and education level, sickness at the time of interview.

6.2 Conclusion

The finding from this study concludes that there is a high prevalence of zinc deficiency among pregnant women in Naivasha and it is of public health concern in the study area. This may increase the risk of poor pregnancy outcomes in these women. Although there was no significant association between dietary zinc and serum zinc levels among pregnant women, consumption of Vitamin C below the RDA as key predisposing factor to zinc deficiency hence the first null hypothesis that stated “There is no significant relationship between dietary factors and serum zinc levels during pregnancy” was rejected.

Socio-economic status was not significantly associated with serum zinc levels among the study participants. This was despite the fact that according to KDHS 2008-09, majority of the study population were in low socio-economic class, as the findings revealed. Therefore the second null hypothesis that stated “There is no significant relationship between socio-economic factors and serum zinc levels during pregnancy” was accepted.

Parity was significantly associated with zinc deficiency. Grand multi parity was negatively associated to serum zinc levels. The study findings indicate a significant relationship between socio-demographic factors (parity) and serum zinc levels among pregnant women in Naivasha. Age in years and maternal education level were key predisposing socio-demographic factors to zinc deficiency, although they were not significantly associated to serum zinc levels among the study participants. The third null hypothesis that stated "There is no significant relationship between demographic factors and serum zinc levels during pregnancy" was rejected.

The study findings did not show a significant association between serum zinc levels and morbidity patterns and health seeking behaviour among the study participants, and therefore the forth null hypothesis that stated "There is no significant relationship between morbidity patterns, health seeking behavior and serum zinc levels during pregnancy" was equally rejected. The findings however revealed a tendency of association between participants that were sick at the time of interview with their zinc status. More research in the area and others with similar characteristics needs to be carried out to explain further on this phenomenon.

The study findings therefore conclude that the zinc deficiency prevalence among pregnant women in Naivasha, Nakuru County is influenced by a number of factors. The influencing factors are more of food consumption patterns and related behavior other than dietary intake. The study findings also revealed that socio demographic factors influence serum zinc levels during pregnancy with parity being the most significantly associated and maternal education and age were predisposing factors to serum zinc deficiency among these women. There were no socio economic factors found to influence serum zinc levels among the study participants.

6.3. Recommendations

This study gives recommendations for policy, practice and further research to the Government of Kenya nongovernmental organizations, health care facilities, maternal health and nutrition scholars and to all women of reproductive age.

6.3.1 Recommendations for Policy

The high prevalence of ZD (69.9) calls for public health concern through interventions to reduce the prevalence among pregnant women in urban Kenya. Awareness programs about the consequences of ZD, including prevention could be made available in all health care facilities, working places and in the community as well. This can be a combined initiative among all the stakeholders working to improve maternal and child health (MCH). The government could provide in service training to the health care providers in order to well equip them in handling and providing proper healthcare services to the pregnant women.

Even as the Government, NGOs and other stakeholders working in MCH struggles to address other problems in pregnancy like Iron deficiency, some efforts on ZD should be included in the routine check-up for ANC in all healthcare facilities. Health care providers could integrate education on zinc during pregnancy in the routine ANC education programmes. The problem needs to be emphasised as the problem of ZD has been increasing in the developing countries. It may continue to worsen if appropriate preventive measures are not put in place.

The high prevalence of ZD in the area may be addressed through a combination of short, medium and long term strategies. Interventions drawn to address the problem of zinc deficiency among pregnant women should focus on nutrition education that is geared towards increasing absorbable zinc content from plant foods. This findings point to a need to focus more on food practices that will increase absorbable zinc as a way of preventing zinc deficiency among pregnant women. This includes household based phytate reduction food processing techniques like fermentation, soaking and sprouting, which can be considered as a short term option. Studies have shown that majority of the population in most developing countries, Kenya included consume cereals, starchy root tubers and legumes. These foods have high contents of phytates, fiber and phytic acid and they are documented to be zinc binding agents (Walingo, 2009; IZiNCG, 2009; GOK/UNICEF, 2002).

The Government through the Ministry of Industrialization could put up a policy on women empowerment that would recognise the role played by women in the small and medium enterprises that they get involved in. This would enable them have access to financial support in improving their businesses. This would promote women’s empowerment and improve on their economic status which will give them a higher purchasing power of food. This is important since most of the decision making regarding food choice and what is to be eaten at home is made by women.

This livelihood promotion and socio-economic empowerment of women can be used to yield a long-term solution. Based on the fact that food sources that are high in bio available zinc are animal protein which tends to be expensive to acquire, the above improvements could go well with ensuring that women are able to purchase foods that are superior in bio availability of zinc.

The government, through the Ministry of Health, could enhance the provision of family planning to all health facilities in the country. These services should be made easily available and affordable to all women of reproductive age. This will go well in educating women on the consequences of having a parity of more than three. The findings of the present study found a negative association on parity and serum zinc levels among the study population.

6.3.2 Recommendations for practice

Good heath prior and during pregnancy should be put into consideration by all women of reproductive age. Although this study did not find an association on morbidity pattern and health seeking behavior with serum zinc levels, association on the same have been documented (IZiNCG, 2009). It is important therefore to ensure that medical services are made available and affordable to all women of reproductive age. Proper diagnosis and timely treatment should be done. They should also be made available to those seeking the services in order to protect both the mother and the child from the preventable pregnancy outcomes as a result of low zinc deficiency. The government or any organization designing interventions to improve maternal and child health (MCH), should also put this into consideration whenever designing and guiding their intervention programmes.

The high rates of ZD in the study area points to a need in behavior change among women of reproductive age and specifically pregnant women, related to improved dietary practices. This could help to prevent the development of ZD that may lead to adverse birth outcomes. This could be done through adoption of traditional food and dietary practices that increase bio availability of absorbable zinc, more so from plant foods as most diets in developing countries are based on plant foods. These include soaking, fermentation, sprouting and germination that were applied in the preparation and making of traditional foods and beverages practiced by most Kenyan communities but are no longer practiced.

This study points out the need to create awareness on the problem of zinc deficiency among pregnant women in urban industrial areas by the Government of Kenya through the Ministry of Health and Ministry of Agriculture, in the Department of Nutrition. The awareness could focus more on areas such as making healthy food choices and practicing proper dietary and food practices. Right education and awareness on household based agricultural practices. These includes kitchen gardening, keeping domesticated animals like chicken, rabbits and other animals for food to provide high bio available zinc foods. This could help cut down on cost of food as well.

6.3.3 Suggestions for further research

Due to the high prevalence of zinc deficiency among the study population, there is need to undertake similar studies in various parts of the country to assess the serum zinc levels and the magnitude of zinc deficiency amongst pregnant women in Kenya. The comparison could be made with the present study which could help establish factors influencing serum zinc levels among pregnant women in these other areas.

A study on the prevalence of prenatal zinc status and its associated birth outcomes could be conducted in the area and any other area with similar characteristics. Another comparative study between zinc deficiency among pregnant women and non-pregnant women could be carried out in the area and any other with similar characteristics.

Since the study excluded HIV-positive pregnant women during sampling, a study on zinc deficiency amongst HIV-positive pregnant women could be carried out in the area and any other with similar characteristics. Zinc plays a crucial role in immunity. Also a comparative study between zinc deficiency amongst HIV-positive and healthy pregnant women in the country could be carried out. Studies have showed significant association between HIV infections and serum zinc levels (Were, *et. al*., 2009).

Since this study did not put into consideration assessing other micronutrients such as copper, selenium and Iron it would be important for other studies to consider assessing them. This would give a clear assessment on their level of interactions with serum zinc levels especially during prehnancy. Other studies have revealed some interactions which could affect the levels of each individual micronutrients in the body particularly so during pregnancy (Gebremedhin, Enquselassie, and Umeta, 2011; Essam, Hesham, and Hani, 2010; Zeyrek, *et al.*, 2009).

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8. APPENDICES

8.1 Appendix I Researcher Administered Questionnaire

8.1.1 Letter of Introduction

Hello. My name is --a masters student at Kenyatta University. I am conducting a research that asks about dietary, cultural, socio economic and demographic factors influencing serum zinc levels of pregnant women. I and my two research assistants will ask you dietary, demographic and socio-economic questions that you will be required to answer as correctly as possible. The questionnaire will take between 40 to 45 minutes to complete. You will then be directed to the laboratory for blood sample collection, needed for serum zinc levels determination. A qualified laboratory technician will draw 5 ml blood (equivalent to a one teaspoonful) from your arm. This process will have no serious risks to you, however, it will involve injecting your arm with a small needle which may cause little pain and discomfort at the site of the needle prick. Necessary care will be taken to stop the discomfort in a short while within the same day, as minimal as possible, and the laboratory technician will ensure that you have stopped bleeding before letting you go. The findings from the study may contribute to knowledge on maternal and child healthcare in the study area and any other with similar characteristics. The findings may be used in formulating policies that will help improve nutrition status of pregnant women of all communities in the country. Whatever information you provide will be kept confidential and will not be shared with anyone other than my research Supervisors. Participation in this research is voluntary, and if we should come to any question you don't want to answer, just let me know and I will go on to the next question; or you can stop the interview at any time, not participating in the interview will not interfere with the services offered at this hospital. I would very much appreciate your participation in this research and hope that you will participate since your views are important.

Signature of interviewer: ………………………... Date: ……………………………..

8.1.2 Letter of Consent (English)

My name is --- I am a residence of --------------------------------------location, Naivasha division. I have been informed about the research and the researcher has informed me on the benefits and the risks involved. The information given in this research will assist in the improvement of maternal and child health services. I have been assured of confidentiality on any information that will be given. Participation in this research is voluntary. I have willingly accepted to participate in the research.

Signature of interviewee: ……………………… Date: ……………………………..

8.1.3 Letter of consent (Kiswahili)

Jina langu ni ---. Mimi ni mkaaji wa kata hii ya ---------------------------------- tarafa ya Naivasha. Nimejulishwa kuhusu utafiti, na mtafiti amearifu kuhusu manufaa na hatari zinazohusiana nao. Matokeo ya utafiti huu utasaidia katika kuimarisha afya ya uzazi na watoto. Nimeahidiwa kuwa habari zote nitakazotoa zitakuwa siri. Kuhusika na kishiriki kwangu ni kwa kujitolea bila kulazimiswa. Nimekubali kushiriki katika utafiti huu.

Sahihi ya mhojiwa--------------------------- Tarehe------------------------

8.1.4 Letter of Consent to the parent/guardian

My name is --- I am a residence of ---------------------------------------location, Naivasha division. I have been informed about the research and the researcher has informed me on the benefits and the risks involved. The information given in this research will assist in the improvement of maternal and child health services. I have been assured of confidentiality on any information that will be given to my daughter. My daughter's participation in this research is voluntary. She has willingly accepted to participate in the research.

Signature of guardian: ……………………… Date: ……………………………..

A RESEARCH TOOL/INSTRUMENT FOR PREGNANT WOMEN

DIETARY, CULTURAL, SOCIO ECONOMIC AND DEMOGRAPHIC FACTORS INFLUENCING SERUM ZINC LEVELS OF PREGNANT WOMEN AT NAIVASHA LEVEL 4 HOSPITAL NAKURU COUNTY, KENYA

ADMINISTRATIVE DETAILS

Questionnaire Code NO……………………………………..
Name of the interviewer……………………………Code No…………………..
Respondent's Residence…………………………
Date of interview………………..Time started………………Time finished……….
Questionnaire checked………. ☐☐

Inclusion criteria

1. Residents of Naivasha division
2. Must have visited the hospital at least once at the time of interview.

Exclusion criteria

1. Women visiting the clinic for the first time.
2. Pregnant women suffering from cancer, diabetes, Hypertension, HIV positive
3. Non residence of Naivasha division.

SECTION A: Demographic characteristics

Put a tick or a number in the spaces provided when answering a question for example

☑ ☐1

Date of Birth…………………..Age in years………… **(Confirm from mothers health card)**

A2. Parity **(confirm from mothers health card)**………………

A3. Period of pregnancy in trimester **(confirm from mothers health card)** ☐

1-1 Trimester 1
2-2 Trimester 2
3-3 Trimester 3

A4. Marital status ☐

1- Married
2- Single
3- Widow
4- Divorced
5- Separated

SECTION B. **Morbidity Data**

B1. Have you suffered any illness during the pregnancy period? ☐

Yes=1
No=2

B2. If yes, specify the illness……………………………………..

B3. Have you been on treatment for the above named illness?

Yes=1
No=2

B4. If yes, specify the kind of treatment and the medication given……………………

SECTION C. Education Information

C1. Have you ever attended school?

1=Yes
2= No

C2. Please let me know the highest level of education reached/attained?

1- No formal education
2- Adult education only
3- Completed primary
4- Not completed primary
5- Secondary level education
6- Certificate level training
7- Diploma level education
8- Degree level education
9- Others (specify)

C3. Please let me know your occupation?

1- Casual worker
2- Housewife
3- Formal/regular job (specify type of job)……………………………
4- Self-employed (specify)……………………………………………
5- Student
6- Others (specify)…………………………..

SECTION D: Socio-economic characteristics

D1. Please let me know your main source of income?

1-Salaried job
2- Husband
3- Self employed
4- Casual income
5- Other (specify) ……………………….

D2. Please may I know what your Husband/ partner does for a living/work/job?

1-casual labourer
2-formal/regular job
3 -unemployed/not working
4 -self employed
5 - Student

6 -others (Specify)……………………

D3.In what kind of house do you leave in? ☐

1-Rental house
2- Own house
3- Other specify………………………………..

D4. If rented, how much rent do you pay per month in Kshs? ☐

1- Below 2000
2- 2000-4000
3- 4000-6000
4- 6000-8000
5- 8000-10000
6-Above 10000

D5- Please let me know the number of rooms in your house? ………rooms.

D6- How much do you approximately earn per month in Kshs? ☐

1- Below 5,000
2- 6,000- 10, 000
3- 11,000-15,000
4- 16,000-20,000
5- 21000- 30,000
6- Above 30000

D7- Approximately, how much money do you spend on food per week? ☐

1-Below 500
2-600-1000
3-1100-1400
4-1500-1900
5- 2000-2400
6- 2500-2900
7-Above3000

Questionnaire Code NO…………Age of respondent………………….
Name of the interviewer………………………..Code No.................
Date of interview……………….

SECTION E: Dietary practices

Part 1: 24-hour recall recording sheet

Establish the meals taken in the last 24 hours, ingredients and amount in the meals, the method of preparation, amount in household measure and the amount taken in grams.

TICK THE DAY OF THE WEEK WHICH YOU ARE RECALLING **(IT SHOULD BE THE DAY BEFORE THE INTERVIEW)**

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Step 1: Please think back to when you woke up yesterday morning to the time you went to sleep in the evening. Now, I want you to try and remember what you ate or drank yesterday from the moment you got up until you went to sleep again last night. Run through the whole day in your mind and try to remember everything that you ate or drank. (THE INTERVIEWER MUST GIVE THE RESPONDENT A LITTLE TIME TO DO THIS). Now I would like you to tell me what you ate and drank in the morning after you got up. AFTER THE PARTICIPANT MENTIONS AN ITEM, THE INTERVIEWER SHOULD PROMPT THE RESPONDENT BY SAYING "AND THEN?" **ENTER THE INFORMATION IN COLUMN 1)**

STEP 1: Food/drink eaten/drank during the day	**STEP 2:** Forgotten foods (PROMPTI

STEP 2: NOW ASK THE FOLLOWING QUESTIONS ON FORGOTTEN FOODS AND ENTER THEM IN COLUMN 2.

Did you have any cold drinks or soda yesterday?
Did you have any sweets and or chocolate yesterday?
Did you have any cake and or cookies yesterday?
Did you have any snacks like chips, samosa, yesterday?
Did you have any (other) fruit yesterday?
Did you have any (other) vegetable yesterday?
Did you have any bread and or rolls yesterday?
Did you have any mandazi yesterday?
Did you have anything else yesterday?

Q. What you ate/ drunk yesterday; was it same as, more than or less than usual?
(MARK **X** WHERE APPROPRIATE)

Same as usual		More than usual		Less than usual	

If not as usual give reasons;

1. Adequate food ☐ **3.** Sicknesses ☐ **5.** Decreased appetite ☐
2. Inadequate foods ☐ **4.** Increased appetite ☐

Step 3: TO FIND OUT MORE DETAIL ABOUT EACH ITEM THAT WAS EATEN OR DRUNK, THE FOLLOWING CAN BE SAID AND ASKED: *"Now I am going to ask you more about each food or drink that you ate/drank yesterday. Let us start with the first item on the list. At what time did you eat? (= item 1 on the list)".* (DO NOT SPEND TOO MUCH TIME TRYING TO FIND OUT THE EXACT TIME. ANY COMMENTS ON THE TIME CAN BE ENTERED IN **COLUMN 2)**. *Now I want you to tell me more about this food item…."* (THIS WILL INCLUDE A DESCRIPTION OF THE FOOD AS WELL AS THE PREPARATION. **ENTER THIS INFORMATION IN COLUMN 4).** *"Now we are going to find out how much of this item you ate/drank."*(THE INTERVIEWER NOW USES THE DIFFERENT AIDS TO HELP THE SUBJECT TO IDENTIFY THE PORTION SIZE. A DESCRIPTION OF THE PORTION SIZE IN TERMS OF CUPS, SPOONS, BOWLS, GLASSES, MATCHBOXES, MANUAL PICTURE SIZE OR CENTIMETERS (USING THE RULER) IS THEN **ENTERED IN COLUMN 5.** IF THE FOOD CODE AND THE PORTION SIZE IN GRAMS OF THIS PARTICULAR ITEM IS EASY TO FIND, IT CAN BE **ENTERED COLUMN 6).** IF IT IS NOT CLEAR OR EASY, THE CODE AND GRAM WEIGHT CAN BE LEFT OUT TO BE COMPLETED AFTER THE INTERVIEW. (THIS PROCESS IS REPEATED FOR EACH FOOD ITEM THAT WAS ENTERED ON FORM 1).

Time (1)	**Comment on time (2)**	**Food item carried from step 1 and 2 (3)**	**Detailed description of the item (ingredients and cooking method) (4)**	**Detailed description of Portion Size (household measures) (5)**	**Weight In (g) (6)**

Time (1)	Comment on time (2)	Food item carri from step 1 and 2 (3)	Detailed description of the item (ingredients and cooking method (4)	Detailed description of Portion Size (household measures) (5)	Weight (g) (6)

STEP 4: RECORDING SHEET FOR INFORMATION COLLECTED IN STEP 3 OF THE 24-HOUR RECALL

Probe for sickness: **Yes** ☐ **No** ☐

If yes, did sickness affect appetite? **Yes** ☐ **No** ☐

If yes how? **Increased** ☐ **Decreased** ☐

Probe for alcohol: **Yes** ☐ **No** ☐

Probe for supplements: **Yes** ☐ **No** ☐

If yes give type used…………………………………

When do you drink tea or coffee? ☐
1-During a meal
2-After a meal
3-Before a meal

Part 2: 7 day food frequency

State the frequency of consumption of the selected food items in the last seven days

	Frequency of consumption in the last one week (Tick where appropriate)								
	Once	**2 times**	**3 times**	**4 times**	**5 times**	**6 times**	**Daily**	**Never**	**source**
Cereals, carbohydrates, starch									
Ugali									
White bread									
Whole meal bread/ Brown bread									
Brown rice									
White rice									
Pasta									
Porridge									
Whole meal chapatti									
Sifted wheat flour chapatti									
Githeri									
Mandazi									
Roasted maize									
Commercial breakfast cereals									
Chips									
Green bananas									
White roots and tubers									
Arrow roots									
Yams									
Irish potatoes									
Vitamin A rich vegetables and tubers									
Carrots									
Sweet potatoes									
Dark green vegetables									
Kales									
Spinach									
Kunde (cow pea leaves)									
French beans									
Other African leafy									

vegetables (specify)									
Other vegetables									
Cucamber									
Cabbage									
Tomatoes									
Vitamin A rich fruits									
Pawpaw									
Mangoes									
Other fruits									
Melon									
Passion									
Pineapple									
Avocado									
Apples									
Bananas									
Citrus fruits									
plums									
Others (Specify)									
Organ meats									
Matumbo									
Liver									
Kidney									
Heart									
Flesh meats									
Beef									
Mutton									
Pork									
Chicken									
Processed meat (sausages, bacon, ham, smokies, brown etc)									
Eggs									
Eggs									
Fish and sea food									
Fish									
Omena									
Legumes / pulses, nuts and seeds									
Dry peas									
Dry beans									
Lentils (kamande)									
Green grams									
Mbaazi/peagon peas									
Black eye									

peas (Njahi)									
Groundnuts/ peanuts									
Sesame seeds (simsim)									
Coconut									
Peanut butter									
Milk and milk products									
Whole milk									
Fermented milk (mala)									
Yoghurt									
Ice cream									
Oils and fats									
Margarine									
Butter									
Oils									
Fats									
Sweets									
Sugar									
Honey									
Cakes									
Biscuits									
Sweets									
Sugar cane									
Jam									
soda									
Spices Condiments and beverages									
Alcohol									
Spices									
Coffee									
Tea									
Other beverages									

8.2 Appendix II Focus group discussion guide for pregnant women

1. What are the health and dietary risks associated with the nutrition status of pregnant women?
2. What are the main factors which determine the choice of food you eat?
3. Is there any association between health of women with the kind of food they eat during pregnancy?
4. Suggest possible ways and means you consider appropriate to reducing the level of malnutrition in pregnant women in your area?
5. What community organizations are working in your community, to reduce the level of malnutrition in pregnant women?
6. Which are the areas that require priority intervention as far as maternal and child health is concerned?
7. In your own opinion, are there food preparation methods that affect your eating behavior during pregnancy?

8.3 Appendix III Biochemical analysis sheet

Questionnaire Code no…………..

Name of the interviewer…………………………………..Code No………………..

Date of Birth…………………………..Age……………

Date of Sampling…………………Time of Sampling…………………

Temperature……………………….

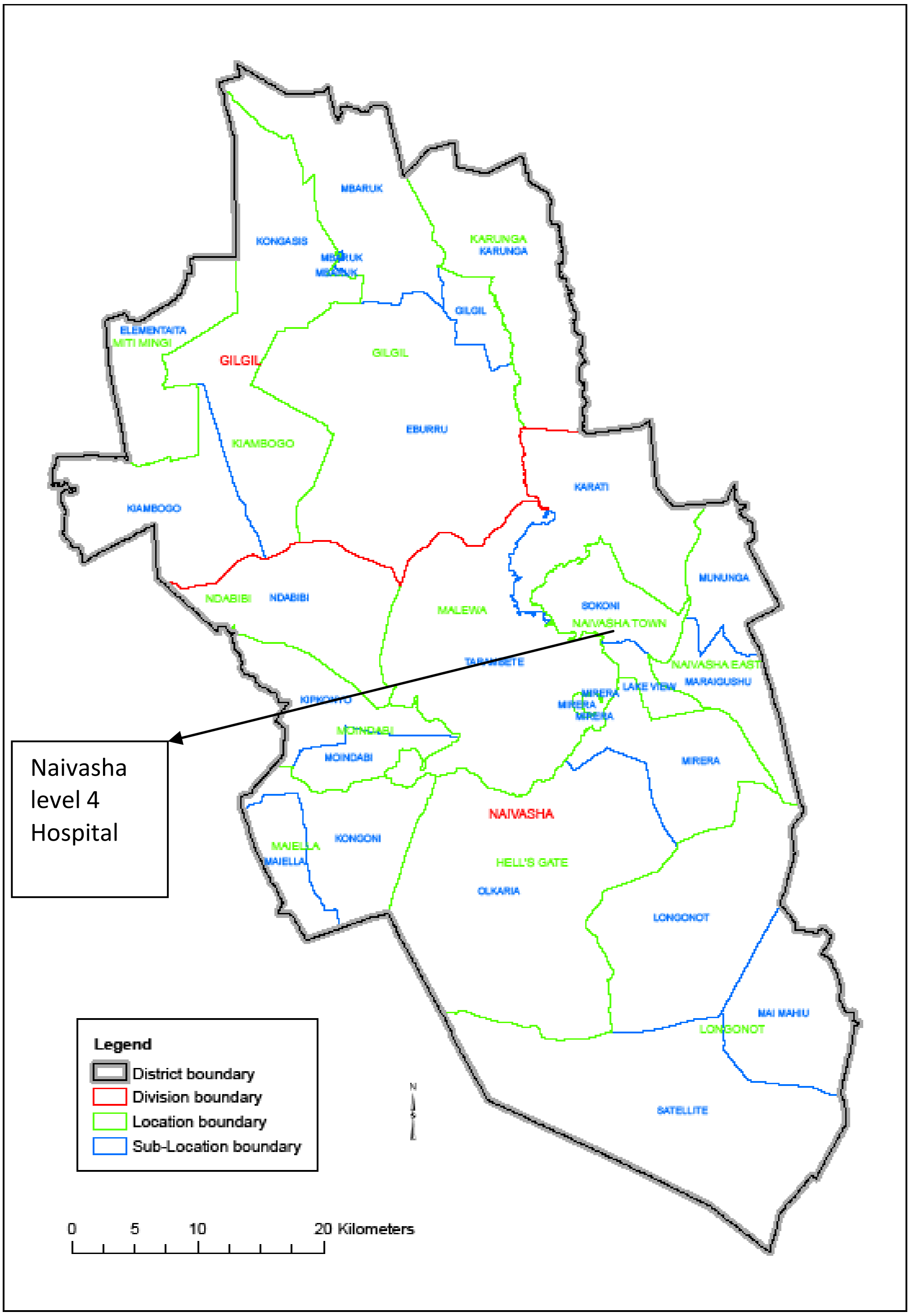
Name of Laboratory Technician……………………………Signature………………

(For official use only)

Sample Code no	**Serum Zn (mg/ml**	**C-reactive protein**

8.4 Appendix IV Map of the study location

NAIVASHA DISTRICT ADMINISTRATIVE UNITS

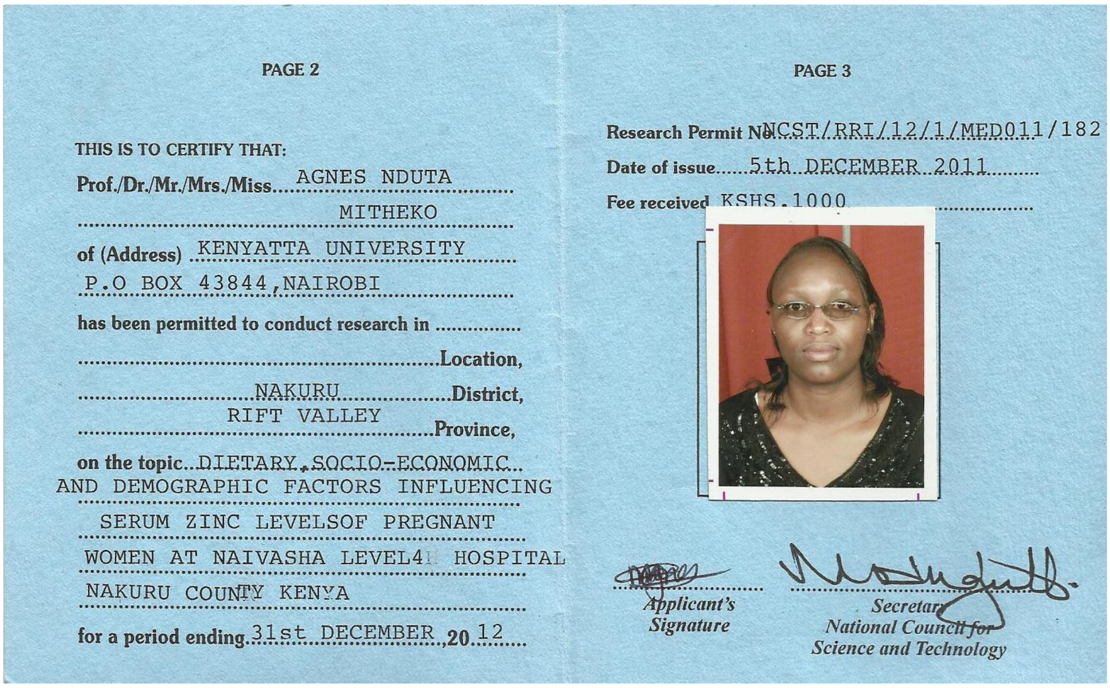


Source: Naivasha District development plan 2008-2012, 2009

8.5 Appendix V Work plan for the study

Year	**2011**				**2012**			
Activity	**Jan**	**Feb-Mar**	**Apr**	**May-Nov**	**Jan-Feb**	**Mar-May**	**June-Sep**	**Oct**
Concept presentation								
Writing and typing research proposal								
Proposal corrections								
Submission of proposal and presentation								
Data Collection								
Data Analysis								
Thesis Writing								
Presentation of Findings at the department								
Submission of thesis								

8.6 Appendix VII Research permit



PAGE 2

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss. AGNES NDUTA MITHEKO

of (Address) KENYATTA UNIVERSITY P.O BOX 43844,NAIROBI

has been permitted to conduct research in .... Location,

NAKURU District,

RIFT VALLEY Province,

on the topic. DIETARY,SOCIO-ECONOMIC AND DEMOGRAPHIC FACTORS INFLUENCING SERUM ZINC LEVELSOF PREGNANT WOMEN AT NAIVASHA LEVEL4 HOSPITAL NAKURU COUNTY KENYA

for a period ending. 31st DECEMBER ,20 12

PAGE 3

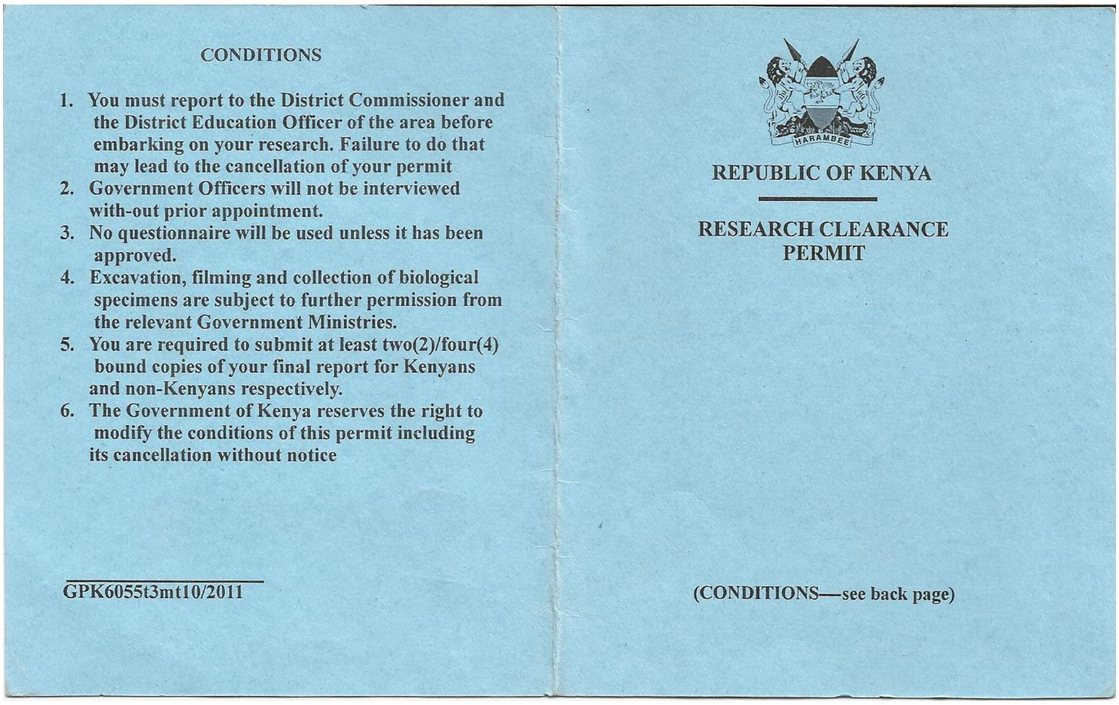
Research Permit No. NCST/RRI/12/1/MED011/182

Date of issue 5th DECEMBER 2011

Fee received KSHS.1000

Applicant's Signature

Secretary
National Council for
Science and Technology



CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

GPK6055t3mt10/2011

HARAMBEE

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

(CONDITIONS—see back page)

8.7 Appendix VIII Research Authorization

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123.
Fax: 254-020-2213215, 318245, 318249
When replying please quote

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RRI/12/1/MED-011/182/5**

Date: **5th December, 2011**

Agnes Nduta Mitheko
Kenyatta University
P. O. Box 43844
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Dietary, socio-economic and demographic factors influencing serum zinc levels of pregnant women at Naivasha level 4 hospital, Nakuru County, Kenya***" I am pleased to inform you that you have been authorized to undertake research **in Nakuru County** for a period ending ***31st December 2012.***

You are advised to report to **the Director/CEO Naivasha level 4 Hospital** before embarking on the research project.

On completion of the research, you are expected to submit **one hard copy and one soft copy** of the research report/thesis to our office.

Dr. M. K. Rugutt, Ph.D, HSC
DEPUTY COUNCIL SECRETARY

Copy to:

The Director/CEO
Naivasha Level 4 Hospital
Nakuru County

4/1/2012 Approved
Seen 5/01/2012 APPROVED
Seen - 05/01/2012 DR. RONO APPROVED

8.8 Appendix IX Ethical clearance

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
(254-020) 2726300 Ext 44355

KNH/UON-ERC
Email: uonknh_erc@uonbi.ac.ke
Website: www.uonbi.ac.ke
Link:www.uonbi.ac.ke/activities/KNHUoN

QUALITY HEALTH CARE

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/25

30th January 2012

Mitheko Agnes Ndutah
H60/12713/2009
School of Applied Human Sciences
Kenyatta University

Dear Agnes

Research proposal: "Dietary, Socio-economic and Demographic Factors influencing serum zinc Levels of pregnant women at Naivasha Level 4 Hospital, Nakuru county, Kenya" (P453/11/2011)

This is to inform you that the KNH/UON-Ethics & Research Committee has reviewed and **approved** your above revised research proposal. The approval periods are 30th January 2012 – 29th January 2013.

You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given. Clearance for export of biological specimens must also be obtained from KNH/UON-Ethics & Research Committee for each batch.

On behalf of the Committee, I wish you a fruitful research and look forward to receiving an **executive** summary of the research findings upon completion of the study.

This information will form part of the data base that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely

PROF A N GUANTAI
SECRETARY, KNH/UON-ERC

c.c. The Deputy Director CS, KNH
The Principal, College of Health Sciences, UON
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