DIETARY DIVERSITY, IRON INTAKE AND IRON STATUS AMONG PREGNANT WOMEN IN EMBU 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.

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DEDICATION

This thesis is dedicated to my dear husband Renson, my beloved sons Keith and Keefer and my lovely daughter Hope for their support and encouragement.

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OPERATIONAL DEFINITION OF TERMS

Anaemia in pregnancy is defined as hemoglobin concentration of <11g/dl of blood.

Dietary diversity is the number of foods consumed across and within food groups over a 24 hour reference period.

Dietary diversity score is the total count of different food groups consumed by individuals over the last 24 hour period.

Women dietary diversity score is the total count of different food groups consumed out of 9 food groups for the previous 24 hour period by the pregnant women.

Individual Dietary Intake is the number of foods groups consumed by an individual for the last 24 Hour period**.**

Individual dietary diversity score is total number of food groups consumed by an Individual for the last 24 hour reference period.

Iron status is defined by the concentration of hemoglobin in the blood.

Iron deficiency anemia is defined as hemoglobin level of below 11 gm/dl above the sea level.

Minimum dietary diversity woman is the consumption of at least five food groups by the woman out of ten food groups in the last 24 hour period.

Nutritional status is the state of the body that is influenced by the nutrient intake and the utilization of the nutrients by the body which determines whether the individual physiological needs for nutrients are being met and was assessed using MUAC.

ABBREVIATIONS AND ACRONYMS

ANC	Antenatal care
CDC	Centers for disease control and prevention
DDS	Dietary diversity score
FAO	Food and Agriculture Organization
FANTA	Food and Nutrition Technical Assistance
FGD	Focus group discussion
GOK	Government of Kenya
HB	Hemoglobin level
HDDS	Household dietary diversity score
ID	Iron Deficiency
IDA	Iron Deficiency Anemia
IDDS	Individual dietary diversity score
IFPRI	International Food policy Research institute
KHDS	Kenya Demographic and Health Survey
KNBS	Kenya National Bureau of Statistics
MCH	Mother and Child Health
MDD-W	Minimum dietary diversity for women
MUAC	Mid upper arm circumference
NCOSTI	National Council for Science, Technology and Innovation
RDA	Recommended dietary Allowance
SPSS	Statistical Package for Social Sciences

UNICEF	United Nations Children Education Fund
WDDS	Women Dietary Diversity Score
WHO	World Health Organization
WFP	World Food Programme
WRA	Women of reproductive age

ABSTRACT

Iron deficiency is one of the most common micronutrient deficiencies in the world today. Maternal anemia is still a cause of considerable prenatal morbidity and mortality. The number of anemic women in the world is estimated to be 56 million, majority of them (75-80%) being diagnosed with iron deficiency anemia. In Kenya iron deficiency for women of reproductive age is at 48% while anemia in pregnancy is at 55%. One of the most important factors responsible for maternal iron deficiency is poor dietary practices. Dietary diversification is essential for nutrient adequacy as there is no single food that contains all the nutrients required to maintain good health and nutritional status. The purpose of this study was to establish dietary diversity, iron intake and iron status among pregnant women in Embu County. Cross- sectional analytical design was used and the sample size was 172 pregnant women. Sampling was done by systematic sampling technique. A structured researcher administered questionnaire was used to collect data on dietary diversity and iron intake and demographic and socio- economic characteristics of pregnant women.Mid upper arm circumference (MUAC) was used to assess nutritional status; iron status was assessed by measuring serum hemoglobin (HB) levels. The data was entered and analyzed using Statistical Package for Social Sciences (SPSS) Version 16 software. Data from 24 hour recall was analyzed using Nutri-survey. Pearson correlation and chi–square were used to determine the relationship and association between variables. The statistical significance was set at a value of $p< 0.05$. Data was presented as frequencies, percentages and means. The mean age of the study population was 27±5.3 years, 88.4% were married, and 68.3% had attained secondary education. About 28% of the participants were not meeting the minimum dietary diversity for women (MDD-W).About 45.7% were not meeting the recommended dietary allowances (RDA) for dietary iron and 20.1% were anemic. The MUAC mean was 26.9 ±3.7 with 86.6% having MUAC of 23 or more. A significant relationship was found between the level of income and dietary diversity score (DDS)($r=0.39$, $p=0.047$),DDS and HB ($r=0.48$, $p=0.041$),iron intake and DDS ($r=0.57$,$p=0.038$) and between iron intake and HB ($r=0.54$,$p=0.031$).A significant relationship was found between MUAC and DDS ($r=0.26$, $p=0.03$).A significant association was found HB and morbidity ($\chi2$) = 7.98, $p= 0.034$).It is recommended that dietary diversity and intake of adequate dietary iron be promoted through regular talks and demonstrations to the pregnant women attending the mother and child health (MCH) clinic at all health facilities. The information obtained from this study may be useful to the ministry of health in the county in designing appropriate interventions programs to promote adequate dietary iron intake and mitigate iron deficiency anemia among pregnant women in Embu County.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Iron deficiency anemia has been described as one of the most common nutritional deficiency during pregnancy with an impact on the health of the pregnant women and increased risk of fetal, neonatal and infant mortality (Akhatar & Hassan, 2012;Okube et al., 2016). Iron deficiency anemia is also one of the most common preventable causes of prenatal problems including; intrauterine growth retardation, premature birth and prenatal deaths. Anemia during pregnancy contributes to 20% of maternal deaths (WHO, 2015).Iron deficiency anemia negatively affects lives of many pregnant women and children leading to improper mental development, it also leads to high rates of maternal mortality and decreased work productivity among the pregnant women (KNBS & ICF Macro, 2008-2009).

Some studies have shown that anemia during pregnancy has a significant impact on the health of the fetus and that of the mother. Presence of severe anemia during pregnancy is said to limit the oxygen delivered to the placenta and the fetus thus affecting the intrauterine growth. The weight, volume and surface area of the placenta are reduced if the pregnant woman is moderately anemic.Moreover anemia during pregnancy has been shown to result to about 20% to 28% of fetal loss, about 30% prenatal deaths and 7% to 10% of neonatal deaths (Akhatar & Hassan, 2012; Nuzhat et al., 2011; Okube et al., 2016).The number of anemic women in the world is estimated to be 56 million, majority of them (75-80%) being diagnosed with iron deficiency anemia (Kumar, 2015;

WHO, 2007; WHO,2011;WHO, 2012). It has been indicated that about 41.8% to 43.8% of pregnant women in the world are anemic and more than a half (57.1%) of the pregnant women in Africa are anemic (Kumar, 2015; Mclean et al., 2008; Stevens, 2013).

In Kenya, anemia for women of reproductive age is at 48% while anemia in pregnancy is at 55 % (Ministry of health, Republic of Kenya, 2013;Okube et al., 2016).In most of the developing countries including Kenya, the causes of anemia among pregnant women are said to be due to nutrients deficiency such as iron deficiency, deficiency of folic acid and deficiency of vitamin B_{12}.Other causes that have also been shown to cause anemia include diseases such as malaria and hookworm (Okube et al., 2016). Some studies have pointed out that iron deficiency causes about 75% of anemia during pregnancy (Balarajan et al., 2011; Haida, 2010).

Iron deficiency is defined as a condition in which there are no mobilizable iron stores and therefore there is reduced supply of iron to body tissues. Iron deficiency anemia during pregnancy is defined as hemoglobin level of below 11gm/dl above the sea level (WHO, 2011; WHO, 2012).Iron deficiency occurs due to inadequate dietary iron intake, consumption of staples with low bio-available iron, inadequate intake of food that enhances iron absorption from diet such as vitamin C rich foods, meat, fish and poultry as well as consumption of foods high in phytates or phenolic compounds that inhibit iron absorption.

Pregnant women are among those at high risk of suffering from iron deficiency due to high demands of iron because of expanding blood volume, the demands of the foetus and placenta and the blood losses to be incurred during childbirth (Gropper et al., 2009). Moreover iron requirement are high during pregnancy with a net iron requirements of about 840mg (Nuzhat et al., 2011). Malnutrition among women of reproductive age has being shown to range from 10% to 19% across the world in most of the countries. In Africa, about 27% to 51% women of reproductive age are estimated to be underweight (Black et al., 2008; Conceição et al., 2011).In Kenya approximately 9% of women of reproductive age are malnourished (BMI<18.5 kg/m2) while 12.8% of women of reproductive age are malnourished in Embu County (KDHS, 2014).

Dietary diversification has been described as an important food based strategy to meet iron needs and involves the consumption of different types of foods or food items from different food groups (Allen, 2008; Kennedy, 2009; Kennedy et al., 2011). Dietary diversity is assessed as the number of foods consumed across and within food groups over a reference period and it is an important dimension of diet quality (Arimod et al., 2010; Kennedy et al., 2010; Olumakaiye, 2013). Dietary diversification is a strategy that aims at enhancing the availability, access and utilization of foods with a high content and bio available dietary iron and is the most common method of preventing iron deficiency among the pregnant women (Gibson & Hotz, 2001; GoK, 2008).

In most developing countries including Kenya, diets consumed by pregnant women have been found to be monotonous consisting of starchy staples, grains and cereals often lacking in vegetables, fruits and animal based foods which are rich in bio available iron. These monotonous diets therefore contributes to inadequate dietary iron intake among pregnant women (Daniels & Mellissa, 2009; Ekesa et al., 2011., Gittlesohn et al., 2008; Kennedy, 2009; Ruel, 2003; Ruel, 2010; Savy, 2007).Dietary diversity is important in order to achieve nutrient adequacy especially adequate intake of iron and other micronutrients (Allen, 2008; FAO/WHO, 2002; Nutrition &Health in Developing Countries, 2008).

Dietary diversification had been described as an important aspect of diet-based strategies that is recommended in order to increase the intake of multiple micronutrients from the diet (Boy et al., 2009; FAO/WHO, 2002; Nutrition & Health in developing countries, 2008). Dietary diversity appears in many nutritional guidelines because it has been recognized as a key element of high quality diets (Allen, 2008; Boy et al.,2009). Pregnant women are likely to be at risk of iron deficiency when their diet is monotonous. Increased dietary diversity at both household and individual level is associated with sufficient dietary energy intake and dietary diversity is positively correlated with nutritional status of individuals (Kennedy, 2009; Savy et al., 2008).

In developing Countries, insufficient dietary iron intake is a concern because most foods eaten by pregnant women comprise of cereals and legumes which are sources of non-haeme iron. The body absorbs haeme iron about two to three times better than non-haeme iron and a small amount of haeme iron in the diet is known to improve absorption of non-haeme iron. The diet composition is an important determinant of the amount of iron actually absorbed. This is because some dietary content such as diets rich in whole grains, legumes and maize contain phytic acid which forms insoluble complexes (iron chelates) with iron thus prevents the absorption of iron and thereby contribute to iron deficiency (Gropper , 2009) .

Lack of dietary diversity, leading to consumption of monotonous diet and inadequate consumption of fruits and vegetables and food from animal sources among pregnant women are some of the common factors that contributes to under nutrition and thus iron deficiency anemia and may also result to poor birth outcome (Hassan et al., 2013; Nutrition & Health in developing Countries, 2008). The Consumption of a wide variety of foods across different food groups is a recommended strategy to help achieve adequate intake of dietary iron and improve iron status among the pregnant women. Dietary diversification is therefore a long term approach that has been known to play a crucial part in preventing iron deficiency through increasing the consumption of iron rich food (GoK, 2008; Kennedy, 2009). Therefore promotion of diverse diet is one of several approaches to improving iron intake in order to prevent anemia among pregnant women.

A morbidity pattern affects the nutritional status as well as iron status of pregnant women directly and has been identified as an immediate cause of malnutrition (Olumakaiye , 2013; UNICEF,1990).The dietary intake and diversity of an individual is affected negatively by the illness and also by the treatment given to cure the illness. When the dietary intake is low it affects the health of the women which may eventually lead to reduced immunity thus increasing likelihood of developing infections and diseases. Infections caused by Helminth are one of the factors that contribute to anemia among pregnant women while malaria is a major cause of morbidity and mortality in Kenya (KNBS & ICF Macro, 2010).

Maternal factors such as age, marital status, education, income and occupation are some of the demographical and socio economic characteristics that have been shown to correlate with dietary practice and hence dietary diversity among the pregnant women (Fatima, Inayat & Shahzad, 2014; Fatemesh, Tabrizi & Saraswathi, 2012; Koryo et al., 2012). Educational attainment has been shown to have a strong effect on the health and eating habits of an individual. Dietary patterns have been correlated to demographic and socio economic factors such as parity, maternal age, education and occupation. Increasing maternal age and high maternal education have been correlated with a healthy and a diverse diet among the pregnant women. However, women who are less educated and are not working and have a high parity have been said to be more prone to unhealthy and non-diverse diet (Fatima et al.,2014;KNBS&ICFMacro,2010; Northstone et al .,2007).

1.2 Problem statement

Pregnancy is known to be the most nutritionally demanding period in a women's life. Therefore pregnant women are required to consume a more diversified diet than usual (Abriha, 2014; Okube et al., 2016). Most pregnant women may have inadequate iron intake when their diet lack diversity and are dominated by staple starchy foods (Arimond, 2010; Ekesa et al., 2011; Gittlesohn et al., 2008; GoK, 2008; Kennedy, 2009). Iron deficiency anemia has been identified as a major cause of morbidity and mortality among pregnant women and increased risks of fetal, neonatal and infant mortality (Akhtar & Hasan, 2015; Okube, 2016).Anemia during pregnancy has been said to contribute to about 20% of all maternal deaths (WHO, 2015). The nutritional status of the pregnant woman has an important implication for her health and the health of her children.

Adequate dietary intake during pregnancy is important for satisfactory birth outcome and good health of the mother. Maternal nutrition has also been shown to have a critical role in fetal development (Cheng, 2009; Popa et al., 2013; Sajjad, 2012; Vakili et al., 2013).Another study has shown a strong positive relationship between the maternal nutritional status and the birth outcome (Saaka & Osman, 2013). For instance, a pregnant women who has poor nutritional status as indicated by low MUAC measurement or anemia has a greater risk of obstructed labor, of having a baby with low birth weight, of producing low quality breast milk, mortality due to postpartum hemorrhage and of morbidity of both herself and her baby (KNBS & Macro, 2010).

Taking in to consideration that iron deficiency anemia has adverse effect on the health of the pregnant women and that of her child, it is important to address factors that contribute to its occurrence. Dietary diversity has been recognized as a long term measure towards the prevention of iron deficiency anemia. However the association between dietary diversity and iron status among pregnant women has not been adequately documented. There is limited literature with regard to dietary diversity, iron intake and iron status among pregnant women in Kenya, more so in Embu County which this study aimed at addressing.

Different initiatives have been put in place in Embu County by the government of Kenya through the ministry of health and County government and other stakeholders in order to improve the iron status and prevent iron deficiency anemia in pregnancy .Such initiatives include iron and folic acid supplementation (IFAS). Iron and folic acid supplementation has been implemented through focused antenatal Care (ANC). Focused ANC aims at increasing the percentage of women who start ANC visit in the first trimester and also to increase the percentage of women who attend at least four ANC visits. Focused ANC is also regarded as an important entry point for the starting of micronutrients supplementation such as IFAS (Perumal et al., 2013).Other initiatives such as nutritional counseling and encouragement to take a diversified diet throughout the pregnancy, malaria prevention and deworming are also being implemented in Embu level five hospital in Embu County in order to reduce iron deficiency anemia and improve health and nutritional status among pregnant women. Other interventions in place are fortification of food with iron (Ministry of health division of nutrition; Accelerating reduction of iron deficiency anemia among pregnant women in Kenya plan of action 2012-2017, Government of Kenya).

Irrespective of all the initiatives which have been put in place to improve dietary diversity and iron intake in order to reduce iron deficiency anemia among pregnant women in Kenya as well as in Embu County, major gaps exists between the initiatives in place and availability of data on how these initiatives have impacted dietary diversity, iron intake and iron status among pregnant women. Moreover, more often than not, all the information collected from the pregnant women regarding their iron status most of the time remains as raw data in the health facility. In addition, data on ANC clinic attendance, micronutrient supplementation intake and adherence, number of anemic pregnant women in Kenya and more so in Embu County is limited.

Despite being agriculturally productive Embu County has posted a malnutrition prevalence of 12.8% among women of reproductive age a value which is higher than the national malnutrition level of 9%, KDHS (2014) making this study of great importance. Moreover, other nutritional data such as iron status among the women of reproductive age and more so pregnant women in Kenya and in Embu County were not documented in KDHS (2014) report. Therefore scientific data on the prevalence of anemia and the factors associated with iron deficiency anemia in Kenya and more so in Embu County is limited and partial. Due to paucity of scientific data in Kenya and more so in Embu county on dietary diversity, dietary iron intake and iron status among pregnant women, this current study aimed at providing evidence based data on the dietary diversity, iron intake and iron status among pregnant women in Embu county . The study also aimed at providing data on morbidity patterns among the pregnant women, ANC attendance, micronutrients supplementation as well as the health seeking behavior among pregnant women, which can also have an impact on iron status of pregnant women. The study also determined the demographic and socio economic status affecting the dietary diversity, dietary iron intake and iron status among pregnant women in Embu County.

1.3 Justification of the study

This study was carried out to determine dietary diversity, iron intake and iron status among pregnant women so as to shed light on the dietary diversity, iron intake and iron status among pregnant women. Similarly, there may be other maternal factors that may affect dietary diversity and thus iron intake and iron status among pregnant women that are not adequately documented. Therefore the present study sought to address these gaps by determining the dietary diversity, iron intake and iron status among pregnant women and identify factors influencing the dietary diversity ,iron intake and iron status among pregnant women in Embu County. Such information will add to the existing body of knowledge in the prevalence of iron deficiency anemia and factors associated with iron deficiency anemia and is valuable towards improving dietary diversity, iron intake and iron status among pregnant women by the policy makers and the program implementers.

1.4 Purpose of the study

The purpose of this study was to assess the dietary diversity, dietary iron intake and iron status among pregnant women attending Embu level-five hospital in Embu County.

1.5 Study objectives

The objectives of this study were;

1. To establish the demographic and socio-economic status among pregnant women.
2. To assess dietary diversity and iron intake among pregnant women.
3. To determine the haemoglobin levels and nutritional status among pregnant women.
4. To determine the morbidity, health seeking behaviour, antenatal care attendance and micronutrient supplementation among the pregnant women.
5. To establish the relationship between study variables.

1.6 Study hypothesis

Ho_1: There is no significant relationship between demographic and socio- economic status and dietary diversity among pregnant women.

Ho_2: There is no significant relationship between demographic and socio economic status and hemoglobin levels among pregnant women.

Ho_3: There is no significant relationship between dietary diversity, iron intake and hemoglobin levels among pregnant women.

Ho_4: There is no significant relationship between dietary diversity and nutritional status (MUAC) among pregnant women.

H_{05}: There is no significant relationship between morbidity patterns and hemoglobin levels among pregnant women.

1.7 Significance of the study

This present study has generated information on the dietary diversity, iron intake and iron status among the pregnant women in Embu County. The study has also shown the association between demographic and socio economic status and dietary diversity, iron intake and iron status among the pregnant women. The information generated from this current study will add to the existing body of knowledge in the field of food, nutrition and dietetics.

The findings of the study could also inform the county health ministry to implement nutritional programs aimed at improving the dietary diversity and iron status and nutritional status among pregnant women in the county. The information obtained from this study is useful to the ministry of health in the county in designing appropriate interventions programs so as to improve dietary iron intake and mitigate iron deficiency anemia among pregnant women. The study has also contributed to knowledge on dietary diversity, dietary iron intake and iron status and related factors among pregnant women. This study has outlined major determinants of iron deficiency anemia among pregnant women so as to inform policy and therefore to design targeted interventions to halt iron deficiency anemia among pregnant women. This study has generated date on prevalence of anemia among pregnant women in Embu County which there before was limited and partial.

The study has pointed out that iron deficiency is related to parity, dietary diversity, dietary iron intake, and morbidity as well as level of income and wealth index. This information will inform the relevant stakeholders to enact programmes both long term and short term which will address the factors contributing to iron deficiency anemia among pregnant women. For instance importance of a diverse diet as well as consuming iron rich food especially haeme iron should be emphasized among pregnant women by all service providers in all health facilities during routine ANC visit. Based on the fact that monthly income as well as wealth index are positively related to iron status as shown in this study long term programmes should be put in place by the government of Kenya to improve the living standard of women so as to empower them economically to enable them to access adequate diet to thus cap iron deficiency among pregnant women.

1.8 Delimitation/scope of the study

The study was carried out in Embu Level Five Hospital in Embu County. The study only investigated pregnant women who were attending Embu level five Hospital MCH clinics at the time of the study. Therefore the research findings of this study are only applicable to counties with similar characteristics.

1.9 Limitation of the study

The study was cross sectional and therefore the data was collected at a point in time and thus the data does no show dietary diversity across the seasons of the year.

1.10 Assumptions of the study

The study assumed that the respondents were on iron and folic acid supplements.

The study also assumed that pregnant women were consuming a diverse diet.

1.11 Conceptual framework

The study was based on a conceptual framework (Figure1.1) by the author, adopted and modified from UNICEF conceptual framework on causes of malnutrition (UNICEF, 2010).Dietary diversity has been recommended as an important approach for alleviating nutritional deficiencies resulting from insufficient intake of micronutrients (FAO/WHO, 2002).When the dietary diversity of the woman is low it affects the woman's health status because of reduced immunity therefore increasing the chances of developing infections. When the pregnant woman is sick, the dietary intake and dietary diversity and hence dietary iron intake of the pregnant women is affected negatively by the illness as well as the treatment given to cure the illness. Seeking medical care and attending antenatal care is very importance for early detection and treatment of anemia and other infections. It has also been argued that the iron requirements during pregnancy are normally too high to be achieved only by dietary intake.

Therefore iron status during pregnancy can be enhanced through iron supplementation. Iron supplementation of women during pregnancy is known to protect the pregnant woman and fetus against anemia. Starting ANC has early as possible ensures the pregnant women starts taking the iron supplements in the first trimester as recommended by KNBS & ICF macro, 2015 & WHO, 2012 .A diet that is diversified has been shown to be associated with a good nutritional status and iron status. A diversified diet is therefore important in ensuring sufficient intake of micronutrients such as iron and in realizing an optimal nutritional status (Drimie, 2013; Ey, 2012).

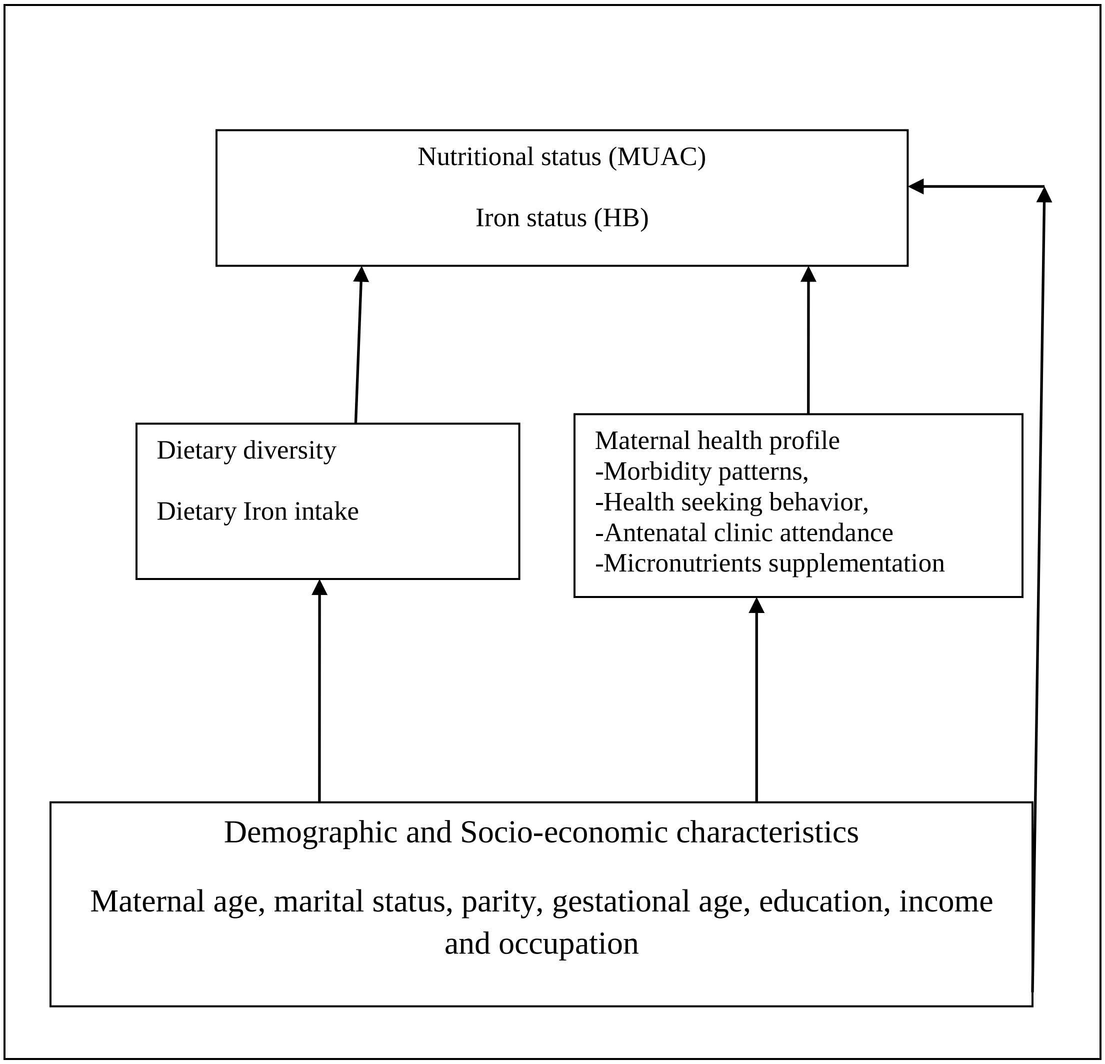

Figure 1:1:Conceptual framework
Adopted and modified from UNICEF conceptual framework on causes of malnutrition (UNICEF 2010).

There is a positive relationship between nutritional status and health of the mother. Therefore an adequate diet is important for the health of the mother and for positive pregnancy outcome. Due to increased nutritional requirements, pregnancy is a critical period for meeting the body's needs for macronutrients and micronutrients so as to eliminate such deficiencies as iron deficiency anemia. Iron deficiency anemia has been shown to result in serious health consequences including morbidity of both the mother and the child. Dietary diversity is important in order to meet the increased demands of nutrients during pregnancy. Studies have reported that dietary diversity among the pregnant women is influenced by maternal socio economic and demographic characteristics such as age, parity, education and income. Further morbidity has been inversely related to socio economic status.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Iron deficiency anemia is a global public health problem in the developed and the developing countries (Mclean et al., 2009). It is more prominent in pregnant women with a global prevalence of 42% and is one of the major causes of maternal mortality (Balarajan et al., 2011; Kumar, 2015; WHO, UNICEF, UNFPA & World Bank, 2007). Studies have pointed out that Sub Saharan Africa is the most affected region with anemia prevalence estimated to be about 17.2 million pregnant women, which is estimated to be 30% of the total global cases (Kumar 2015; Susan & Blackburn, 2007).

Iron deficiency anaemia is the most common nutritional deficiency in the world and is the most common hematological disorder during pregnancy with considerable complication to both the mother and fetus. Anemia in pregnancy is said to contribute to about 12% to 28% of neonatal deaths. Iron deficiency anaemia during pregnancy is associated with high rates of premature birth and low birth weight as well as maternal mortality and morbidity (WHO, 2007). Studies have shown that anaemia early in pregnancy is related to increased risk of preterm premature rupture of membranes while anaemia later in pregnancy may result to spontaneous premature labor (Zhang, 2009).

In most developing country Kenya included, dietary diversity and its association to iron intake and iron status among pregnant women has received little attention necessitating further research. In Kenya there is limited scientific data on the dietary diversity and its association to iron intake and iron status among pregnant women. Even though the pregnant women have always been assessed for iron status during the routine ANC visit little statistics are available on the prevalence of iron deficiency among pregnant women in Embu County .This present study was therefore conducted to assess dietary diversity, iron intake and iron status among pregnant women in Embu County Kenya.

2.1 Demographics and Socio-economic characteristics of the pregnant women

Age, marital status and number of children are some of the important demographic variables and they form some of the basic category of the demographic classification for women. Women of reproductive age, in which pregnant women are, mainly fall under the age of between 15 to 45 years. In the Kenyan population most of the women are in the age group of below 35 years of age. For example 37% of women are in the 15-24 age group, 34% of women are in 25-34 age group and the remaining are in the age of 35 -49 years (KNBS & ICF macro, 2015).

In Kenya about 55% of women are said to be married or are living in an informal relationship with a man, 29% of the women have never married and the total fertility rate in Kenya is 3.9 births per women. In Embu County total fertility rate is 3 births per women. On the age at first pregnancy 15% of women in age 15-19 have already given birth while 18% have a life birth or are pregnant with their first child. The percentage of women who have begun child bearing increases rapidly with age (KNBS & ICF macro, 2015).Socio-economic status has been defined as an economic and sociological combined total measure of a person's work experience and of an individual's or family's economic and social position in relation to others, based on income, education, and occupation (Werner et al.,2007).

Socio-economic status is normally broken into three categories, high, middle and low socio-economic status to describe the three categories a household or an individual may be categorized in. When categorizing a household or individual into one of this classification one or all of these three variables (education, income and occupation) can be assessed (Werner et al., 2007). Moreover a more inclusive approach is whereby when classifying a household or an individual on the low, middle or higher socio economic status the principal complex analysis (PCA) is used to calculate the wealth index of the family or an individual. When determining the wealth indexes all the assets of the family or an individual are used. This study used the principle complex analysis to classify the study participants to various socio economic statuses.

According to KDHS (2014), 7% of women in Kenya have no education, 24.6% have finished primary education while 26.9% of women have completed the secondary education. Demographic and socio economic factors such as age, education, income and occupation have been shown to correlate positively with the dietary habits and therefore the nutrient intake among the pregnant women (Koryo et al., 2012). In Kenya and especially in Embu county there is limited data on the demographic and socio economic status of the pregnant women. Similarly there is limited data on the association of the demographic and socio economic status to dietary diversity and iron status among pregnant women. This study thus filled this gap by identifying the demographic and socio economic status among pregnant women and established their relationship to the dietary diversity, iron intake and iron status among pregnant women in Embu County.

2.2 Dietary intake among pregnant women

Pregnancy is a nutritionally demanding period and adequate dietary intake is important in order to meet the increasing nutritional needs for the mother and the fetus. Moreover, pregnant women are often nutritionally vulnerable because of the physiological demands of the pregnancy and therefore they require a more nutrient dense diet (Akther et al., 2015; Torheim & Arimond, 2013). Insufficient dietary intake during pregnancy affects both the woman and their infant and yet many pregnant women don't consume adequate diet. Studies have shown that an adequate diet during pregnancy is positively associated with the infant development, maternal and child health, healthier pregnancy and delivery, lower risk of chronic diseases and better academic achievement for the children (Vakili, 2013; World Health Organization, 2012).

Adequate dietary intake during pregnancy is known to play a major role in the well-being of the expectant mother and her newborn baby and also influences the health of the child during childhood and adulthood. Strong evidence indicates that insufficient dietary intake during pregnancy, may lead to spontaneous abortion, poor pregnancy weight gain, impaired fetal growth, learning impairment and behavioral problems of the children (Koryo et al.,2012).Therefore during pregnancy the diet quantity as well as the quality of the diet is very importance for positive birth outcome.

2.2.1 Dietary intake based on dietary diversity among the pregnant women

Dietary diversity is the number of food groups consumed by an individual over a specific reference period of time (Kennedy, 2009; Ruel, 2004). Dietary diversity is usually regarded as a major indicator in measuring the access, utilization and quality of an individual's diet (FAO, 2011; Fatima, 2016). A diversified diet is related to the micronutrient adequacy and good nutritional status of an individual (Jayewardene et al., 2013; Kennedy, 2009; Mirmiran, 2006; Ruel, 2004). Consumption of a variety of food or food items in the diet has been considered important in achieving adequate intake of major nutrients and realizing an optimal nutritional status (Drimie et al., 2013 & EY et al., 2012). An adequate diet is defined as a diet that delivers sufficient amounts of essential micronutrients to meet the dietary requirements of the pregnant women (Deniels & Melissa, 2009).

Different studies have been carried out to establish the relationship between micronutrient adequacy of the diets of women of reproductive age and their dietary diversity. These studies were carried out in five different regions and in all the sites dietary diversity was shown to be significantly correlated with micronutrient adequacy (Arimond et al., 2011; Kennedy, 2009). Moreover some other studies which were carried out in different countries involving different age groups showed correlations ranging between 0.36 to 0.66 between various dietary diversity scores and micronutrient adequacy of the diet of an individual (Arimond et al., 2011; FAO,2011;Kennedy ,2009).

The Women's Dietary Diversity Project carried out by FAO measured the possibility of simple dietary diversity scores to be a measure of the micronutrient sufficiency of diets of women. These studies were carried out in five countries and various food groups were used to measure the dietary diversity score (Arimond et al., 2010; Arimond, 2011; FAO, 2011).The findings of these studies concluded that all the dietary diversity scores were associated significantly with micronutrient sufficiency of the diet (Arimond et al., 2011).

Most of the previous studies on dietary diversity among women have been done using the women dietary diversity score. The women dietary diversity score is said to reflect the probability of a diet that meets the micronutrient requirement of the women of reproductive age. The WDDS is based on nine food groups which include; starchy staples, dark green leafy vegetables, other vitamin A rich fruits and vegetables, other fruits and vegetables, organ meat, meat and fish, eggs, legumes, nuts and seeds, milk and milk products (FAO, 2011) . However the WDDS does not include the threshold or the number of food groups that the women should have consumed in order to be described to have consumed sufficient micronutrients.

FAO has therefore developed another dietary diversity indicator namely minimum dietary diversity for women (MDD-W) which applies an open recall method to collect data on all the food and drinks consumed by individual woman over the previous 24 hours (FAO & FHI 360, 2016) .The minimum dietary diversity for women has been described as a food group diversity indicator that has been shown to reflect micronutrient adequacy. The micronutrient adequacy has been summarized across eleven micronutrients which include; Iron ,Zinc, Calcium ,Vitamin A, Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12 and Vitamin C (Martin-Prevel et al., 2015).The MDD-W dietary diversity indicator is calculated based on ten food groups which include; grains, white roots and tubers and plantains, pulses (beans, peas and lentils), nuts and seeds, dairy, meat, poultry & fish foods, eggs, dark green leafy vegetables, other vitamin A-rich fruits and vegetables, other vegetables, and lastly other fruits (FAO & FHI 360, 2016).

Promotional of a diverse diet is one of the several approaches to improving micronutrients adequacy for pregnant women. The MDD-W is regarded unique because unlike the former dietary diversity scores, it not only gauges the amount of dietary diversity in a woman’s diet but it usually offers a specific threshold for meeting the micronutrient needs of women of reproductive age. It states that a woman of reproductive age who consumes food or food items from at least five out of the ten stated food groups has a higher possibility of micronutrient adequacy (FAO & FANTA III, 2014).

The present study used the minimum dietary diversity for a woman which is based on ten food groups to assess dietary diversity among the pregnant women. The MDD-W is a dichotomous indicator of whether or not the pregnant women have consumed at least five out of ten defined food groups the previous day and night. The MDD-W is usually a proxy indicator used to reflect the micronutrients adequacy of the women's diet. An adequate quality diet has been defined as a diet that gives an adequate amount of selected micronutrients to meet the need of the pregnant women. In addition to micronutrients adequacy, high quality diets are characterized by balance in intake of protein, carbohydrates and fat and moderation of foods that are low in nutrients density and those associated with increased risks for chronic diseases (Deniels & Melissa, 2009; FAO & FHI 360, 2016; Institute of medicine, 2005).

Based on the MDD-W, the pregnant women who consume food items from at least five of the ten food groups can be said to have a higher probability of achieving micronutrient adequacy than other groups that have lower proportion of women achieving the threshold of food items from at least five food groups. This implies that a higher prevalence of a MDD-W is a proxy for better micronutrients adequacy among the women of reproductive age including the pregnant women. The pregnant women who consume food items from five or more of the ten food groups are also likely to consume at least one animal source food and either pulse or nuts and seeds and food items from two or more of the fruit/vegetable food groups (FAO & FHI.360,2016; Martin-Prevel et al., 2015 ; Torheim & Arimond, 2013).

Most of the studies on dietary diversity by FAO have been based on the women of reproductive age. The present study narrowed down upon pregnant women and studied the dietary diversity among pregnant women which is a very critical period in a women's life. This current study aimed to fill the gap of lack of data on dietary diversity among pregnant women based on MDD-W which is a relatively new indicator with added advantage of stating the threshold of the number of food groups that reflect micronutrient adequacy of the pregnant women's diet.

The study further assessed the association between dietary diversity and the demographic and socio economic status, of the pregnant women. Moreover there is limited data on the relationship between dietary diversity, iron intake and iron status among the pregnant which this study aimed at filling. This study used MDD-W to assess the dietary diversity among the pregnant women in Embu County because it is single, simple dichotomous indicator recommended by FAO for determining dietary diversity for women (FAO & FHI.360, 2016).The study also established the association between dietary diversity, iron intake and iron status among the pregnant women.

2.2.2 Dietary intake of pregnant women based on 24 hour recall

The 24 hour recall is quantitative method of assessing the dietary intake of individual over the previous 24 hour (FAO & WHO, 1996; Geffen, 2003). A 24 hour recall relies on the memory of the respondents who are required to recall all the foods and beverage consumed in the previous 24 hours. Further information is elicited on whether the food or drink was consumed during the meal time or as a snack and the ingredient of the dish and method of preparation after the listing of the foods and drinks reported to have been consumed by the respondent (Perez-Escamill & Segall-Correa 2008).

The present study used the 24 hour dietary recall to determine the dietary intake of the pregnant women because 24 hour recall period is usually less cumbersome to the respondents and tend to be less subject to recall error. Moreover, 24 hour recall is the common time period that is used in most dietary diversity studies (Arimond, 2010; Kennedy et al., 2007; Ruel et al., 2004). The 24-hour recall was used in the present study to obtain approximate quantities of the food consumed in order to obtain the percentages of the pregnant women who were meeting the recommended daily allowances for iron as well as other selected micronutrients and calories.

2.2.3 Dietary intake of the pregnant women based on food frequency questionnaire

The food frequency questionnaire is a limited checklist of foods and beverage with a frequency response section for the respondents to indicate how often each item was consumed over the previous week. Consumption of a food for at least thrice a week is considered to be regular intake while less than thrice in a week is considered to be irregular consumption (Ahmed et al. 2008; Chege, 2012; Dahl, Maeland & Bjorlkkjaer, 2012). Food frequency questionnaire was used in the current study to assess the consumption of variety of foods by the pregnant women and to analyze the frequency of consumption of iron rich foods among pregnant women.

2.2.4 Dietary diversity and dietary iron intake among the pregnant women

Dietary diversification has been described as the art of including a variety of foods or food items in a meal with the aim of getting sufficient nutrients through complementation and is one of the food based approaches of tackling iron deficiency anemia. Studies have sufficiently demonstrated that dietary diversity is strongly associated with micronutrient adequacy (GoK, 2008; Jayawardena, 2013; Kennedy, 2009; Mirmiran, 2006; Ruel, 2003). This has been based on the argument that there is no any one single food which may contain the essential nutrients that are required for optimal nutritional status (Kennedy, 2009). In addition, studies have shown that a diet that is diversified is correlated with an optimal nutritional status and that including different foods from different food groups in the diet is important in order to ensure adequate intake of essential micronutrients and macronutrients (Drimie, 2013; Ey, 2012; Kennedy ,2009) .

In most developing countries Kenya included, iron deficiency is still a major public health problem (Kenndey, 2007).This problem is attributed to the intake of monotonous cereals, grains and starch based diets that are lacking in diversity. Moreover diets in most developing countries have been described as that which lacks fruits, vegetables and animal source foods (Daniels & Melissa, 2009; Kennedy,2007;Kiboi,Kimiywe & Chege,2016).Due to this inadequate nutrient intake among women, iron deficiency anemia has remained prevalent in most developing countries including Kenya (Abebe,2014;Allen,2014;Kiboi,Kimiywe&Chege,2016;Rodriguez-Bernel,2012).

To overcome this problem, food based approaches like dietary diversification have been recommended and appears in most countries' dietary guidelines (Kennedy, 2009). Pregnant women are said to be the most vulnerable to iron deficiency and other micronutrients deficiency when their diets lack diversity thus failing to meet the increased nutrients needs (Lee et al., 2013). Unfortunately in most developing countries dietary diversity, iron intake and iron status among the pregnant women has received little attention and therefore the need for further research which this study aimed at achieving (Willy et al., 2016; Rashid, 2011).

The current study aimed at establishing the dietary diversity and its relationship to iron intake and iron status among the pregnant women in Embu county.This study used MDD-W to assess the dietary diversity of the pregnant women. The study also aimed at establishing the proportions of pregnant women who were achieving the minimum dietary diversity for women. Based on MDD-W, pregnant women who consume food items from five or more of the ten food groups are also likely to consume at least one animal source food and either pulse or nuts and seeds and food items from two or more of the fruit/vegetable food groups which provide essential micronutrient iron included. Therefore women who have consumed food items from five or more food groups have higher likelihood of consuming adequate iron from the diet (Amugsi et al., 2016).

2.3 Iron intake and iron requirements during pregnancy

There is an increased iron requirement during pregnancy and it is estimated that the net iron requirements for pregnancy are approximately 840mg (Nuzhat et al.,2011).The pregnant women requires daily intake of iron not less than 30mg (WHO, 2007). Iron is usually obtained in the form of non-haeme iron from plant sources and as haeme iron from animal sources (Gropper et al., 2009). Haeme iron is absorbed about two to three times better than non-haeme iron. A small amount of haeme iron in the diet can improve absorption of non-haeme iron and thus the diet composition is an important determinant of the amount of iron actually absorbed. Poor absorption of non-haeme iron is aggravated by dietary contents. For example, diets rich in whole grains, legumes and maize contain phytic acid which forms insoluble complexes with iron (iron chelates) preventing absorption of iron, thereby contributing to iron deficiency (Gropper et al., 2009).

Haeme iron obtained from the hemoglobin and the myoglobin which is found in meat, fish, and poultry is more absorbed effectively by receptors in the gut. The bioavailability of non-haeme iron from plants sources is usually determined by the presence of dietary factors that enhance or inhibit its absorption (Gropper et al., 2009). Inadequate dietary iron and folate intake due to low leafy vegetable consumption, low vitamin B^{12} intake due to low intake of animal based foods and poor bioavailability of dietary iron from fibers, phytates and phenolic compounds are the major dietary factors responsible for high prevalence of iron deficiency among pregnant women.Some dietary factors that have been found to enhance non haeme iron absorption include ascorbic, citric, lactic and tartaric acids, sugars such as fructose and sorbitol, meat, poultry and fish or their digestion products. Digestion products from animal tissues high in the contractile proteins actin and myosin promotes iron absorption (Gropper et al., 2009). On the other hand there are dietary factors which inhibit iron absorption. These include polyphenols such as tannin derivatives of gallic acid found in tea and coffee, oxalic acid found in spinach ,chard, berries, chocolate and tea, and phytates found in maize, whole grains and legumes and phosvitin a protein containing phosphorylated serine residues found in eggs yolks (Gropper et al.,2009).

Iron is essential for several body activities. It is an important constituent of hemoglobin in the red blood cells which is responsible for transportation of oxygen from the lungs to the cells. Iron is also a constituent of myoglobin which serves as an important reservoir of oxygen in the muscles (Gropper et al., 2009). In addition, iron is a requirement in metabolically active cells for the production of cytochromes in the mitochondria and it also a vital player in the synthesis of hormones and neurotransmitters. Iron is also a component of many enzymes that is required for the metabolism of glucose and fatty acids for energy. Iron is an essential nutrient that is vital in the body's tissues for basic functions of the muscles, brain and cells including red blood cells, hence its main role is for hemoglobin production.

Moreover, iron plays a vital role in the body's immune functions and is an important micro-nutrient for the development of the foetus brain and cognitive abilities of the new born (Gropper et al., 2009).Iron supplies oxygen and nutrients to the foetus, supports placental functions, manufactures red blood cells, and acts as insurance against blood loss during delivery (WHO, 2007). Pregnant women need more iron than usual because their body is manufacturing more blood since blood volume increases by 60% during pregnancy. An adequate supply of iron is essential for the normal development of the foetus and new born child. The total iron loss associated with pregnancy and lactation is approximately 100mg.Therefore the recommended daily dietary allowance for iron in pregnancy is 30 mg instead of 18mg which is needed for adult non-pregnant population (WHO, 2007).

Considering the importance of sufficient iron intake during pregnancy and scarcity of information on the number of pregnant women who actually meet iron requirement during pregnancy, the current study aimed at filling this gap.

2.4 Assessment of iron status among the pregnant women

Iron status is considered as a continuum from iron deficiency with anemia to iron deficiency with no anemia to normal iron status with varying amounts of stored iron and finally to iron overload which can cause organ damage when severe. Iron deficiency is said to be as the result of the long term negative iron balance during which iron stores in the form of hemosiderin and ferritin are progressively diminished and can no longer meet the needs of normal iron turnover. Iron deficiency has been defined as a condition in which there are no mobilizable iron stores and therefore the signs of a compromised supply of iron to tissues are noted. The more severe form of iron deficiency is associated with anemia (WHO/UNICEF/UN, 2001; WHO, 2007).

When iron deficient erythropoiesis occurs hemoglobin concentrations are reduced to below optimal levels .When the individual's hemoglobin levels are found to be below the -2SD of the distribution mean for haemoglobin in an otherwise normal population of the same gender and age who are living at the same altitude, iron deficiency is considered to be present. Since the term anemia is the most common indicator used to screen for iron deficiency the term anemia, iron deficiency and iron deficiency anemia are usually used interchangeably (WHO/UNICEF/UN, 2001; WHO, 2007).

The world health organization defines anemia among pregnant women as haemoglobin below 11.0 g/dl at the sea level. The WHO also uses hemoglobin levels to diagnose the severity of anemia in pregnant women in grams/ deciliter as follows; greater or equal to

11.0g/dl has been classified as non-anemic, between 10.0-10.9 g/dl has been classified as mild anemia, between 7.0-9.9 g/dl has been classified as moderate anemia and below 7.0g/dl has been classified as severe anemia. The WHO further categorizes the severity of anemia as a public health problem according to its prevalence in percentages among a population. For prevalence below 5% it is categorized as no public health problem. For prevalence of between 5 to 19.9% it is categorized as a mild public health problem, between 20 to 39.9% prevalence is categorized as a moderate public health problem and for prevalence of above 40% it is categorized as a severe public health problem (WHO 2001;UNICEF/UN/WHO, 2011).

Screening for iron deficiency in developing countries is usually based on hemoglobin levels (Mclean et al., 2009). Measurement of hemoglobin is the most cost efficient and commonly used method to screen for anemia. Moreover, hemoglobin concentration is used to determine the level of anemia because it’s considered the most reliable indicator of anemia at the population level (WHO, 2007). Iron status can be determined by several other tests in addition to hemoglobin. However there is no single standard test to assess iron deficiency without anemia. Serum ferritin is referred as the most specific test that correlates positively with relative stable body iron stores. A low serum ferritin levels reflects iron stores that are depleted and is a precondition for iron deficiency in the absence of infection. Serum apoferritin is an acute phase reactant protein and is usually elevated in response to any infections or inflammatory process. Consequently serum ferritin in the normal range reflects only iron sufficiency in the absence of infections or inflammation. Serum ferritin measurement is one of the preferred method for detecting depleted iron stores though it is of limited usefulness during pregnancy because it diminishes late in pregnancy even when marrow iron is present.

WHO recommends that when assessing the iron status of populations the concentration of hemoglobin should be measured (WHO, 2001; WHO, 2007).Determining the concentration of hemoglobin, an iron-containing protein, in red blood cells is a more sensitive and direct indicator of anemia. In this current study hemoglobin concentration was used as a measure of iron status because of its reliability, relative ease of measurement and is considered as the most reliable indication of anemia at population level (WHO, 2007).

2.5 Iron deficiency anemia in pregnancy

Iron deficiency anemia affects approximately 1.3 to 2.2 billion persons of which 50% are estimated to be women of reproduction age (Abriha et al., 2014; Saeed et al., 2013).Nutritional anemia is the most prevalent type of anemia in the world today and mostly include iron folic acid and vitamin C deficiencies (Balarajan, 2013; Cogswell et al., 2009; Mbule, 2013).Iron deficiency anemia contributes to half the burden of anemia globally (Saeed et al., 2013). About 52% of women in low-resource countries and 23% of women in high resource regions suffer from anemia (Kumar, 2014; WHO, 2010).

Anemia is a condition in which the number of red blood cells and consequently their oxygen-carrying capacity is insufficient to meet the body's physiologic needs. Anemia during pregnancy is defined as hemoglobin level below 11g/dl at the sea level (Kumar, 2014; WHO, 2011). Because of the increased iron requirements during pregnancy and growth, pregnant women and infants are recognized as the groups most vulnerable to iron deficiency anemia. The primary cause of anemia during pregnancy is iron deficiency a condition that is mostly caused by inadequate intake or low absorption of iron and the increased demands of iron during pregnancy and repeated pregnancies especially if the pregnancies are not well spaced (Fiedler et al., 2014).

When anemia is accompanied by an indication of iron deficiency it is referred to as iron deficiency anemia. However, even though iron deficiency is the most common cause of anemia globally, other factors such as nutritional deficiencies (folic acid, vitamin B^{12}, vitamin C and vitamin A), acute and chronic inflammation, parasitic infections, malaria, HIV, tuberculosis and inherited or acquired disorders that are known to affect the haemoglobin synthesis, the red blood cell production or red blood cell survival, can all result to anemia. While iron deficiency anemia accounts for about half of all anemia cases, it often coexists with these other causes (Fiedler et al., 2014; WHO, 2007; WHO, 2012).

Iron deficiency anemia is mainly caused by inadequate intake of bio-available iron coupled with increased iron requirements during pregnancy. Iron deficiency anemia during pregnancy is usually caused by combination of factors which include the previously decrease in iron supply due to inadequate dietary iron intake, the increased iron requirements of the growing fetus and expanding maternal plasma volume. Other additional risk indicators that contribute to iron deficiency anemia during pregnancy include multiple pregnancies and low socio economic status and morbidity (Fiedler et al., 2014; Nuzhat, 2011).

Anemia in pregnancy has been shown to have a negative impact on the health of the fetus as well as the mother. When anemia is severe, it may limit the delivery of oxygen to the placenta and fetus therefore it may interfere with the intrauterine growth of the fetus (Nuzhat et al, 2011). The placenta weight, volume and surface area are reduced if the expectant mother has moderate anemia. Moreover, when the pregnant woman's iron stores are depleted the fetus cannot accumulate enough iron and there is a decreased iron store in fetus. This also results in limited transfer of iron to the fetus and thus increases the infant's risk of iron depletion and anemia in early infancy. In addition, iron deficiency results in poor cognitive development in children (Nuzhat et al., 2011).

Iron deficiency is also a major cause of low birth weight and neonatal mortality and many short term and long term complications have been associated with low birth weight including, cerebral palsy, hydrocephaly, blindness, deafness, diabetes, hypertension and heart disease (Laflamme, 2011; KDHS, 2010).Low preconception hemoglobin and ferritin levels increases the risk of poor fetal growth and low birth weight (Dean et al., 2014). Deficiency of iron in pregnant women impairs oxygen delivery to cells causing fatigue, poor work performance and reduced immunity. Iron deficiency anemia during pregnancy may also result to maternal deaths since anemic women are more likely to die from blood loss during delivery (Nuzhat et al., 2011).

Due to the dire consequences of iron deficiency anemia during pregnancy it is important to ensure that iron deficiency whether severe, mild or moderate is eliminated to ensure the optimal health of the mother and the infant. Iron needs in pregnancy cannot be overlooked and it is important that pregnant women get enough dietary iron intakes to ensure that they get recommended dietary intake for iron to prevent iron deficiency anemia. This current study determined the prevalence of iron deficiency anemia among the pregnant women in Embu County.

2.6 Factors related to iron status in pregnancy

The factors associated with anemia in pregnant women are different and more often than not interaction of multiple factors such as the demographic factors, socio economic factors, nutritional and health related factors contribute to anemia during pregnancy (Abriha et al.,2014).Various studies have revealed that number of pregnancies, marital status, maternal age and gestational age are some of the maternal demographic factors significantly associated with iron deficiency anemia among pregnant women (Chowdhuny et al.,2015;Erlindawati et al., 2008; Gebre & Mulugeta,2015;
Saaka et al.,2017).Gestational age has been shown to be significantly associated with anemia

in pregnant women with pregnant women in the third trimester having higher incidences of anemia than those in first and second trimester (Chowdhury et al., 2015; Saaka et al., 2017). Anemia has also been significantly associated with the number of pregnancies (parity) with the risk of developing anemia increasing with the number of pregnancies. For instance pregnant women who have had 3 to 5 pregnancies have a high risk of developing iron deficiency anemia when compared with women who had less than 3 pregnancies (Chowdhury et al., 2015; Saaka et al., 2017).

Socio economic factors such as education level, occupation and family monthly income have been shown to be associated with iron deficiency anemia (Chowdhuny et al., 2015; Erlindawati et al., 2008; Gebre & Mulugeta, 2015; Saaka et al., 2017). Moreover, several studies have revealed that the level of education of the women have significant association with maternal anemia. This is because literacy of the pregnant women has been shown to have a significant association with the use of antenatal care services. In addition, education level of the pregnant women has shown to have an impact on the awareness and use of health services among the pregnant women. On the other hand low maternal education level significantly predicated anemia in some studies (Chowdhuny et al., 2015, Erlindawati et al., 2008, Gebre & Mulugeta, 2015; Saaka et al., 2017).

It has been argued that women who have higher education are less likely to be anemic perhaps because more educated women are more likely to adopt healthier eating habits.

This could also be partly explained by the fact that more educated women may be able to secure well paying jobs and therefore be able to access an adequate diet (Chowdhuny et al.,2015, Erlindawati et al.,2008;Gebre & Mulugeta.,2015; Saaka et al.,2017). Moreover education may also enable women to have greater access to household resources that are important to access a diverse diet. Pregnant women who have some level of formal education may be aware of anemia during pregnancy and thus take preventive measures such as consuming iron rich food and taking iron supplements (Chowdhuny et al.,2015; Erlindawati et al.,2008 ; Gebre & Mulugeta.,2015 ; Saaka et al.,2017).Studies have also revealed that monthly income of the household is associated with iron deficiency anemia with low-income group comprising a higher portion of anemic women (Bekele et al., 2016; Chowdhuny et al., 2015).

Dietary practices factors such meal frequency, dietary diversity, frequent consumption of meat and nutrition education are some of the factors that have significant association with iron deficiency anemia (Abel & Afework,2015;Abriha et al.,2014;Bekele et al.,2016;Saaka et al.,2017;Willy et al.,2016) .Other studies have found iron deficiency anemia among pregnant women to be significantly associated with frequency of ANC attendance, number of under-five children in the household, iron supplementation, presence of infection and illness such as malaria (Chowdhuny et al .,2015;Onenge et al.,2014;Saaka et al .,2017).

The MUAC of the pregnant women has also been associated with anemia. A MUAC value of less than 23cm is found to increase the risk of developing anemia. On the other hand pregnant women with MUAC value of greater or equal to 23cm have been shown to have about 59% less risk of developing anemia (Addis & Mohamed, 2014).Iron supplementation has also been shown to reduce anemia among pregnant women (Onenge et al., 2014).

Anemia during pregnancy is a major cause of morbidity while diseases, infections and illness have been shown to contribute to anemia during pregnancy (Bekele et al., 2016). Self reported episodes of malaria infection have been found to be insignificantly associated with anemia in some studies (Onenge et al., 2014; Saaka et al., 2017). Other studies have supported that anemia is significantly associated with history of malaria attack (Alem et al.,2013;Ononge et al.,2014).Moreover the presence of parasitic infections, particularly hookworm has been significantly associated with anemia in pregnant women (Alem et al.,2013 ;Ononge et al .,2014).

Dietary intake of a woman during pregnancy is crucial since a diet that is inadequate negatively affects the health of the mother, the fetus, and the newborn (Saaka et al., 2017). Dietary diversity has been significantly associated with iron status of pregnant women in some studies (Abriha et al., 2014; Saaka & Rauf, 2015).However other studies have shown that dietary diversity is not associated with iron status (Kabuga et al., 2016; Saaka et al., 2017).Irrespective of the fact that a high quality diet can protect against anemia among pregnant women, some eating habits may predispose pregnant women to a higher risk for developing anemia. For instance, high fibre diets, low fat diets, high consumption of tea and coffee all inhibit iron consumption. Presence of vitamin C in the diet enhances absorption of iron (Wen, 2010).

There is no adequate information on factors associated with anemia in pregnant women in Kenya and in Embu County in particular. This study sought to assess dietary diversity, dietary iron intake and iron status among pregnant. Further this study aimed at providing evidence based estimates of the prevalence of anemia and factors associated with anemia among pregnant women in Embu County.

2.7 Nutritional status of the pregnant women

Pregnancy is regarded as a very important period in a women's life during which the intake of adequate nutrients and thus good nutritional status is paramount because it affects the health of the fetus, the infant and the mother. Good nutritional status of the mother is known to be an important component of health and development (Akther et al., 2015; Vakill et al., 2013; Willy et al., 2016). A strong positive relationship between maternal nutritional status and birth outcome has been shown by some studies (Akther et al., 2015; Fatemeh et al., 2012; Saaka & Osman, 2013).Maternal nutrition status has been shown to play a major role in the growth and development of the fetus. A diet that is adequate during pregnancy is important for the good health of the mother and for a satisfactory birth outcome (Cheng et al., 2009).

Pregnant women are one of the groups most vulnerable to nutritional deprivations. They are vulnerable because their nutritional requirements are proportionally higher and the effect of malnutrition is severe and long lasting (Akther et al., 2015; Cheng et al., 2009; Saaka & Osman, 2013). The end result of pregnancy, the newborn, depends for its growth in the uterus on the nutrient transferred from the mother and its birth weight is dependent to a large extent on her nutritional status. A pregnant woman's nutrition status has an important implication for her health as well as the health of her children (Akther et al., 2015; Cheng et al., 2009; Saaka & Osman, 2013).

The nutritional status of pregnant women has been shown to be associated positively with the growth as well the development of the fetus. This is because the fetus feeds through the placenta in the mother's uterus. Therefore the fetus is dependent sorely on the mother's diet for its survival. Moreover a healthy balanced diet during pregnancy is known to reduce the risk of maternal and child mortality and morbidity (Akther et al.,2015; Fatima et al.,2014).Unfortunately, inappropriate dietary intake characterized by low dietary diversity, reduced number of meals and inadequate consumption of fruits and vegetables among pregnant women is still very common which contributes to under nutrition that may cause complications during pregnancy and lead to poor birth outcomes (Akther et al., 2015; Hussan et al., 2013).

Malnutrition during pregnancy women is known to result to decreased productivity, increased susceptibility to infections, delayed recovery from illness and high risks of poor pregnancy outcomes. For instance, a pregnant women who has poor nutritional status as indicated by; low mid upper arm circumference, low haemoglobin level and other micronutrient and macronutrients deficiencies may have higher risks of obstructed labor, of giving birth to a baby with low birth weight, of producing low quality breast milk as well as of mortality and morbidity of both the mother and her child (KNBS & Macro, 2010; KNBS & Macro, 2015).

The birth weight is an indirect mechanism of assessing maternal nutritional status but this method is retrospective method of assessment which precludes any meaningful intervention to prevent possible harmful effects of malnutrition on the fetus (Akhatar & Hassan, 2012; Assefa, Berhane & Workua, 2012; Ververs et al., 2013). The nutritional status of the pregnant woman can be assessed either by weight increase or by the mid-upper arm circumference (MUAC). The weight increase during pregnancy has been shown to be closely correlated with newborn's weight and with the maternal nutritional intake but it requires at least knowing two measurements at different points in time. The pre pregnant weight and height and the weight increase should be known. However a problem in many cases is that assessment of nutritional status may be needed at the first prenatal visit and that very often the pre pregnant weight is unknown (Assefa, Berhane & Workua 2012; Ververs et al., 2013).

The mid-upper arm circumference (MUAC) is a nutritional status assessment measure that requires only one contact with women and is useful in cross sectional studies. Moreover MAUC is easy to measure and requires one time measurement and is a good indicator of malnutrition because a thinner arm reflects wasted lean muscle .The MUAC measurement does not vary much during pregnancy and is therefore an appropriate measure of nutritional status during pregnancy compared to BMI or weight gain (Assefa, Berhane & Workua, 2012; Ververs et al., 2013).Some studies have been conducted to determine the relationship between MUAC and pregnancy outcome and they have shown that MUAC is a good indicator of pregnancy outcome (Akther et al., 2015; Assafa, 2012; Ververs et al., 2013).

In Embu level five hospital where the study was conducted the pregnant women were routinely assessed for the weight gain in each ANC visit but data on the overall nutritional status of the pregnant women in Embu county is limited .The MUAC measurement was not routinely assessed during the normal ANC visit therefore this present study aimed at filling this gap and established the nutritional status among the pregnant women in Embu County based on MUAC. The MUAC measurement was used to assess nutritional status in this current study because it is easy to measure and requires only one time measurement thus suitable for cross sectional studies. A MUAC measurement lower than 23 cm was indicative of poor nutrition status while a MUAC value equal to or greater than 23cm was regarded as normal nutrition status (Assafa, 2012; UNICEF, 2009; Ververs et al., 2013). This study established the nutritional status of the pregnant women assessed by MUAC measurement and determined its relationship to dietary diversity.

2.8 Morbidity, health seeking behavior and antenatal clinic attendance among pregnant women

Morbidity affects the nutritional status as well as iron status of pregnant women directly and is an immediate cause of malnutrition (Olumakaiye, 2013; Ruel, 2010; UNICEF, 1990).The dietary intake and dietary diversity of an individual is affected negatively by the illness and also by the treatment given to cure the illness. Helminthiasis has been shown to be one of the factors which contribute to anemia among pregnant women. Malaria has been found to be a leading cause of morbidity and mortality in Kenya (KNBS & ICF Macro, 2014).

In Kenya malaria is one of the most common diseases affecting pregnant women (Agan et al., 2010). Pregnant women who have co-morbidities such as existence of hypertension, anemia and low mid upper arm circumference are more likely to give birth to low weight babies (Assefa, Berhane & Workua, 2012). Life threatening morbidity during pregnancy includes, swelling of hands and feet, paleness, virginal bleeding, hypertension and convulsions (Sigh et al., 2013). Seeking health early is very crucial during pregnancy to ensure that all infections and diseases are treated or managed promptly for a health pregnancy and positive pregnancy outcome.

Attending antenatal care regularly is important in order to monitor the progress of the pregnancy and therefore reduce the risk of morbidity for mother and fetus. Moreover ANC attendance is very crucial in order to detect and treat anaemia and other infections as early as possible. Pregnant women should attend at least four ANC visits in the course of the pregnancy (KNBS & ICF macro, 2010; KNBS & ICF macro, 2014). According to KDHS (2014), 58% of Kenyan women reported to have made four or more ante natal visits for their most recent births. Urban women are more likely to have four or more ANC visits compared with women in rural areas (KDHS 2014).Both education and wealth are positively associated with receiving the recommended number of ANC visits. About 43% of women with no education attended four or more ANC visits while 69% of women with secondary or higher education made more than four ANC clinics. In addition, 44% of women in the lowest wealth quartile attended four or more ANC visits compared with 75% in the highest quartile. In Mombasa, Embu, Machakos and Nandi Counties, ANC attendance is almost a hundred percentage with 99% having attended ANC during their last birth KDHS,2014The number of ANC clinic visits is associated with low birth weight. Attending less than four ANC visits doubles the risk of low birth weight as compared to those visiting four times (Assefa, Berhane & Workua, 2012).

The current study was carried out in Embu County among pregnant women who were attending the ANC clinic at Embu level 5 hospital to establish the gestation age at which ANC visit was started and the number of ANC visits were made. The present study aimed at filling the gap of scarcity of data on ANC attendance and morbidity patterns and their relationship to iron status among pregnant women in Embu County.

2.9 Micronutrients supplementation among pregnant women

The iron requirements during pregnant are said to be very high to be met only through food intake. Therefore iron supplementation is necessary for women during pregnancy in order to meet the iron requirements and thus improve the iron status. Iron supplementation to the pregnant women has been shown to protect the mother as well as the fetus against iron deficiency anaemia. In Kenya, it is a policy that all pregnant women take a combined folic acid and iron tablets (IFAS) daily from the conception up to the delivery (KNBS & ICF Macro, 2010;KNBS & ICF Macro, 2014). The WHO recommends 60 mg of iron and 400ug of folic acid supplement daily during pregnancy for all women beginning as soon as possible during gestation and no later than third month of pregnancy (WHO 2010; WHO 2011).

Supplementation with iron is usually recommended during pregnancy in order to meet the increased iron needs of both the mother and the fetus. Routine intake of supplements during pregnancy is most important to anaemic pregnant women and even for women who enter pregnancy with reasonable iron status. Starting the ANC clinic early gives the pregnant women time to start the intake of iron and folic acid supplement. In Embu level five hospital where the current study was conducted pregnant women visiting the ANC clinic were given iron and folic acid pills (IFAS). However there is limited data on the number of pregnant women who were actually adhering recommended daily consumption of the IFAS in Embu County .Therefore this present study sought to establish the proportions of pregnant women who were consuming the micronutrients prior to the study as well as those who were consuming the micronutrients on daily basis.

2.10 Summary of literature review

Studies have sufficiently demonstrated that dietary diversity is strongly associated with micronutrient adequacy and that a diet that is diversified has been correlated significantly with good nutritional status. Moreover a variety of foods in the diet has been shown to be important in ensuring adequate intake of essential nutrients and in realizing an optimal nutritional status. Literature reviewed has demonstrated that maternal demographic and socio economic characteristics and morbidity affect the dietary diversity, iron intake and iron status of the pregnant women.

However major gaps exit in the reviewed literature such as limited knowledge on dietary diversity and its association with the iron intake and iron status among pregnant women in Kenya and in Embu County.There is also limited information on demographic and socio economic status of the pregnant women and the effect of the demographic and socio economic status on dietary diversity, iron status and iron intake among the pregnant women. There is limited information on the morbidity, and health seeking behavior and its relationship on the dietary diversity, iron intake and iron status among the pregnant women in Embu County. The present study therefore determined the dietary diversity, iron intake, and iron status among pregnant women in Embu County. The study also established the demographic and socio economic status of the pregnant women. This study also analyzed the relationship between the demographic characteristics, socio economics status and morbidity to the dietary diversity, iron intake and iron status among pregnant women in Embu County.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

3.1 Research design

The study adapted a cross sectional analytical design (Ketzenellenbogen et al., 2002). The study design was chosen because it could show the dietary diversity, iron intake and iron status of pregnant women at one point in time.

3.2 Study variables

3.2.1 Independent variables

The independent variables included; dietary diversity which was measured by minimum dietary diversity for women (MDD-W), iron intake which was assessed using the 24 hour recall and analyzed in terms of frequencies, percentages and mean, morbidity and health seeking behavior, ANC attendance, micronutrients supplementation analyzed in terms of frequencies and percentages. Demographic and socio economic characteristics which were measured by age, parity, marital status, education level, occupation, level of income and wealth index and analyzed in terms of frequencies, percentages and mean.

3.2.2 Dependent variable

The dependent variables of the study were iron status which was measured by the hemoglobin concentration (HB) and nutritional status which was measured by the mid upper arm circumference (MUAC).

3.3 Study area

The study was carried out at Embu level five hospital in Embu-County. Embu County was chosen because despite being agriculturally productive, Embu county suffers from high rate of malnutrition especially among women of reproductive age (12.8%) which is higher than the national level of 9% of women of productive age who were found to be malnourished during the KDHS (2014.) Moreover scientific data on dietary diversity, iron intake and iron status among pregnant in Embu is unavailable thus necessitating this study. Moreover Embu level five hospital is the only referral hospital in the region.

Embu level five hospital is located in Embu town which is the Embu county headquarters. The hospital is frequented by people from various sub- counties, districts, divisions and locations within Embu County as well as from neighboring counties. The major economic activity in Embu County is tea and coffee production in the upper regions and production of cereals in the lower region. Farming is mostly practiced in the rural areas in the county. Most of the residents of Embu town are business people while others are employed in formal sector within the county and others are in informal employment. Embu County borders Kirinyaga to the West, Kitui to the East, Tharaka Nithi to the North and Machakos to the south. Embu County has a health infrastructure consisting of both public and private facilities. It has one major referral level five hospitals and three sub–county hospitals; there are a large number of health centers spread across the county.

3.4 Target population

The study target population was all the pregnant women in Embu County.

3.4.1 Accessible population

The accessible population for this study was all the pregnant women who were visiting the MCH clinic at Embu level five hospital at the time of study. The monthly approximate attendance was 550 pregnant women.

3.4.2 Inclusion criteria

Pregnant women attending Embu level five hospital MCH clinic who gave the informed consent were included in the study.

3.4.3 Exclusion criteria

Pregnant women who were chronically ill as established by the clinical officer from the hospital were excluded from the study. Women who declined to give informed consent were also excluded from the study.

3.4.4 Confounding factors

The confounding variables in this study were micronutrients supplementation and morbidity.

3.5 Sample size determination

The formula ($n = Z^2Pq /e^2$) by (Israel, 1992) was used to determine the sample size. Where, n is the desired sample size, Z is the standard normal deviation at 95% level (1.96), p is the proportion of the target population estimated to have the characteristics being measured, q is 1-p and e is the level of statistical significance set (0.05).The prevalence of under nutrition of 0.17 among women in Eastern province where the study was done was used (KNBS & ICF macro, 2010).

$n = (1.96)^2(0.17)\ (0.83)/\ (0.05)^2 = 217$. The finite population correction for population less than 10,000 was done to produce a sample size proportional to the population by the formula (Israel, 1992).

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

n = sample size, n_o = desired sample size ,N=estimate of the population size. The estimate of the population size was the average monthly attendance calculated from the previous year ANC records. The Embu level 5 ANC monthly average attendances were 550 pregnant women.

$$n = \frac{217}{1 + (217-1)/\ 550} = 156\ .$$

The sample size is often increased by10% to compensate for non response. Therefore the calculated sample size of 156 was increased by 10% to make a total of 172 to cater for non-response (Israel, 1992).

3.6 Sampling technique

Embu level five hospital was purposively selected because it is the major referral hospital in Embu County and the neighboring Counties of Kirinyaga and Tharaka Nithi. Systematic sampling method was used to select the sample. Systematic sampling technique involves selection of subjects directly from the sampling frame that was listed progressively (Mugenda,2008).For this study the sampling frame was listed numerically by assigning each pregnant women a number from the hospital ANC visits records which had an average of 550 attendance per month. The researcher then started at a random point and selected every k^{th} pregnant women. Where k=N/n. The N (550) is the average monthly attendance in Embu level five MCH clinic and n (172) is the required sample size k=550/172=3.20 thus approximately every 3rd pregnant woman was included in the sample until the required sample size was obtained. Sampling was done from Monday to Friday within a period of one month during the research period until the required sample size was obtained.

3.7 Recruitment of the study participants

The study participants were recruited during the study period which lasted one month. The researcher visited the MCH clinic in Embu level five hospital each week day during the research period and explained to the pregnant women the purpose and procedure of the study to the sampled pregnant women and those who agreed to sign the informed consent were recruited to participate in the study.

3.8 Research instruments

3.8.1 Structured questionnaire

The data was collected using a structured questionnaire (appendix B). The questionnaire was divided into the following sections; demographic and socio-economic characteristics of the respondents, socio-economic characteristics of the respondents' household, dietary diversity questionnaire, 24 hour dietary recall form and food frequency questionnaire, morbidity and health seeking behaviour among the respondents, antenatal clinic attendance, micronutrient supplementation and the last section in which MUAC and HB were taken and recorded, gestation period and MDD-W was calculated and also recorded in this section.

The dietary diversity data was collected by use of structured dietary diversity questionnaire which was adapted from FAO (FAO & FHI 360, 2016). The dietary diversity questionnaire was adjusted to include the locally available foods. The dietary diversity questionnaire was based on16 food groups questionnaire which was later consolidated to ten food groups as recommended by FAO (FAO, 2011; FAO & FHI 360, 2016).The 24 hour recall questionnaire was used to collect quantitative data on the dietary intake of the respondents in the previous 24 hours. The food frequency questionnaire was used to collect data on the number of times a given food item was consumed for the previous seven days.

3.8.2 Pre-testing of data collection tools

The questionnaire was pre-tested to check on the content, the wording, the language, the length and for any omissions and corrections. The pre-testing sample for the questionnaire included 17 pregnant women (10% of the sample size) attending Majimbo health centre in Embu County. The questionnaire was modified by correcting all mistakes and including any missing information as well as including all the foods that could have been left out.

3.8.3 Reliability of research instruments

The reliability of the research instruments was tested to measure the degree to which the research instruments would yield the same results after repeated trials. Test-retest method was used to test reliability of the questionnaire and test-retest coefficient was used to measure the reliability of the research instruments .Test retest coefficient is a measure of how consistent the instruments are. Test-retest reliability coefficients of 0.9

or greater have excellent reliability while coefficient between 0.9 and 0.8 are good reliability (Robert, 2010). A test- retest coefficient of 0.8 was obtained when data was analyzed for reliability in the present study.

3.8.4 Validity of the instruments

Validity of the research instruments was tested to ensure that the instrument was measuring what it was supposed to measure. The questionnaires to be used were pre-tested and clarity of information ascertained. To ensure validity of the study questionnaire a panel of experts who were competent in the field of maternal nutrition were involved in the assessment of the questionnaire to review the relevance and validity of the content of the questionnaires and give their independent feedback to the researcher. All the contributions from the experts were then used to construct the final questionnaires.

3.9 Selection and Training of the research team

The research team comprised of the researcher and three research assistants. One research assistants with a diploma in nutrition, food and dietetics, one clinical officer with a diploma in clinical medicine and one medical laboratory technologist with a diploma in medical laboratory were trained on the research objectives, purpose and procedure before embarking on the research. The research assistants were taken through the questionnaire in order to familiarize themselves with the procedures of asking the questions and filling in the response accurately. Demonstrations were done on the procedures of taking the MUAC using the adult UNICEF MUAC tape.

3.10 Data collection procedures and techniques

The researcher assisted by the research assistants visited the MCH clinic in Embu level-5 hospital daily for a period of one month during the month of April and with the help of the nurse in charge recruited the research participants and then explained the purpose, objectives and the procedure of the study to the respondents. The recruitment was done after the pregnant women had been given the routine ANC services. Data on iron status and MUAC was collected at the hospital after the respondents had given an informed consent to participate in the study. The respondents were then followed to their households to collect data on 24 hour dietary recall, food frequency, dietary diversity and demographic and socio economic characteristics.

3.10.1 Demographic and socioeconomic data

A researcher administered questionnaire was used to solicit information on demographic and socioeconomic characteristics of the respondents. The demographic and socio economic information included the age, parity, education level, occupation, marital status, income earned per month and the source of income. Other characteristics of the household such as house ownership, assets ownership and housing type of the respondents were also collected.

3.10.2 Dietary diversity data

The dietary diversity questionnaire was used to collect information on all the foods and food items as well as the drinks that were consumed by the individual pregnant woman for the last 24 hour period. The respondents were asked to report all the foods, beverages and snacks they had consumed in the previous day from the time they woke up and throughout the day up to the time they went to sleep. Probing was used to ensure no food consumed was left out. All the food and drinks that were reported by the participants were then recorded to a 16 food group questionnaire which was later consolidated to a standardized 10 food group to calculate the minimum dietary diversity for women.

3.10.3 Nutrients intake based 24-hour dietary recall data

A 24 hour dietary recall questionnaire was used to collect data on all the food, snacks and drinks consumed the previous day including details on the time of the meal, the place the meal was consumed, details of the method of preparation and the amount consumed. The 24 hour dietary recall questionnaire was administered at the household of the study participants. The 24 hour dietary recall involved soliciting information from the respondents on all the foods and beverages consumed in the previous day from the time they woke up to the time they went to sleep. All the foods, beverages and snacks consumed, the time of consumption, detailed description of the food item and preparation method, amount eaten and weight in grams of the foods and beverage were then recorded in the respective columns. Household's utensils such as glasses, cups, bowls, tablespoons, teaspoons, serving spoons; plates were used to estimate the amount of food and drinks consumed by the respondents. Fruits which were on season were purchased and used for estimation of the portions sizes. Vegetables were purchased and cooked for portion estimation. Probing was used to ensure that no food or drinks was forgotten.

3.10.4 Dietary intake based on food frequency questionnaire

The food frequency questionnaire was used to collect data on the number of times the food items were consumed per week. The food frequency table included the food items which were readily available in the market during the period of the study and the respondents were asked the number of times they consumed a given food per week and the number of times the foods items were consumed was recorded in the questionnaire. A seven day food frequency questionnaire was used to gather information on the consumption of the locally available foods which were identified at the market and at the households. A list of 77 commonly consumed food items was made and the respondents were asked to state the number of days they consumed each of the food in a week. Consumption of a food for at least thrice a week was considered to be regular intake where less than 3 days was considered to be irregular consumption (Ahmed et al., 2008; Chege, 2012, Dahl, Maeland & Bjorlkkjaer, 2012).

3.10.5 Assessment of nutritional status of the pregnant women

The nutritional status of the pregnant women was assessed using the MUAC measurement. The MUAC measurement of the pregnant women was taken in the private room in the hospital during the interview. The MUAC of the respondents was measured using the adult standard MUAC tape and recorded on the questionnaire. The MUAC was measured in the midpoint of the upper arm of the left arm to the nearest 0.1 centimeter with no clothing. The MUAC measurement was done at least twice for each respondent to ensure accuracy.

3.10.6 Assessment of iron status of the pregnant women

The iron status of the respondent was determined by assessing the hemoglobin concentration in the respondent's blood. The hemoglobin concentration of the pregnant women was determined using HemoCue B-Hemoglobin analyzer. The laboratory technician who was part of the research team did the hemoglobin test in Embu level five laboratories. The assessment of hemoglobin was done following the specimen analysis procedure as laid down in the laboratory procedure for the blood specimen test which included, assembling required supplies at the respondent location, removing the appropriate number of cuvettes from the vial and then place the cap back on vial promptly. The whole blood sample was then obtained from capillary by finger prick. The filled micro cuvette was placed into holder and pushed in to stop point in the Hemocue photometer for hemoglobin analysis. After approximately 45 seconds the hemoglobin value would be displayed on the window. The cuvette was removed and disposed of in the appropriate container. The hemoglobin levels for each of the respondent were immediately recorded in the laboratory request form and later on the questionnaire.

3.10.7 Morbidity, health seeking behaviors ,antenatal clinic attendance and micronutrients supplementation among the respondents.

The data on the morbidity and health seeking behavior, ANC attendance and micronutrient supplementation was collected and recorded in section E of the questionnaire. The respondents were asked whether they had been sick for the previous two weeks and the illness they were suffering from and whether medical care was sought. The respondent were also asked to report the gestation age when they had their first ANC visit, the number of times they have had ANC visit , whether they were consuming any micronutrient supplement as well as whether they were consuming the micronutrient on daily basis. The information was cross checked by the information on the mother and child ANC clinic attendance booklet.

3.11 Focus Group Discussion

Two focus group discussions (FGD) were conducted with two groups of purposively selected participants. The pregnant women who participated in FGD were selected from those women who had not participated in the filling of the questionnaires but had met the inclusion criteria. Women who had not participated from the study would give non biased ideas because they had not seen the questionnaire before. The FGD were done to gather qualitative data that would give more understanding and also complement the information gathered from the quantitative data. The FGD aimed at gathering information on the opinion, beliefs and attitudes of the study participants on food choices and dietary practices.

The two focus group discussions were done at the end of the study period when all interviews had been concluded. The Participants were assured of the confidentiality of the discussions and were informed that the information shared during the discussion was only to be used for the research. Each of the two groups involved in focus group discussions comprised of 15 pregnant women. The focus group discussions lasted for about 40 minutes. The FGD sessions were held in a private room with only the participants, the recorder, an observer and the researcher who was the moderator. The findings from the FGD were than summarized and then discussed along the quantitative data that was gathered using the questionnaire.

3.12 Data analysis and presentation

At the end of the day the completed copies of the questionnaire were reviewed to ensure errors were corrected on time and clarification sought where necessary. Data was edited, coded, cleaned and entered using MS excel. Statistical Package for Social Sciences (SPSS) version (16) was used to analyze data from the demographic and socio economic status, dietary diversity questionnaire, food frequency questionnaire, morbidity, health seeking behavior and antenatal clinic attendance and micronutrient supplementation. The data gathered using the 24 hour recall was entered and analyzed using the Nutri-survey software for analysis of macronutrients and micronutrients intake and presented as frequencies, percentages and mean. The MDD-W dietary diversity indicator was calculated based on ten food groups which included; grains, white roots and tubers and plantains, pulses (beans, peas and lentils),nuts and seeds, dairy, meat, poultry & fish foods, eggs, dark green leafy vegetables, other vitamin A-rich fruits and vegetables , other vegetables, other fruits. Those who did not consume food from at least five groups were classified as not meeting the minimum dietary diversity while those consuming foods from five food groups or more were described as having met the minimum dietary diversity for women (FAO & FHI 360, 2016).The finding were presented as frequencies and percentages.

The hemoglobin concentration (HB) was used to determine the iron status. The hemoglobin cut-off points was as follows; those with HB level greater than 11.0 g/dl were classified as being non anemic, those with HB level between 10.0-10.9g/dl were classified as being mildly anemic, those with HB level between 7.0-9.9 g/dl were classified as being moderately anemic while those with HB level less than 7.0 g/dl were classified as being severely anemic. Iron deficiency anemia was defined as hemoglobin level of below 11g/dl at the sea level (WH0, 2001; WHO, 2011). Hemoglobin values for the effects of altitude in diagnosis of anemia were adjusted by 0.3 for Embu altitude of 4429 feet above the sea level.

The findings were then presented as frequencies and percentage. On the severity, anemia is classified as a public health problem according to its prevalence among the study population. Where the prevalence of anemia among the study participants is less than 5%, it is classified as no public health problem. Where the prevalence of anemia among the study participants is between 5 to 19.9% it is classified as a mild public health problem. Where the prevalence of anemia among the study participants is between 20 to 39.9% it is classified as a moderate public health problem and where the prevalence of anemia among the study participants is greater or equal to 40% it is classified as a severe public health problem (UNICEF, UN, WHO, 2001; WHO, 2011).

The MUAC measurement was used to assess the nutritional status of the pregnant women. A MUAC value of less than 23.0 cm was considered under nutrition and

MUAC of equal to or more than 23.0 cm was considered normal (Assafa, 2012; UNICEF 2009; Ververs, 2013; UNICEF, UN, WHO, 2001). The MUAC values were analyzed and presented in frequency, percentage and mean.

Morbidity, health seeking behavior and ANC attendance was analyzed as frequencies and percentages Descriptive statistics such as frequencies, percentages and mean were used to analyze data for the demographic and socioeconomic status. Pearson correlations and chi-square were used to establish relationship between variables. A p-value of <0.05 was used as the criteria for statistical significance. Logistical regression was done to assess the contribution of dietary intake to hemoglobin levels thereby controlling for micronutrients supplementation and morbidity as confounding variables.

3.13 Logistical and ethical considerations

Research clearance was obtained from graduate school at Kenyatta University (Appendix D). Ethical clearance (Appendix E) was obtained from Ethical Review Committee from Kenyatta University. A research permit (Appendix G) was sought from the National Council for Science, Technology and Innovation. Permission was sought from the county government and from the hospital administration (Appendix H). Any medical personnel needed to assist during the research were sourced from the hospital. Informed and signed consent was sought from the respondents (Appendix A).

The researcher assured the respondents of confidentiality of the data and that the data was only to be used for the purpose of the study. The respondents were also informed that to be included in the study was voluntarily and that no payment or gifts was to be offered to those who participated in the study.

3.13.1 Care and protection of the research participant

The research procedures such as drawing of blood was explained clearly to the participants especially to reassure them that there was no risk associated with the procedure either to the mother or the fetus. The procedure for obtaining the blood for assessing the hemoglobin levels was done following the standard operating procedures (SOPs) for blood sample removal and infection prevention procedures so as to ensure the safety of both the respondent and the research assistant and to ensure that the results are not interfered with .The respondents were also assured that the tools used to draw blood were safe and the drawn blood was only to be used for the study and not for any other purpose.

3.13.2 Community considerations

The benefits of the study included the study participants knowing their HB levels and MUAC measurements as well as their dietary diversity. The participants who had not met the minimum dietary diversity and those who had low HB levels of less than 11g/dl or MUAC value of less than 23cm were referred to the MCH nutritionist for further follow up.

CHAPTER FOUR: RESULTS

4.0 Introduction

This chapter presents the study findings according to the objectives of the study which include; the demographic and socio-economic status of the pregnant women attending the MCH clinic in Embu Level 5 hospital, dietary diversity and iron intake, haemoglobin level and nutritional status, morbidity, health seeking behaviour, antenatal clinic attendance and micronutrient supplementation as well as relationship between variables.

This study targeted 172 pregnant women but only a total of 164 pregnant women fully participated in the study. Out of the targeted sample of 172, eight respondents did not respond. The eight respondents declined to finish the interview therefore the eight questionnaires were incomplete. The results were analyzed from a total sample of 164 pregnant women visiting the MCH clinic who fully completed the questionnaire.

This study was designed to establish dietary diversity, iron intake and iron status among pregnant women attending ANC clinic at the MCH clinic at Embu level 5-hospital at Embu County. The dietary diversity was assessed by MDD-W; iron intake was assessed by 24 hour recall while iron status was assessed by HB levels.

4.1 Demographic and socio-economic characteristics of the respondents

The demographic and socio economic characteristics of the respondents are presented in Table 4.1. The respondents were aged between 15-39 years. The mean age of the study population were 27±5.3 years with highest proportion of the respondents being between 25-29 years (35.4%), followed by those in 20-24 years (25%) with the least number (4.9%) being in the age group of 15-19 years.

Regarding parity, 77.4% of study participants were in their first pregnancy. In regard to gestation age more than a half (56.7%) of the respondents were in the second trimester. About 88.4% of study participants were married. About (40.2%) of the respondents had completed secondary education while 29.9% had completed primary education.

In regard to occupation, source of income and monthly income, most of the respondents (42.1%) reported to be involved in small scale business. A high proportion (59.2%) of respondents reported to be earning below KSH.10, 000, another 15.9% were earning between 10,000 and 20,000 while 11% of the respondents were earning more than KSH 20,000 per month .The main source of income for the majority of the respondent was small scale business (41.5%) while 16.5% obtained their income from formal employment and another 10.9% from sale of cash and food crop (Table 4.1).

Table 4.1: Demographic and socio –economic characteristics of the respondents

Variables	*n=164*	*%*
Age		
15-19	8	4.9
20-24	41	25
25-29	58	35.4
30-34	35	21.3
35-39	22	13.4
Parity		
≤ 1	127	77.4
2	29	17.7
≥3	8	4.9
Marital status		
Married	145	88.4
Not married	19	11.6
Gestational age		
1st trimester(0-12 weeks)	3	1.8
2nd trimester(13-28 weeks)	68	56.7
3rd trimester(29-40 weeks)	93	41.5
Education level		
Primary education	52	31.7
Secondary education	66	40.2
Post-secondary	46	28.1
Occupation		
Farmer	12	7.3
Business	69	42.1
Casual worker	9	5.5
Housewife	31	18.9
Civil servant	6	3.7
Private sector	18	11
School going	5	3.0
Unemployed	14	8.5
Income per month (KSH)		
2001_4000	26	15.9
4001_6000	29	17.7
6001_8000	8	4.9
8001_10,000	15	9.1
10,001_20,000	26	15.9
>20,000	18	11
Source of income		
Business	68	41.5
Formal employment	27	16.5
Cash crop and food crop	18	10.9
Casual labour	9	5.5

4.2 Socioeconomic characteristics of the respondent's households

The socioeconomic characteristics of respondent's household are presented in Table 4.2. More than a half (53%) of the respondents were found to live in rented houses while 47% were found to live in their own houses. About 32% of the respondents lived in three roomed house. All the respondents (100%) reported to own a mobile phone while 84.8% reported to own a radio. About (73.3%) of the respondents reported to own a television set. Most of respondents (61.6%) in this study reported to be using electricity for lighting while 29.3% of the study participants used firewood as the source of fuel. In regard to farm and livestock ownership, 50.7% of the respondents reported to own a farm. The animals owned by the respondents were reported to be poultry (40.9%), cattle (23.2%), goats (18.3%), sheep (7.3%), and donkey (2.4%) (Table 4.2).

Table 4.2: Socio-economic characteristics of the respondent's households

House ownership	***n***	***%***
Rented	87	53
Owned	77	47
Number of rooms in the house		
1	17	10
2	44	26.8
3	54	32.9
>4	50	29.8
Materials used to make the wall		
Mud	5	3.0
Bricks	17	10.4
Cement and stone	105	64
Iron sheets	2	1.2
Timber	35	21.3
Materials making the roof		
Papyrus/glass	3	1.8
Iron sheets	160	97.6
Tiles	1	6
Material making the floor	***n***	***%***
Cement	127	77.4
Timber	16	9.8
Earthen	21	12.8

Table 4.2 Continued socio economic characteristic of the respondent household

Electricity	101	61.6
Kerosene lamp	47	28.7
Solar	12	7.3
Kerosene burner	2	1.2
Open fire	2	1.2
Source of fuel		
Firewood	48	29.3
Charcoal	46	28
Gas	42	25.6
Kerosene	25	15.2
Electricity	3	1.8
Assets Ownership		
Television set	121	73.8
Radio	139	84.8
VCD/DVD	109	66.5
Mobile phone	164	100
Sofa set	127	77.4
Bicycle	39	23.3
Motorcycle	28	17.1
Car	26	15.9
Farm and livestock ownership		
Farm	83	50.7
Poultry	67	40.9
Cattle	38	23.3
Goat	30	18.3
Sheep	12	7.3
Donkey	4	2.4

4.3 The socio economic status of the respondents

Wealth index was calculated using the Principle Component Analysis (PCA) where all variables namely; assets and housing characteristics were used to determine the socio economic status of the respondents. Most of the respondents (31.7%) were in the second wealth quartile followed by (25.6%) who were in the low wealth quartile, 20.1% were in the middle quintile while 12.8% were in the fourth wealth quartile. A very small proportion of the respondents (9.8%) were found to be in the highest wealth quartile (Figure 4.1).

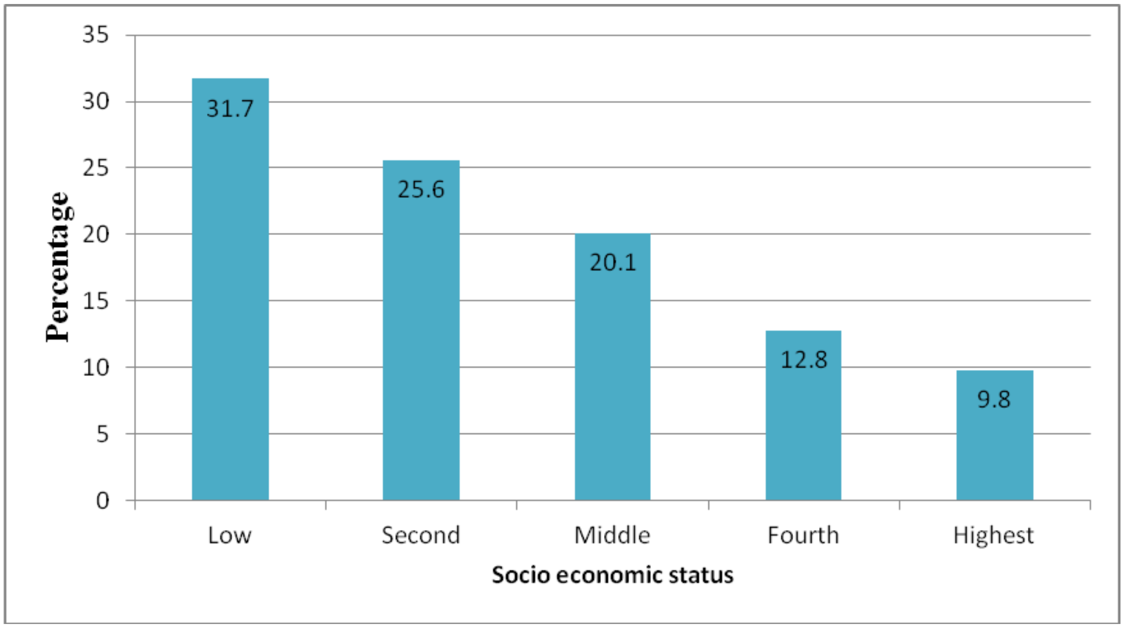

Figure 4:1: Socio economic status of the respondents

4.4 Dietary intake among the pregnant women

The dietary intake among the study participants was assessed based on the dietary diversity, 24 hour recall and food frequency questionnaire.

4.4.1 Dietary intake among the pregnant women based on Dietary Diversity

The dietary diversity for the respondents was calculated based on the minimum dietary diversity for women which comprised of ten food groups as recommended by FAO (FAO & FHI 360, 2016) and presented in Figure 4.2. Most of the study participants (72.6%) had met the minimum dietary diversity for women since they were consuming foods from more than five food groups. About 27.4% had not met the minimum dietary diversity for women since they were consuming food from less than 5 food groups (Figure 4.2)

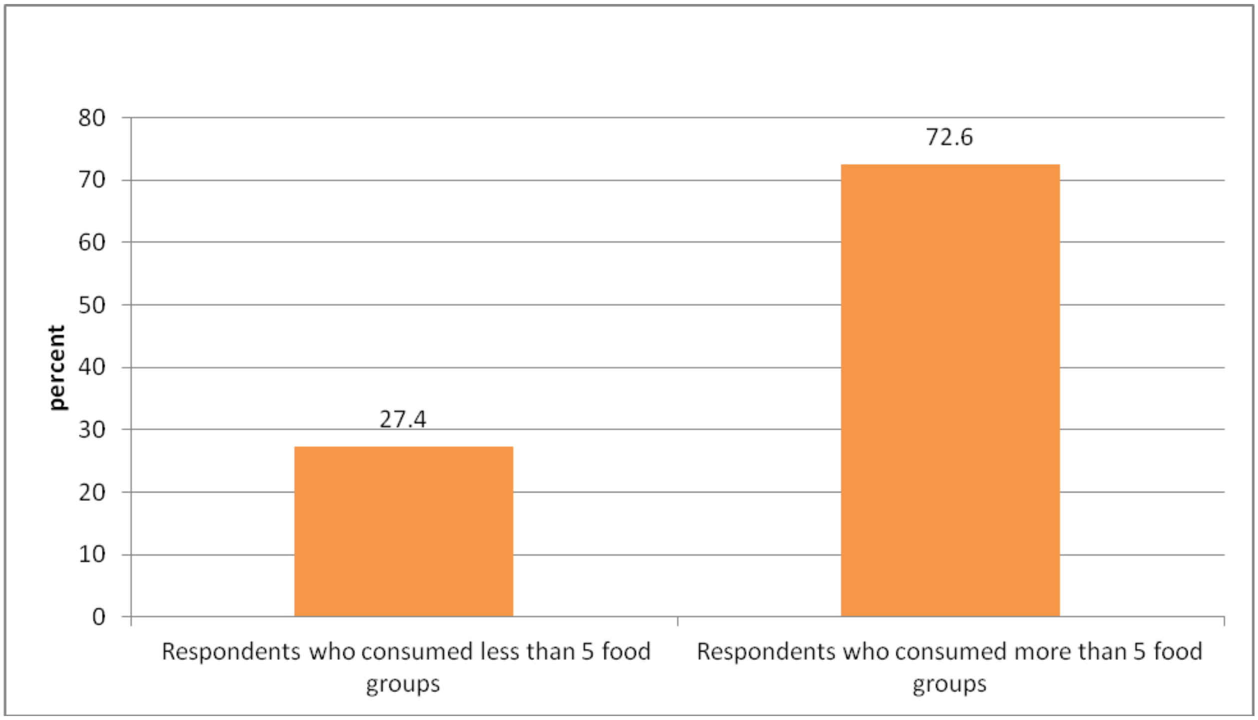

Figure 4:2: Dietary Diversity among pregnant women

4.4.2 Dietary intake of the respondents based on food groups

The mainly consumed food groups based on the 10 food groups used to collect data on the minimum dietary diversity for women were; grains, white roots and tuber and plantains, and other vegetables which were consumed by 100% of the study participants. Pulses (beans, peas and lentils) were being consumed by 96.3% of the respondents. Vitamin A rich fruits and vegetables were consumed by 73.8 % while dark green leafy vegetables were being consumed by 63.4%. Eggs were consumed by 82.7%.

Meat, poultry and fish were consumed by 39.7% of the respondents while nuts and seeds food groups were consumed by 30.5% (Figure 4.3).

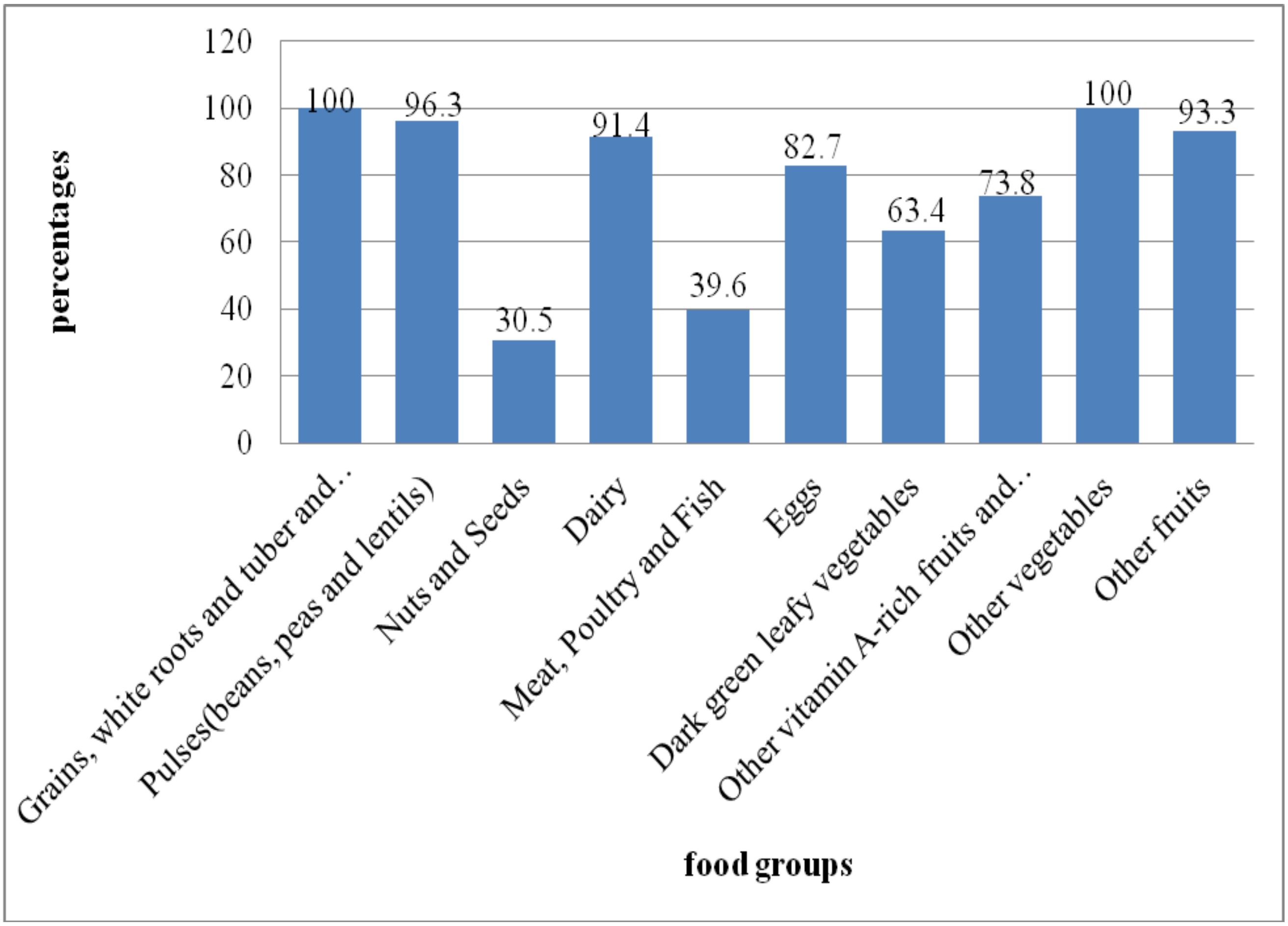

Figure 4:3: Dietary diversity of respondents based on Food groups

4.4.3 Dietary intake of the pregnant women based on 24 hour recall

Dietary iron intake and intake of other micronutrients was assessed by a 24-hour recall and presented in Table 4.3. All measures of foods that were reported to have been consumed by the participant for the last 24 hour were converted from household measures into grams and other relevant measures and then into values of energy, protein, iron, folic acid, zinc ,calcium, magnesium ,Vitamin A ,Vitamin C, Vitamin B_2,Vitamin B_1, Vitamin B_{12} Vitamin B_6 and Selenium. The mean energy intake of the respondents was 2263± 94.9 kilocalories with values ranging from 2100 to 2426 kilocalories. Majority of the respondents (86.6%) met the RDA for energy from their diet (Table 4.3)

Table 4.3: Proportion of respondents consuming sufficient amount of selected macronutrients and micronutrients based on 24 hour dietary recall

Nutrients	*Frequency*	*Percent*	*RDA*	*Mean*	*SD*	*Minimum*	*Maximum*
Energy(Kcal)	142	86.6	2350	2263.0	94.9	2100	2426
Protein(g)	134	81.7	60-80	72.4	20.3	51.3	105.6
Vitamin A(IU)	135	82.3	2500	68.6	2.5	42.3	78.5
Zinc(mg)	95	57.9	12	13.34	1.92	9.2	17.8
Folic acid (mg)	121	73.8	4.0	4.94	1.02	2.1	7.8
Iron (mg)	89	54.3	30	29.9	5.1	17.3	41.12
Vitamin B_1(mg)	121	73.8	1.4	1.51	0.74	0.6	2.6
Vitamin B_2(mg)	109	66.5	1.4	1.63	0.74	0.8	2.82
Magnesium(mg)	135	82.3	400	288.4	8.9	236.4	625.25
Calcium(mg)	150	91.5	1500	1560.56	14.5	1140.14	1786.63
Selenium(mg)	106	64.6	60	62.2	1.8	52.3	71.6
Vitamin C(mg)	152	92.7	85	90.6	0.87	74.2	98.3
Vitamin B_{12}(mg)	149	90.9	2.6	3.01	0.4	2.03	3.9
Vitamin B_6(mg)	138	84.1	1.9	2.2	0.05	1.08	2.75

RDA values obtained from WHO 2004; FAO&WHO 1996 and Food and nutrition dietary board

About 81.7% of the study participants had adequate proteins from their diet with a mean of 74.4 ± 2.5 with consumption ranging from 51.3 to 105.6 g. Slightly more than half (54.3%) of the respondents were meeting the RDA for iron with a mean of 29.9 ± 5.1mg with consumption ranging from 17.3 to 41.12 mg. About 73.8% of the respondents were meeting the RDA for folic acid with a mean of 4.94 ± 1.02 mg. Most of the respondents (90.9%) and (92.7%) were consuming adequate B12 and vitamin C respectively from their diet (Table 4.3).

4.4.4 Dietary intake among the pregnant women based on food frequency

The regularly consumed foods were determined based on the seven-day food frequency questionnaire. Regular consumption referrers to consumption of a given food for more than three times per week while irregular consumption referrers to consumption of a given food for less than three times per week.

Foods rich in haeme iron, such as fish, chicken, flesh meat and liver were not regularly consumed. Fish was regularly consumed only by 7.3% of the respondents with consumption range of 0-3 and a median of once per week. Poultry was regularly consumed by only 3.0 % with a range of 0 to 4 times per week and a median of 2 times per week. Meat was consumed for more than three times per week by about 28% of the respondents with a range of 0-6 days and a median of 3 times per week. About 18.3% consumed liver regularly with a range of 0 - 4 and a median of 2 times per week. Eggs were consumed regularly by 31.7% of the respondents with a range of consumption of between 0 - 6 and a median of 3 time per week. During the FGD, the women affirmed that meat, chicken, fish and liver were not regularly consumed with cost being the common reason for not consuming them. The women also affirmed that majority of the pregnant women did not consume eggs regularly for fear of having big babies.

Milk was consumed for more than three days per week by 47.0 % of the respondents with a range of between 0 to 7 time per week and a median of 4 times per week. However majority (82.3%) of the respondent reported to consume milk in form of tea with consumption ranging from 0 to 7 times per week and a median of 4 times per week. During the FGD, the women affirmed that most of them consumed tea daily and that tea was regularly consumed together with meals.

Among the Vitamin C rich fruits, oranges were the most regularly consumed with 42.7% of the respondent reporting to consume oranges for more than three time a week with a range of between 0 to 7 times per week and a median of 4 times per week. Vitamin A rich fruits such as pawpaw and mangoes were regularly consumed by 39% and 28.1% of the respondents respectively with a range of between 0 to 6 times per week.

The most regularly consumed legumes, were cowpeas which were being consumed by about 26.8% of the respondents for more than three days per week with a range of between 0 to 6 times per week. Beans were also commonly consumed by the respondent with about 25% of the respondents reporting to consume beans for more than 3 times per week with consumption ranging from 0 to 6 times per week.

Concerning the consumption of green leafy vegetable, Amaranth was the most regularly consumed vegetable with about 37.3% of the respondents reporting to consume it for more than 3 times per week .Spinach was also regularly consumed with 36.6% of the respondents reporting to consume spinach for more than 3 time per week., Other vegetables consumed regularly included tomatoes (48.2%) with a range of 0-7 and a median of 4, cabbage (34.8%) with a consumption ranging from 0 to 6 times per week and a median of 3, onions (90.9%) with consumption range of 0-7 times per week and a median of 4 times per week. During the FGDS most of the participant pointed out that spinach was commonly consumed mainly mixed with amaranth and kales.

Maize was consumed regularly with 76.8% of the respondents reporting to consume maize for more than three times per week with a range 3 to 7 days per week. Maize flour was regularly consumed with 51.8% of the respondents reporting to consume maize flour for more than three days per week with consumption range of between 0 to 7 times per week and a median of 4 times per week. Sorghum and millets were consumed regularly by 74.4% and 70% of the respondent respectively mainly in form of porridge with consumption ranging from 0 to 7 days per week and a median of 4. Wheat flour was consumed regularly by 34.8% of the respondents in form of cakes, doughnut, bread and chapatti with a consumption range of between 0 to 4 times per week. Rice was consumed regularly by 66.6% of the respondents with a consumption range of between 0 to 7 times per week. This was affirmed during the FGDS where the women confirmed that, maize, wheat and rice were the most consumed staples with most women agreeing to be consuming these cereals and their products almost daily because there were readily available and within their economic reach.

Irish potatoes were the most regularly tubers being consumed regularly by 58.5% of the respondents ranging from 0 to 6 times per week. Vitamin A rich foods such as pumpkins was not regularly consumed with only 28.1% reporting to consume pumpkin for more than three time per week with a consumption range of between 0 to 3 times per week. Carrots were regularly consumed by 58% of the respondents with a consumption range of between 0 to 6 times per week. Among the sugary food items, sugar was regularly consumed by 51.2 % with consumption range of 0 to 7 times per week. Soda was regular consumed by 44.5% of the respondents with consumption range of between 0 to 4 times per week. Alcohol was consumed regularly by 11 % of the respondents with consumption range of between 0 to 3 times per week. Most of the members of the FGD were in agreement that sugary food items were regularly consumed with sugar and soda being the most commonly consumed (Appendix C).

4.5 Nutritional status of the pregnant women

The nutritional status of the pregnant women was assessed using MUAC. About 13.4 % of the respondents were malnourished with a MUAC value of less than 23cm and (86.6 %) were well nourished with a MUAC value of greater than 23cm (Table 4.4).

Table 4.4: Nutritional status of the respondents

Mid Upper Arm Circumference in cm	***n=164***	***%***
<23cm	22	13.4
>23cm	142	86.6
Total	164	100

References for MUAC (mid-upper arm circumference) were obtained from UNICEF, (2009).

4.6 The iron status of the pregnant women

A total of 164 blood samples from 164 pregnant women was analysed for haemoglobin levels in grams/decilitre (g/dl). About 4.3% of the respondents had a haemoglobin level of below 10g/dl, 15.9% had haemoglobin levels ranging from 10.1 g/dl and 10.9g/dl while 76.9% had haemoglobin of between 11.1 g/dl and 12 g/dl. Blood haemoglobin levels were used to assess iron status of the pregnant women and women with haemoglobin levels of less than 11grams/decilitre were classified as being iron deficient. In this study, 20.1 % of the respondents were found to be anaemic with haemoglobin level of less than 11g/dl (Table 4.5).

Table 4.5:Iron status of the respondents

Haemoglobin level(g/dl)	***n=164***	***%***
7.1-10.0	7	4.3
10.1-10.9	26	15.9
11 -12	126	76.9
12.1- 14	4	2.4
14.1- 1 5	1	0.6
Total anaemic (HB <11 g/dl)	33	20.1
Total Non anaemic(HB>11g/dl)	131	79.9
Total	164	100

References HB (hemoglobin level) was obtained from WHO, (2011)

4.6.1 Iron intake, iron status and dietary diversify of the pregnant women

About 54.3% of the respondents were meeting the RDA for iron from their diet while 45.7% were not meeting the RDA for iron from their diet. All the respondents who were meeting the RDA for iron (54.3%) were non anemic. Among the respondents who did not meet the RDA for iron, 56% were non anemic and 44% were anemic. Among the respondents who did not meet the RDA for iron, 3.4% had not met their minimum dietary diversity.

Majority (96.6%) of the respondent who had met the RDA for iron had met the minimum dietary diversity for women. Most (98.7 %) of the respondents who were meeting the minimum dietary diversity for women were also meeting the RDA for iron. Dietary diversity was positively related to iron intake of the pregnant women ($r = 0.57$, $p = 0.038$) and to the iron status of the pregnant women. ($r=0.48$, $p = 0.031$) (Table 4.6).

Table 4.6: Iron intake, iron status and dietary diversity of the respondents:

Iron status	***Respondent who met RDA for iron***		***Respondents not meeting RDA for iron***	
	n	***%***	***n***	***%***
Anemic (HB<11)	0	0	33	44
Non- anemic (HB>11)	89	100	42	56
Total	89	54.3	75	45.7
Iron intake	***Respondents who did not meet MDD-W***		***Respondents who met MDD-W***	
	n	***%***	***n***	***%***
Respondents not meeting RDA for iron	3	3.4	86	96.6
Respondents who were meeting RDA for iron	1	1.3	74	98.7

Dietary diversity	***r***	***p=value***
iron intake	r= 0.57	0.038
iron status	r=0.48	0.041

Reference for RDA obtained from WHO 2003 FAO&WHO 1996 and Food and nutrition dietary board. MDD-W (FAO&FHI 360, 2016)

4.6.2 Iron intake, Iron status and intake of micronutrients among the pregnant women

The data on iron and other micronutrient intake was collected using the 24-hour recall and then analyzed and cross tabulated with iron status and intake of selected micronutrients and presented in Table 4.7. The iron intake, iron status and intake of selected micronutrients such as vitamin C, Vitamin B_{12}, and Folic acid were cross tabulated. More than a half (54.4%) of the respondents met the RDA for iron. For those who did not meet the RDA for iron 44% were found to be anemic. About (26.2%) of the respondents was not meeting the RDA for folic acid. About 51.2% of those not meeting RDA for folic acid were found to be anemic. Approximately 92.7% of the respondents were meeting RDA for vitamin C. About 33.3% of the respondents who were not meeting RDA for vitamin C were found to be anemic (Table 4.7).

Table 4.7:Iron intake, iron status and selected micronutrients:

Intake of selected micronutrients by the respondents	***Respondents who were anemic (HB<11)***		***Respondents who were non –anemic (HB>11)***		***Total***	
	n	***%***	***n***	***%***	***n***	***%***
Those who did not meet RDA for iron	33	44	42	56	75	45.7
Those who met RDA for iron	0	0	89	100	89	54.3
Total	33	20.1	131	79.9	164	100
Those who did not meet RDA for vitamin C	4	33.3	8	66.7	12	7.3
Those who meet RDA for vitamin C	29	19.1	123	80.9	152	92.7
Total	33	20.1	131	79.9	164	100

Those who did not meet RDA for vitamin B_{12}	7	46.7	8	53.3	15	9.1
Those who met RDA vitamin B_{12}	26	17.4	123	82.6	149	90.9
Total	***33***	***20.1***	***131***	***79.9***	***164***	***100***
Those who did not meet RDA for folic acid	22	51.2	21	48.8	43	26.2
Those who met RDA for folic acid	11	9.1	110	90.9	121	73.7
Total	***33***	***20.1***	***131***	***79.9***	***164***	***100***

4.6.3 The iron status and selected demographic and socio economic status of the pregnant women

The iron status of the pregnant women was cross tabulated with demographic and socio economic factors such as gestation age, maternal age, marital status and education level and was presented in Table 4.9. In reference to iron status and gestation age, about 23.2% of pregnant women who were in their second trimester were anemic while 11.1% of women who were in the third trimester were found to be anemic. Anemia was estimated for each age group category and (27.3%) of those pregnant women who were in the age group of between 35-39 years were anemic. About (26.8%) in age group of between 20-24 years were anemic while 17.1% of those in age group between 30-34 years were anemic. Further 15.5% of those in the 25-29 age group were anemic and (12.5%) of the pregnant women in the age group of between 15-19 years of age were anemic .About 21.4% of the married pregnant women were anemic while 11.8% of those who were not married were anemic. In reference to iron status and education level, about 21.7% of those who had post-secondary education were anemic while 19.2% of those who had primary or secondary education were anemic (Table 4.8).

Table 4.8: Iron intake, iron status and demographic and socio-economic characteristics of the respondents

Variables	***Anemic (HB <11g/dl)***		***Non-anemic(HB> 11g/dl***		***Total***	
Gestation age	***n***	***%***	***n***	***%***	***n***	***%***
1st trimester	0	0	3	1.8	3	1.8
2nd trimester	29	23.2	96	76.8	68	56.7
3rd trimester	4	11.1	32	88.9	93	41.5
Age						
15-19	1	12.5	7	87.5	8	4.9
20-24	11	26.8	30	73.2	41	25
25-29	9	15.5	49	84.5	58	35.4
30-34	6	17.1	29	82.9	35	21.3
35-39	6	27.3	16	72.7	22	13.4
Marital status						
Married	31	21.4	114	78.6	145	88.4
Not married	2	11.8	15	88.2	17	10.4
Separated	0	0	2	100	2	1.2
Education level						
Primary	10	19.2	42	77.8	52	31.7
Secondary	13	19.7	53	80.3	66	40.2
Post-secondary	10	21.7	36	78.3	46	28.1

4.6.4 Micronutrients supplementation among pregnant women

In the current study (90.2%) of the respondents had received and were taking micronutrients supplements (Table 4.10). Only 9.8% of the respondents had not received supplements. About 84.8% of the study participants were consuming iron and folic acid pills (IFAS) which contained dried ferrous sulphate 200mg which is equivalent to ferrous iron 65mg and folic Acid 0.4mg. About 77.4% of the respondents ingested the supplements daily while 9.8% did not ingest the supplements on daily basis. About 12.8% were not ingesting the supplements at all. Intake of iron fortified foods can also contribute to improving the iron status of the pregnant women. In the current study 92.1% of the respondents reported to have access to iron fortified food especially fortified processed wheat and maize flour (Table 4.9).

Table 4.9: Micronutrients supplementation among the respondents

Taking micronutrients supplements	***Frequency***	***Percentage***
yes	148	90.2
no	16	9.8
Micronutrient type		
iron -folic acid pills(IFAS)	139	84.8%
multiple micronutrient	9	5.5
Respondents ingesting micronutrient daily		
yes	127	77.4
no	21	12.8
Reasons for not ingesting the supplement		
bad taste	8	4.9
forgetting	11	6.7
does not see the importance	1	0.6
first visit	1	0.6
Access to iron fortified food		
yes	152	92.7
no	12	7.3
processed maize and wheat flour	139	91.4
others	13	8.6

4.7 Morbidity, health seeking behavior and antenatal clinic attendance among the pregnant women

Among the study participants, 39% reported to have been sick in the last two weeks while 61% reported not to have been sick (Table 4.10). Majority (48.4%) of the respondents who had been sick reported to have had suffered from malaria, 15.6% had suffered from sexually transmitted infections and 23.4% had suffered from respiratory tract infection.

Majority of the respondents (79.7%) who had been sick reported to have sought medical care services while 20.3 % did not seek any medical care services. Majority (90.2%) of the respondents who sought medical care visited government hospitals while (7.8%) visited private clinic.

Among the participants only 29.9% started attending ANC in the first trimester. About 65.2% of the respondents started attending ANC in the second trimester while 4.9% of the respondents started attending ANC in the third trimester.

Majority of the respondents (43.9%) had attended ANC twice. ANC attendance by the rest of the respondents was as follows 23.8% once, 23.8% thrice and 8.6% had attended more than four times (Table.4.10).

Table 4.10: Morbidity, health seeking behavior and ANC visit among the respondents

Sick	***Frequency(n)***	***Percentage (%)***
No	100	61.0
Yes	64	39
Sickness		
Malaria	31	48.4
Sexually transmitted disease	10	23.4
Respiratory tract infection	15	15.6
0thers	8	12.5
Seeking medical care		
Yes	51	79.7
No	13	20.3
Health facility visited		
Government hospital	46	90.2
Private clinic	4	7.8
Bought medicine from chemist	1	2
Time the respondent started attending ANC		
first trimester	49	29.9
second trimester	107	65.2
third trimester	8	4.9
Number of times of attending ANC		
once	39	23.8
twice	72	43.9
three times	39	23.8
four times	7	4.3
more than five times	7	4.3

4.8 Relationship between variables

4.8.1 Relationship between dietary diversity and maternal demographic and socio economic factors

A significant association was found between the level of education and the dietary diversity (χ^2=16.17, p=0.042) of the study respondents. This implies that as the level of education increased the dietary diversity increased. A positive significant relationship was also found between the level of income and the dietary diversity (r=0.39; p=0.047) of the study respondents. When chi-square test was performed, a significant association was found between marital status and dietary diversity of the pregnant women (χ^2 =18.58, p=0.037). Notably a negative insignificant relationship was found between gestation age and dietary diversity (r=-0.004, P=0.958) of the respondents. Negative insignificant relationship was also found between maternal age and dietary diversity (r=-0.038, p=0.626) (Table 4.11).

Table 4.11: Relationship between dietary diversity and demographic and socio economic status among pregnant women

Dietary diversity	***variables***	***statistics***	***p-value***
	Education	(χ^2)= 16.17	0.042
	Income	r= 0.39	0.047
	Marital status	(χ^2)=18.58	0.037
	Gestational age	-0.004	0.958
	Maternal age	-0.038	0.626

4.8.2 Relationship between dietary diversity, iron intake and iron status

Pearson's correlation coefficient revealed a significant positive relationship (r=0.48, p=0.031) between dietary diversity and iron status of the pregnant women. Moreover a positive significant relationship was found between dietary diversity and iron intake of the pregnant women (r=0.57; p=0.0038) (Table 4.12).

Table 4.12: Relationship between dietary diversity, iron intake and iron status of the pregnant women

Dietary diversity	variables	r	p=value
	iron intake	r= 0.57	0.038
	iron status	r=0.48	0.041

4.8.3 Relationship between nutrition status and other variables

A positive significant relationship was established between MUAC and dietary diversity (r=0.26; p=0.035). Significant association was found between MUAC and morbidity (χ^2=1.3; p=0.025). A significant positive relationship (r=0.275 p=0.000) was found between MUAC and maternal age. The MUAC reading of the pregnant women increased with the increase in age .No significant relationship (r=0.004, p=0.962) was found between MUAC and gestation age. Chi-square test showed a significant association (χ^2 = 5.2, p= 0.041) between education level and MUAC. Pearson's correlation coefficient shown a positive significant relationship (r= 0.34,p=0.038) between MUAC and monthly income (Table 4.13).

Table 4.13: Relationship between MUAC and other variables among pregnant women

MUAC	***Variables***	***Statistics***	***p-value***
	Dietary diversity	r=0.26	0.035
	Education	(χ^2)=5.2	0.041
	Occupation	(χ^2)=3.6	0.063
	Income	r=0.34	0.038
	maternal age	r= 0.275	0.000
	Parity	(χ^2)=185	0.574
	Marital status	(χ^2)=0.14	0.214
	Gestational age	r=0.004	0.963
	Maternal age	r=0.004	0.963
	Morbidity	$\chi^{2=}$1.3	0.025

4.8.4 Relationship between iron status and demographic and socio economic status of the pregnant women.

In this study it was established that parity of the pregnant women was positively correlated to iron status (r= 0.218, p=0.005). Notably maternal age was negatively related with iron status (r= -0.011, p=0.893) but the relationship was not statistically significant. Gestational age (r= 0.011, p=0.893) was not significantly related to iron status. Marital status of the respondents was associated with their iron status (χ^2=3.074; p=0. 380) but the association was not significant.

Further, a positive significant relationship (r=0.34, p=0.014) was found between iron status of the pregnant women and wealth index. Education level of the respondents was associated (χ^2=2.282, p= 0.62) with their iron status but the association was not statistically significant (p> 0.05).

Monthly income was significantly associated with the iron status of the respondents (χ^2= 16.814, p=0.019). Occupation was associated with the iron status of the pregnant women (χ^2=5.36, p=0.605) but the association was not statistically significant with p> 0.05.The other factor which was associated with iron status among pregnant women in this study was the gestation age at which ANC clinic was started (χ^2= 8.7, p=0.012) (Table 4.14).

Table 4.14: Relationship between demographic and socio economic status and iron status of the pregnant women

Iron status	*Variables*	*Statistics*	*P value*
	parity	r=0.218	0.005
	gestation	r=0.011	0.893
	maternal age	r= -0.138	0.078
	marital status	(χ^2) =3.074	0.380
	income	(χ^2) =16.814	0.019
	education	(χ^2) =2.282	0.682
	occupation	(χ^2) =5.36	0.605
	wealth index	r=0.34	0.014
	Gestation period when first ANC was attended	(χ^2) =8.785	0.012
	Number of times ANC was attended	(χ^2) =8.517	0.074

4.8.5 Relationship between iron status and morbidity among pregnant women

For those who reported to have been sick 32.8% were anemic while 67.2% were non anemic. On the other hand 12% of those were reported not to have been sick were found to be anemic. A high proportion (88%) of the respondents who reported not to have been sick were found to be non anemic. A significant association was found between morbidity of the pregnant women and their iron status (χ^2=11.23; p=0.000) with those who were sick having a high likelihood of been anemic (Table 4.15).

Table 4.15: Relationship between iron status and morbidity among the pregnant women

Iron status	*Respondents who were sick in the previous two weeks*		*Respondents were not sick in the previous two weeks*		*n*	*%*
	n	%	n	%		
Anemic	21	32.8	12	12	33	20.1
Non anemic	43	67.2	88	88	131	79.9
Total	***64***	***100***	***100***	***100***	***164***	***100***

(χ^2) =11.23, P=0.000

4.8.6 Relationship between iron status and micronutrients supplementation among pregnant women

Notably 87.8% of pregnant women who reported to be on supplements were found to be non-anemic. On the other hand 93.8% of the respondents who reported not to be on micronutrient supplements were found to be anemic. In the present study significant association was found between iron status and micronutrients supplementation (χ^2=4.538, p=0.024) (Table 4.16).

Table 4.16: Relationship between micronutrients supplementation and iron status of the pregnant women

Iron status	*Respondents on Supplements*		*Respondents not on supplements*		*n*	*%*
	n	%	n	%		
Anemic	18	12.1	15	93.8	33	20.1
Non anemic	130	87.9	1	6.2	131	79.9
Total	148	100	16	100	164	100

(χ^2) =4.538; P=0.024

4.8.7 Relationship between iron status and iron intake

Dietary iron intake (r=0.54, p=0.031) in this study was positively related to iron status of the pregnant women. Moreover, logical regression analysis revealed that 38% (R= 0.6153 ; R2=0.378 ; P=0.000) of hemoglobin level could be explained by dietary iron intake while controlling for supplementation and morbidity as confounding variables (Table 4.17).

Table 4.17: Model Summary

model	R	R Square	Adjusted R Square	Std.Error of the Estimate
1	.6153	.378	.038	1.19696

CHAPTER FIVE: DICUSSION

5.0 INTRODUCTION

This was a cross sectional analytical study to determine the dietary diversity, iron intake and iron status among pregnant women in Embu County. This chapter discusses the finding of this study in relation to the study objectives in reference to how the finding of this study compare with findings from other studies.

5.1 Demographic and socio-economic characteristics of the study participants.

The demographic and socio economic status and their relationship to dietary diversity, iron intake and iron status of the pregnant women were determined in this study. The present study examined a population cutting across women of the reproductive age group. The mean age of the study population was a 27±5.3 year with ages ranging from 15 to 39 years. This study presented a relatively young population with majority of the study participants being below 30 years. This implies that most of participants were in their youth which compares well with Kenya demographic health survey (2014) which indicated that the Kenyan population structure has a comparatively large youthful age group.

In regard to marital status, majority (88.4%) of the respondents in this present study were married. Regarding to parity the present study indicates that majority (77.4%) of the study participants were in their first pregnancy which may be attributed to the youthful age of the study participants. Majority (56.7%) of the respondents were in the second trimester. A higher proportion of the participant in this present study reported to earn less than or equal to 10,000 thousand shillings per month. The main source of income for the respondents in this present study was small scale businesses with only a small proportion of the study participants reported to be engaged in formal employment. This implies that majority of the study population were unemployed which is in agreement with the report of KNBS & ICF Macro (2014) whereby a higher percentage of women in the youthful age groups were reported to be unemployed .

The physical characteristic of the house in which a household lives is an important indicator of the wealth and economic status of the household. The housing characteristics are a function of the household's socioeconomic status (KDHS,2014).In the current study only a small proportion of the respondents (12.8%) were living in houses made of earth. More than half (77.4%) of the study participants lived in houses made of cemented floor. This is in agreement with KDHS (2014) which indicated that 98.9% of the respondent's houses were made of cement floor.

Majority of the study participants (64%) in the current study reported to be living in houses made of stone walls and iron sheet roofs. On the other hand about less than quarter (21%) of the respondent reported to live in houses made of timber walls, brick and others made of mud. A higher proportion of the respondent (53%) in this study reported to have rented the houses in which they were living in while others reported to own the houses they were living in. It was observed that the respondents lived in houses which consisted of one to seven rooms with majority of the respondents living in houses consisting of three rooms.

In a previous study carried out in Kenya by KNBS & ICF Macro (2014), about 64% of the Kenyan household reported to have electricity and used electricity as source of lighting while 56% used wood as the main cooking fuel. In the present study more than half (61.6%) of the participants were using electricity as source of lighting which compare well with KDHS (2015) report. The main source of lighting in the current study population was electricity followed by kerosene lamp while the sources of cooking fuel were firewood, charcoal, gas and kerosene. This could be attributed to the ongoing rural and urban electrification which has enabled many households to be connected to electricity.

The possession of durable household assets is another indicator of the socio economic status of an individual or a household. Ownership of durable goods varies according to the residence and the nature of the assets. Of the 14 selected items and evaluated in the current study, television, radio, VCD/DVD, mobile phone and motorcycle stood out as the commonly owned assets by the households. This is in agreement with the findings of KNBS & ICF macro (2015) that indicated that most of household in urban areas owns communication assets. According to KNBS & ICF macro (2015), 74% owed radio, 75% owed television and 94% owned mobile phones. In the present study it was observed that most of the respondents owed a radio and television while all those who participated in the study reported to own a mobile phone. The increased percentage of individuals and households owning the mobile phones, other electronic devices and motorcycles could be attributed to increase of affordable motorcycles and electronic devices and increase in supply of affordable mobile phones as well as increase in the numbers of companies providing the service and increase in overall network coverage.

In regard to land and livestock ownership, most of the participant in the present study reported to own land whose size ranged from an eighth of a hectare to two hectares. It was also observed that more than a half (53%) of the respondents owned their dwelling place. This finding is in agreement with the finding in KDHS (2015) that reported that 85% of the respondent owned land on which their dwelling place was situated. More than half of the current study participants reported to own agricultural animals with majority of them reporting to own poultry.

5.1.1 Socio economic status of the respondents

The wealth index was constructed using the household assets and generated via a principal complex analysis (PCA). All the assets and household characteristics were used to determine the wealth quartile of the respondents so as to establish their socio economic status. The participants in this present studies were found to be in the second (31.7%), low (25.6%) and middle (20.1%) wealth quartile. Only a small proportion of the participants were found to be in the highest (9.8%) quartile and fourth (12.8%) wealth quartile. This is in agreement with the finding from KDHS, (2015) which reported that more than 50% of women of reproductive age are in the middle, second or lowest socio economic status (KNBS & ICF macro (2015).

5.2 Dietary diversity among pregnant women

In regard to dietary diversity majority (72.6%) of the pregnant women in this present study were achieving the minimum dietary diversity for women with most of them consuming food items from more than five food groups out of the ten food groups. However a small proportion (27.4%) of the current study participants were observed to have not met the MDD-W due to the fact that they were consuming food items from less than five food groups. Majority (72.6%) of the respondent were meeting the MDD-W which is higher than findings reported in a study conducted in Ghana were 46.1% of the pregnant women were meeting the MDD-W (Saaka et al., 2017).

Dietary diversity was significantly associated with demographic and socio economic characteristics such as the maternal educational level (x^2=16.17, p=0.042), monthly income (r=0.39, p=0.47) and marital status (x^2=18.58, p=0.037). This finding is in consistent with finding reported in various studies which indicated that dietary diversity was significantly associated with socio demographics factors of the pregnant women (Ali et al .,2014; Savy et al., 2008;Torheim et al., 2004).

5.2.1 Micronutrients intake including iron intake among the pregnant women based on 24 hour recall

When the proportions of the respondents who were consuming adequate nutrients based on 24 hour dietary recall was determined, it was observed that about 54.3% of the participants were meeting the recommended daily allowance (RDA) for iron while slightly less than a half (45.7%) were not meeting their RDA for iron. Majority of the respondents were meeting the RDA for selected micronutrients such as vitamin C (92.7%), Vitamin B^{12} (90.9), Folic acid (73.8%). A higher proportion of the participant in this study had achieved the minimum dietary diversity for women (MDD-W) concurring with various studies that have pointed out that all dietary diversity scores are a proxy measure of micronutrient adequacy of the women of reproductive age including pregnant women .Dietary diversity is positively associated with a diet which is adequate in essential micronutrients (Arimond, 2011; FAO, 2011). Therefore the participants who had achieved the MDD-W had a higher likelihood of achieving micronutrient adequacy from the diet than those who were not achieving the MDD-W (FAO, 2011; FAO, 2014).

The relationship between dietary diversity and adequacy of micronutrients of the diets consumed by the women of reproductive age has been done in several studies and has been shown that dietary diversity is related positively with adequacy of essential micronutrients of the diet. A correlation of between 0.36 to 0.66 has been found between dietary diversity scores and micronutrient adequacy of the diet in these previous studies (Arimond et al., 2010; Arimond, 2011; Kennedy et al., 2007; Mirmiran et al., 2004). The current study compares well with these studies findings because the findings in this present showed positive correlations between dietary diversity and iron intake of (r=0.57, p=0.038) and positive correlation of (r=0.48, p=0.041) between dietary diversity and iron status.

5.2.2 Dietary intake among the pregnant women based on food frequency

Based on a seven day food frequency questionnaire foods rich in haeme iron such as fish, chicken, flesh meat, organ meet and eggs were not regularly consumed with majority of the respondent reporting to consume them for less than 3 times per week. The finding of this present study agrees with another study that pointed out that diets of women in developing countries lack or have little animal source food (Daniels & Melissa 2009).

Milk was consumed regularly with majority of respondent reporting to consume milk in form of tea. Tea which is known to inhibit iron absorption was the most consumed beverage by participants. Several other dietary habits which could affect iron absorption were observed in this study. Majority of the current study respondents reported to consume tea and cocoa together with their meals, a finding that was similar to finding obtained from a study carried out among pregnant attending ANC in Pumwani hospital in Nairobi which reported that 93.4% of the pregnant regularly drunk beverages (tea, cocoa or coffee) and 66% of them drink these beverages in less than 20 minutes before or after meals (Okube et al., 2016).

Majority of the respondents also reported to consume spinach as their major vegetables. A high proportion of the respondents also reported to consume maize and its product, wheat and its products and legumes regularly. All these dietary habits could contribute to reduced absorption of iron in the body due to the presence of anti-nutrients (phytates, oxalates, tannins) that bind the iron and thus decrease its absorption. This study findings are in agreement with other studies findings that have pointed out that diet of most pregnant women in developing countries is predominantly based on cereals, legumes and grains (Ekesa et al., 2011; Kennedy et al., 2007; Ruel, 2003).

5.3 Iron status among the pregnant women

The present study findings revealed that 20.1% of the participants were anaemic a value lower than the global (43.8%) and national (55.1%) values (Ministry of Health, Republic of Kenya, 2013; WHO, 2012).The prevalence of anemia in this study is lower than (51.9–59.6%) estimated prevalence of anemia among pregnant women in Africa (Mclean, 2009). It is also lower when compared with the prevalence of anemia (58.6%) among pregnant women reported in China (Ma AG, 2009). The prevalence of anemia among pregnant women in the present study is also lower than findings reported in studies conducted in India where about (87–100%) pregnant women were found to be anemic (Vemullapalli & Rao,2014).

Anemia prevalence finding reported from this present study is in contrast to findings reported from other studies conducted in different counties in Kenya whereby varying anemia prevalence among pregnant women has been reported for different counties. Including 73.6% in West Pokot County, 69% in Kisumu County, 57% in Nairobi County, 40% in Kakamega County, and 16.9% in Laikipia County (Kemuto, et al., 2013; Okube et al., 2016; Siteti et al., 2014; Willy et al., 2016). The present study finding is also in contrast with finding obtained in studies carried out in other African countries which reported anemia prevalence among pregnant women ranging from 63% in Uganda (Mbule et al., 2013), 62.2% in Egypt (Ibrahim, 2011), 56.8% in Ethiopia (Alene, 2014), 54.6% in Nigeria (Olatunbosum , 2014) and 47.4% in Tanzania (Msuya, 2011) .

This current study findings are however comparable to those reported in a study carried out in Mekelle town in Ethiopia which indicated that the overall prevalence of anemia among pregnant women was 19.7% (Abriha et al., 2014) but higher than the finding of a study carried out in Sudan which reported that only 10% of the study participants had low haemoglobin levels (Enaam et al.,2014).This finding are also comparable to findings reported in a study carried out in Northwest Ethiopia which revealed that the overall prevalence of anemia was 22% as well as with finding reported in a study carried out in Addis Ababa with prevalence of 21.3% (Alem et al., 2013; Jufar & Zewede ,2013).

A study a carried out in Pakistan indicated that 29.1% of the respondents were iron deficient which is slightly higher than the finding in the present study(Ali et al., 2014).The prevalence of anemia among pregnant women in the present study was also found to be lower than anemia prevalence found in studies conducted in other countries including: Northen Ghana (70%), Boditi (61.6%), Eastern Ethiopia (56.8%), Northern Ethiopia **(**36.1%) and (32.8%) in Gamo Gofa Zone, Ethiopia (Addis & Abdulahi,2014; Bekele et al.,2016; Gebre &Afework Mulugeta,2015; Hailu & Zewde,2013; Lellisa et al., 2015; Lokare et al., 2012 ;Melku et al., 2014).

The variations in the results obtained from different studies could be attributed to dietary differences, differences in demographic and socio economic factors between the pregnant women from different regions, population differences, differences in study designs and differences in methodology used in determining iron status. Moreover the contextual factors contributing to anemia among pregnant women are varied. Interactions of several factors such as the women's demographic and socio-economic status, dietary diversity, nutritional and health related factors may contribute to iron deficiency among pregnant women (Abriha et al., 2014; Siteti et al., 2014).

Anemia was found to be a moderate health problem in the present study. Presence of moderate anemia among pregnant women in the present study is of concern because anemia in pregnancy whether mild, moderate or severe is known to have detrimental effect on the health of both the mother and the fetus (Nuzhat et al., 2011). Presence of anemia among the pregnant women in the present study irrespective of a higher proportion of the respondents achieving the minimum dietary diversity would be explained by the fact that other factors apart from dietary diversity affect the iron status among pregnant women .This is in agreement with other studies which have reported that hemoglobin level may be affected by other factors other than dietary diversity among the pregnant women (Kubuga et al., 2016; Mcdonat et al., 2015; Saaka, 2017). However many studies are in agreement that those woman who consume food items from five or more of the ten food groups have a higher likelihood of having a higher micronutrient adequacy. In addition promotion of diverse diets is one of the several approaches to improving micronutrients intake including iron among women of reproductive age including the pregnant women (FAO & FHI 360, 2016; GoK, 2008; Jayawardena, 2013; Kennedy, 2009; Mirmiran, 2006; Ruel, 2003).

5.4 Nutritional status of the pregnant women

In this current study the nutritional status of the pregnant women was established by use of a MUAC tape to measure the mid upper arm circumference of the study participants. A MUAC value below 23 cm was categorised as under nutrition. On the other hand a MUAC value above 23 cm was classified as normal nutritional status (Assefa, 2012; UNICEF 2009; Ververs, 2013). Based on MUAC, more than two third of the respondents (86.6%) had normal nutrition status. Therefore 13.4% of the respondents in this present study were malnourished which is lower than 19.3% of pregnant women who were reported to be malnourished in a study carried out in Laikipia County in Kenya (Willy et al., 2016). This was also lower than 31.7% reported in a study carried out in West Pokot County in Kenya (Kemuto et al., 2013).

The finding of this study are higher than finding reported in a study carried out among Pregnant Women in Southern Ethiopia which reported that (9.2%) of the respondents were undernourished (Ali et al., 2014). The proportion of malnourished pregnant women observed in this study was slightly higher than that reported in study carried out in Pakistan where 12.8% of the pregnant women were undernourished (Kuche1 et al., 2015).The finding in the present study is lower than finding reported in a study carried out in Northern Ghana which reported that 28% of the pregnant women were malnourished (Saaka et al .,2017).

Nutritional status in this current study was associated with dietary diversity (r=0.26, p=0.035) which is in agreement with other studies that have pointed out that dietary diversity scores have been associated with anthropometric outcomes (Kennedy,2009; Willy et al.,2016).This is also in agreement with several studies which have documented that a diversified diet is associated with nutrient adequacy as well as good nutritional status (Jayewardene et al., 2013; Kennedy, 2009; Mirmiran, 2006; Reul, 2004). On the other hand inadequate intake of essential nutrients causes malnutrition among pregnant women (Olumakaiye, 2013).

5.5 Micronutrients supplementation among pregnant women

In the current study most of the participants reported to be taking iron and folic acid (IFAS) with highest proportion taking the supplements daily which is higher than finding recorded in the study conducted in Kenya which reported that about 8% of pregnant women ingested iron and folic acid tablets for 90 day or more in their recent pregnancy,5% reported to have taken the iron supplement for 60 -89 days and 53%

reported to have taken the IFAS for less than 60 days while 30% of the women reported not to have taken the IFAS at all (KNBS & ICF macro 2015). Similarly the number of pregnant women taking IFAS in the current study is higher than numbers reported in a study conducted in West Pokot where only 26.9% were consuming the IFAS (Kemuto et al.,2013).This finding may differ because the supplements were readily available in the facility where the current study was carried out.

Irrespective of the high consumption of IFAS observed in the current study, 20.1% of the study respondents were found to be anaemic. Some studies have shown that supplements may not consistently decrease the incidence of iron deficiency anaemia among women who have entered the pregnancy with low haemoglobin levels and low iron stores thus anaemia during pregnancy can be decreased considerably if supplementation is started before conception (Hassan et al., 2014). Regardless of varying study outcome, routine iron supplementation reduces incidences of iron deficiency anaemia during pregnancy and should be practiced and emphasized (Hassan et al., 2014). Regarding accessibility to iron fortified food, 92.1% of the respondents in this current study reported to have access to iron fortified food.

5.6 Morbidity and health seeking behavior among the respondents .

On the morbidity and maternal health seeking behaviour a small proportion of the study participants reported to have been sick in the last two weeks with majority reporting to have suffered from malaria. A small proportion reported to have suffered from sexually transmitted infections and respiratory tract infections while others reported to have suffered from other sickness. A higher proportion of those who reported to have been sick reported to have sought medical care from a government hospital. Only a small proportion reported to have visited private clinic or bought medicine from the chemist.

In this present study morbidity among the pregnant women was significantly associated with the iron status (HB) and nutrition status (MUAC) .This concurs with other studies which have pointed out that morbidity affects the nutritional status as well as iron status of pregnant women directly and is an immediate cause of malnutrition (Fatima, 2014; UNICEF, 2010). This also in agreement with another study which pointed out that morbidity affects food intake, nutrient absorption as well as the utilization of the nutrients leading to poor nutritional status (Pieters et al.,2013). On the other hand poor maternal nutritional status and anaemia are major causes of morbidity during pregnancy (Fatima et al., 2014).

5.7 Antenatal clinic attendance of the respondents

Antenatal clinic attendance has been found to be important in order to prevent negative pregnancy outcomes and it is recommended to be started early enough and continued throughout until delivery (KBNBS & ICF macro, 2010; KDHS, 2014). Antenatal care has been seen as an important entry point for the implementation of health and nutrition interventions aimed at improving maternal nutrition status and iron status (Perumal et al., 2013). Health professionals recommend that the first antenatal visit occurs within the first three months of the pregnancy and also recommends that the women with no complications during the pregnancy should attend at least four ante natal clinics with the first visits taking place in the first trimester. According to KDHS (2014) report, 99.2% of pregnant women obtained antenatal care from a qualified health provider. More than half of the current study participants reported to have attended their first ANC clinic in their second trimester while a small proportion reported to have started the ANC clinic in their first and third trimester.

The major purpose of antenatal care in pregnancy is mainly to detect early enough and therefore treat problems such as anaemia, infections and other diseases (KDHS, 2014).According KDHS (2014), 99.2 % of pregnant women in Embu received ANC from a qualified health provider and about 56.3% made four or more ANC visits. In the current study only 8.6% of the respondent had four or more ANC visits. This is far much lower than 56.3% who made four or more visits in Embu County in the KHDS (2014). This may be attributed to the fact that most of the participants (65.2%) in this present study reported to have started their first ANC visit in the second trimester. In the present study the gestational age at which the ANC visit was started was significantly associated with iron status of the pregnant women.

5.8 Relationship between study variables.

5.8.1 Relationship between dietary diversity and demographic and socio economic factors

In the present study, marital status was significantly correlated to dietary diversity. Concurring with another study that demographic characteristics such as marital status are positively associated with dietary diversity (Nuzhat, 2011). On the other hand negative relationships were noted between dietary diversity and maternal age. Socio economic characteristics, such as education and income level affects access to a diverse diet. Education determines the lifestyle and the position a person enjoys in the society. This present study established a positive relationship between the pregnant women education level and their dietary diversity score. This is in agreement with other studies that have shown that educational attainment has a strong effect on the dietary practices of an individual (Ali et al .,2014; Savy et al., 2008;Torheim et al., 2004).The findings of the current study are also in agreement with other studies conducted by Nord (2007); Tiyou et al., (2012), Walingo & Kidake (2013), which found out that more educated people tend to get better jobs or engage in quality enterprise that generate more income and hence tend to have access to diverse diet.

Fatima et al (2014), also reported that dietary practices have been positively related to demographic and socio economic factors such as parity, education and occupation. Increased education has been correlated with a health, balanced and diverse diet among pregnant women. Other studies have found a significant association between the monthly income, education level of the women to dietary diversity (Chowdhuny et al 2015,Saaka et al.,2017) .In contrast, women who are less educated, are not working and have high parity are more likely to consume diets that are unhealthy and monotonous (Fatima et al., 2014; Northstone et al., 2007).

This study found a positive significant relationship between the level of income and dietary diversity. The findings of the current study are in agreement with other studies which have documented that income is an important aspect in accessing a diverse diet (Aidoo et al., 2010; Bukusuba et al., 2007).The finding of this study are also in agreement with the finding that income, education and occupation are important socio-economic indicators that determine the access to diverse diet (Abriha et al.,2014; Chowdhuny et al.,2015; Gebre & Mulugeta,2015; Saaka et al.,2017).

Education more often than not determines type of occupation one engages in. People with post-secondary training often have access to formal employment compared to those with secondary education or lower (Nord, 2007; Tiyou et al., 2012; Walingo & Kidake 2013). Majority of the respondent in the present study had only secondary or primary education and were self-employed mainly in small scale businesses.

In conclusion the current study findings demonstrated that; education level was significantly associated with dietary diversity of the study participant (χ^2) =16.17, p= 0.042) and that a significant positive relationship (r =0.39, p=0.047) was found between the income level and the dietary diversity of the participants. These findings are in agreement with other studies that have found out that dietary diversity is associated with socio-economic factors such as education and income. Increasing education and income has been associated with a diet that is diverse. Never the less, women who are less educated and are not working are more prone to non-diverse diet (Okube et al., 2016; Northstone et al., 2007).

5.8.2 Relationship between dietary diversity ,iron intake and iron status

A positive significant relationship was found between dietary diversity and iron intake (r=0.57, p=0.038) of the respondents. A positive significant relationship was also found between iron intake and haemoglobin level (r=0.54, p=0.031). Those pregnant women who were consuming more dietary iron were likely to have a higher iron status. There was also a positive significant relationship between haemoglobin level and dietary diversity (r=0.48, p=0.041). This concurs with findings of a study conducted in Northern Ghana which found out that dietary diversity of pregnant women is significantly associated with haemoglobin level (Saaka & Rauf ,2015) .However this finding is in contrast with finding of another study carried out in Northern Ghana which indicted that haemoglobin level of pregnant women was not associated with maternal dietary diversity (Saaka et al.,2017) .A positive significant relationship was also found between dietary diversity and nutritional status of the study participants (r=0.26, p=0.035).

All these positive significant correlations in this present study are in agreement with other studies which have shown that a diversified diet is associated with nutrient adequacy as well as good nutritional status (Jayewardene et al 2013; Kennedy, 2009; Mirmiran, 2006; Reul, 2004). It also concurs that dietary diversity is essential to nutrient adequacy as there is no single food that may contains all of the essential nutrients that are needed for good optimal health and good nutritional status (Kennedy, 2009). Moreover when an individual consumes different foods or food items among and within the various food groups it promotes sufficient intake of essential micronutrients from the diet (Allen, 2008; FAO/WHO, 2002, Kennedy, 2009).

5.8.3 Relationship between iron status and demographic and economic factors of the rspondents

The iron status of the study participants had a positive significant relationship with parity (r=0.218, p= 0.005). This finding is similar to finding obtained in a study by Alem et al., (2013), where significant association between anemia and number of children was observed. The iron status of the pregnant women in this study was insignificantly associated with marital status (χ^2=3.074, p=0.380) of the pregnant women. These findings are in contrast with findings reported in a study done in Ethiopia which reported that marital status of the pregnant women showed a significant association to maternal anemia (Abriha et al., 2014).

No significant relationship was found between haemoglobin level and gestation age (r=0.011, p=0.893) and between haemoglobin level and maternal age (r=0.0138, p=0.078) in the present study. This finding is in contrast with findings from other studies which have shown that the possibility of developing anaemia rises with maternal age as well as gestational age (Adinima, 2002; Gebremedhin, 2014, Hinderaka, 2001; Morsy, 2014; Odimu, 2002, Okube et al., 2016).

In the present study the level of education of the pregnant women was association with hemoglobin level (χ2=2.282, p=0.682) although the association was not statistically significant ($p>0.05$). These findings are in contract with findings reported in a study carried out in Northern Ghana which revealed that low maternal educational level significantly predicted anemia and that women who had higher education level were less likely to be anemic while those with low education were more likely to be anemic (Saaka et al., 2017).This finding is also in contract with finding of Chowdhuny et al (2015) & Erlindawati et al (2008) in which literacy of the pregnant women had a significant association with maternal anemia. The finding are also not in agreement with another study that was carried out in China that demonstrated that the level of education was statistically associated with anemia ($p = 0.005$) (MA AG, 2009). Insignificant association (χ^2=5.36, p=0.605) was also found between iron status and the occupation of the pregnant women.

The finding of this present study revealed that the monthly income of the respondents had a significant association with iron status (χ^2=16.814, p=0.019). This finding is supported with the finding of a study carried out in Pakistan which showed anemia was more prevalent among the low-income group (Rukhsana et al., 2008).Wealth index of the respondents in the present study was also positively related to iron status (r=0.34, p=0.014). This finding is in contract to finding reported in a study conducted in

Northern Ghana which found out that household wealth index was negatively associated with anemia (Saaka et al., 2017).

5.8.4 Relationship between iron status and dietary diversity

Hemoglobin level of the pregnant women in this study was significantly associated with their dietary diversity (r=0.48, p= 0.04).This finding is in agreement with a study done in nine regional states of Ethiopia which found that anemia was significantly associated with dietary diversity (Abriha et al., 2014) but contrary to studies carried out in Ghana and Pakistan which revealed that dietary diversity was not associated with heamoglobin level (Ali et al., 2014; Saaka et al., 2017). Other studies have reported lack of association between dietary diversity and hemoglobin level especially in environments where other factors other than dietary intake affect hemoglobin level among the pregnant women (Kubuga et al 2016; Mcdonat et al 2015; Saaka et al., 2017).Dietary iron intake of the respondents was significantly correlated to the iron status of the respondent (r=0.54, p=0.031) in the present study.

5.8.5 Relationship between morbidity, nutrition status and iron status

Sickness is a direct factor that affects the iron status and nutrition status of the pregnant women. In this study, morbidity, specifically malaria was a key contributing factor as reported by 48.4% of those who had reported to have been sick in the two weeks prior to the study. Morbidity was significantly associated with iron status (χ^2) =7.78, p=0.034) in the present study. This study finding are comparable to a study carried out in Northwest Ethiopia that revealed that presence of parasitic infections especially hookworm was significantly associated with anemia in pregnant women. Anemia was also significantly associated with history of malaria attack in the same study (Alem et al., 2013). In the present study presence of illness was associated with low hemoglobin (χ^2=4.8, p=0.034). This compare well with finding reported in a study which found a significant association between iron status based on hemoglobin level and presence of illness (χ^2 =3.325, p=0.005) (Kemuto et al., 2013).

In the present study morbidity had a significant association with nutritional status (χ2 =1.3, p=0.025) of the study participants.The finding of the present study concurs with other studies which have shown that morbidity affects the nutritional status as well as iron status of pregnant women negatively and is an immediate cause of malnutrition (Fatima et al., 2014; Olumakaiye, 2013; UNICEF, 1990). However these findings are in contrast with findings reported in another study which found no significant relationship between morbidity pattern and nutritional status (χ^2 = 0.348, p=0.555) (Willy et al., 2016).The same study also found no significant relationship between morbidity pattern and hemoglobin level (χ^2=0.059,p=0.808) among pregnant women (Willy et al., 2016).However when logical regression was performed in the present study it showed that 38% (R=0.6153;R^2=0.378;p=0.000) of hemoglobin level could be explained by dietary iron intake while controlling for supplementation and morbidity as confounding variables.

From the findings of the present study it can be concluded that factors associated with iron status among pregnant women are multiple with the parity being the main demographic factor significantly associated with iron status in this study. Gestational age when the pregnant women started attending ANC clinic is also a major factor that is significantly associated with iron status of the pregnant women in this study. Monthly income and wealth index are the socio economic factors significantly associated with iron status in the present study. Dietary diversity was positively related to the iron status of the study participants. When controlling for morbidity and supplementation as the confounding variables dietary iron intake is the major determinant of iron status among the pregnant women in the present study.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter summarizes the study findings and the main conclusions made from the study findings. This chapter also outlines the recommendations based on the study finding for the policy, practice and for further research.

6.1 Summary

The mean age of the study population was 27±5.3 years. More than three quarter of the pregnant women were married. About two thirds of the study participants had completed secondary education while almost one third had completed primary education. Most of the study participants reported to be earning an income with majority earning less than KES.10, 000. Most of the study participants were involved in small scale businesses. Only a small proportion of the study participants were in formal employment. Most of the participants were in the second, low or middle wealth quartile.

About three quarter of the study participants (72.6%) had met MDD-W while a quarter of the study participants (27.4%) had not met the MDD-W. Based on food groups the grains, white roots and tubers and plantains, and other vegetables were the most consumed food groups among the study participants. Meat, poultry and fish, nuts and seeds were the least consumed food group. Based on food frequency, food rich in haeme iron such as fish, chicken, flesh meat and liver were not regularly consumed while cereals were regularly consumed. Milk was regularly consumed in form of tea. Tea was regularly consumed with a number of respondents reporting to consume it along with meals. Fruits and vegetables were regularly consumed.

On the prevalence of anaemia, 20.1% of the study participants were anaemic while 45.7% were not meeting their recommended daily allowances for dietary iron. In regard to the other nutrients adequacy more than 50% of the respondents were meeting their dietary requirement for zinc, vitamin B^2, folic acid and vitamin B^1, selenium, calcium, protein and energy. Most of the study participants were consuming iron and folic acid supplements with majority of the respondents consuming the supplement on daily basis. Majority of the respondents (86.6%) had a normal MUAC of 23cm or more.

6.2 Conclusions

Marital status was positively correlated with dietary diversity. Socio economic characteristics such as education level and monthly income had a significant positive relationship with dietary diversity of the study participants.

Parity in the present study was found to have a positive significant relationship with the haemoglobin level of the pregnant women. Monthly income and wealth index were found to have a positive significant relationship with the haemoglobin levels of the pregnant women.

In the present study dietary diversity had a significant positive relationship with haemoglobin level of the study participants. Iron intake in the present study was found to have a significant positive relationship with haemoglobin levels of the study participants. Iron intake was found to have a positive significantly relationship with dietary diversity of the pregnant women.

Nutritional status of the pregnant women in the present study was found to have a significant positive relationship with dietary diversity of the pregnant women.

Morbidity among the study participant in the present study was found to be significantly associated with the haemoglobin levels of the pregnant women.

Based on the relationships observed between the different variables in the present study, all the study hypothesis were rejected.

From the finding of the current study, it can be concluded that (20.1%) of the study participants were anaemic, 13.4% were undernourished and 27.4% had not met the MDD-W while 45.7% were not meeting RDA for dietary iron. Most of the study participants were married. Majority of study participants had a null or single parity. Majority of the participants were below 30 years of age.

Iron status was significantly correlated to iron intake, dietary diversity, parity, monthly income, wealth index, gestational age when ANC clinic was started and presence of illness. Dietary diversity was positively correlated to level of education, income level, marital status, iron status, nutritional status and iron intake. Iron intake was associated with dietary diversity and iron status. Nutritional status was significantly correlated to dietary diversity, morbidity and maternal age.

6.3 Recommendations of the study

The study recommendations for policy, practice and further research are given to the nongovernmental organizations, the government of Kenya, the ministry of health, the ministry of youth and gender, Embu County government through the ministry of health, health care facilities, health service providers and women of reproductive age.

6.3.1 Recommendation for for policy

The study findings have demonstrated that factors such as education, monthly income and wealth index affect dietary diversity among pregnant women. Therefore the government of Kenya should enact new and improve existing policies on access to education especially among girls and women because increase education could translate to better income and therefore better economic status.

Majority of the respondent were self employed and involved in small scale business. As such the governments of Kenya through the ministry of youth and gender need to support the women to strengthen their businesses in order to generate adequate income that will enable the women to access a diverse diet.

Most of the respondents were in the lower wealth quintile therefore appropriate policies by the policy makers in both the national government and county government need to be enacted to improve the living standard of the women.

Dietary diversity has been shown to be significantly associated with iron intake and iron status in this study. Therefore the policy makers and policy implementers at the health facilities level need to create more awareness on the importance of consuming a diverse diet throughout the pregnancy.

Parity has been shown to be significantly associated with iron deficiency anemia therefore more awareness need to be created on the need to reduce the number of children as well as spacing the pregnancies in order to prevent iron deficiency in pregnancy.

Morbidity is a major contributor of poor nutritional status and anemia among the pregnant women. It is therefore recommended that the government through the ministry of health and other stake holders enhances public awareness on the importance of seeking medical care for early identification and treatment of diseases and infections.

The gestation age when antenatal care clinic is started has been shown to be significantly related to iron status. Therefore the government and other stakeholders need to create more awareness on the importance of starting ANC clinics as earlier as in the first trimester to ensure that all micronutrients are given on time since micronutrient supplementation in this study significantly correlated with iron status of the pregnant women.

6.3.2 Recommendations for practice

The study has revealed that dietary iron intake has a positive relationship with the iron status of the pregnant women. It is therefore paramount that the health facilities through the health service provider promote regular consumption of heme iron rich food such as meat, poultry and fish through regular talks on the importance of dietary diversity among the pregnant women during the routine ANC visits in all health facilities.

Dietary diversity has been found to have a significant relationship to the iron intake, iron status and the nutritional status of the pregnant women in this study. The health service providers especially the nutritionist and dieticians have an important role in educating women of reproductive age on the importance of consuming a diet that is diverse in order to prevent iron deficiency anemia and thus achieve optimum nutritional status for positive pregnancy outcome. Therefore regular consumption of a diverse diet among the pregnant women should be enhanced through regular talks and demonstrations in ANC visits in all health facilities.

6.4 Recommendations for further research

A similar study on the iron status among pregnant using more parameters such as serum ferritin, Serum iron, transferrin and transferrin saturation and Serum transferrin receptors to measures different aspects of iron status among pregnant women.

Longitudinal study on the dietary diversity, nutrients intake and iron status and its impact on the pregnancy outcome is strongly recommended. On the same note since there is limited information in the country on dietary diversity, iron intakes and iron status during pregnancy further research in other counties is highly recommended.

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APPENDICES

APPENDIX A: Informed consent

Dear Respondent;

My name is Nicoleta Muthoni Mwaniki. I am a MSC research student from Kenyatta University. I am conducting a study on dietary diversity, iron intake and iron status among pregnant women in Embu County.

The purpose of the study

The purpose of the study is to assess the dietary diversity, dietary iron intake and iron status and establish whether there is any relationship between the dietary diversity and nutritional status of the pregnant women and also establish whether there is a relationship between dietary intake and iron status and as well as whether there is a relationship between dietary diversity and socio- economic status of pregnant women.

Procedure to be followed

Participation in this study will require that I ask you some questions on the types of food you have eaten for the last 24 hours and other socio economic questions. Your MUAC measurement will also be taken on the left hand to measure your nutritional status by the nutritionist and 4ml of blood sample will be collected from your arm by the lab technologist to measure total blood count. The information from you will be recorded in a questionnaire.

You have the right to refuse participation in this study. You will get the same care and medical treatment whether you agree to join the study or not and your decision will not change the care you receive from the hospital today.

Remember participation in the study is voluntary and no payment or gifts will be offered to those who will participate in the study. You may ask questions related to the study at any time and you may refuse to respond to any question. You may stop the interview at any time without any consequences to the service you receive from this hospital today or in the future.

Discomforts and risks

All the procedures to be performed are safe and will not harm you or the unborn baby. There are no risks associated with the study to either you or the unborn baby. You may experience some discomfort during drawing of blood. The interview may add approximately half an hour on the time you wait before you receive you routine services.

Benefits

If you participate in this study you will be able to know your complete blood count, your nutritional status as well as you dietary diversity score.

Protection of the research participant's confidentiality

The interviews and examinations will be conducted in a private setting within the hospital. You name will not be recorded on the questionnaire. The questionnaires will be kept in a safe locked cabinet and everything will be kept private. The information collected from the research will be confidential and will not be used for any other purposes other than in this research.

Community considerations

In case you have low dietary diversity or your iron status is insufficient or your MUAC is low than recommended you may be advised on how to modify your diet in order to meet your dietary requirement or you may be referred to MCH nutritionists for further assistance.

Contact information

If you have any question you may contact:

Dr Peter Chege on 0722642356 or Dr Ann Munyaka 0712108087 or the Kenyatta University Ethical Review Committee on kuerc@ku.ac.ke

Participant statement

The above information regarding my participation in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that my records will be kept private and that I will get the same care and medical whether I decide to leave the study or not.

Name of the participant……………………

signature/thumbprint__________DATE ______________

Investigator's statement,

I the undersigned have explained to the volunteer in a language she understands the procedures to be followed in the study and the risks and benefits involved.

Name of interviewer ___________signature______Date_________

APPENDIX B: Structured questionnaire;

For the pregnant women respondents.

Questionnaire NO------Date--------Name of the respondent-------Name of county…Name of district……Name of division………Name of location……Name of the village…………Name of interviewer……… ……….

SECTION A*:*

Part 1: Demographic and socio economic characteristics of pregnant women.

1. **Age**: Age in years 1.15-19, 2.20-24,3.25-29,4.30-34,5.35-39,6.40-44
2. **Parity**: 1.0-1, 2. 2-3, 2. 4-5, 3.5-6, 4.7-10 and above
3. **Marital status**: 1.married, 2.not married, 3.single mother, 4. Separated 5.divorced 6, windowed.
4. **Education Level**:1.none, 2.preschool, 3.std 1-4, std 4-8 ,5.form 1-4 , 6.technical, 7.certificate, 8 diploma ,9.Any other (specify)
5. **Occupation**: 1. Farmer, 2. Business, 3 Causal worker, 4.housewife, 5.civil servant , 6.private sector,6.school going, 7.unemloyed, 8.any other specify.
6. **Income: income per month** 1, <2000, 2, 2001-4000, 3, 4001-6000, 4, 6001-8000, 5, 8001-10000, 6, 10001-2000. 7,Above 20,000
7. **Source of income**: 1.sale of cash crop, 2.sale of food croup, 3.sale of livestock,4.bussiness, 5.casual labour, 6.sale of milk, 7.formal employment ,8.no income ,9.Any other----------------- (specify).

Part 2: Socio-economic characteristics of the respondent's household

I. Who owns the house you stay in? 1. Owned 2. Rented 3. Other-------------

II. What material is the Wall of the house made of? 1 .Mud and wooden poles 2. Un-burnt mud bricks 3. Cement or stone blocks 4. Iron sheets 5. Timber 6. Other (specify)__________

III. What kind of Roof is your house you made of? 1. Papyrus/grass 2. Iron sheets 3. Tiles 4. Others (specify_)_______

IV. What material is the floor of your house made of ?1.cement 2.timber 3.earthen

V. What do you use as the Source of Lighting**?** 1**.** Fire 2. Kerosene burner 3. Kerosene lamp 4. Gas lamp 5. Electricity 6. Solar 7. Candle 8 .Other (specify)

VI. What do you use as the source of cooking fuel? 1. Firewood 2. Kerosene 3. Charcoal 4. Gas 5. Electricity 6. Other------------

VII. (Assets ownership____

Assets owned (Please tick)	Number	Assets owned	Number
1.TV		8.Sofa set	
2.Radio		9.Cattle	
3.VCD/DVD		10.Poultry	
4.Phone		11.Goats	
5.Bicycle		12.Sheep	
6.Motocycle		13.Farm	
7.Car		14.Donkey	

SECTION B: Dietary diversity questionnaire for the pregnant women respondents (Adopted fromFAO,2011; FAO & FHI 360, 2016).

PART 1:

Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning up to the last meal of the day before going to sleep (FAO, 2011).

Breakfast	**Snack**	**Lunch**	**Snack**	**Dinner**	**Snack**

Part 2: Dietary diversity food groups

Please write down (1) if any food was consumed in the last 24-hour period in the given food group and write (0) if none of the food was consumed in the given food group(**FAO,2011; FAO & FHI 360, 2016).**

A	food made from grains	examples of food items	Consumed YES=1 NO=0
A	Food made from grains	Maize, rice, wheat, sorghum, millet or other grains or foods made from these (e.g. bread, chapattis, andazi, cakes, biscuit samosa, pancakes noodles, spaghettis porridge/uji,ugali)	
B	White roots and tubers and plantains	White potatoes, white yams, white cassava, arrowroots or white sweet potatoes other food made from roots, green bananas	
C	Pulses(beans, peas and lentils	Dried beans, dried peas, green grams, cowpeas, lentils, soy beans	
D	Nuts and Seeds	Any tree nuts, groundnuts/peanuts, seeds or food made from these(e.g. peanut butter),coconuts	
E	Milk and milk	Milk, cheese, yogurt or other milk product but not	

	product	including butter, ice cream, cream or sour cream	
F	Organ meat	Liver, kidney, heart or other organ meats or blood-based foods, including game	
G	Meat and Poultry	Beef, pork, lamb, goat, rabbit, wild game meat, chicken, duck or other bird	
H	Fish and sea food	Fresh or dried fish, shellfish or seafood	
I	Eggs	Eggs from chicken, duck guinea fowl or any other egg	
J	Dark green leafy vegetables	Dark green leafy vegetables, including wild forms plus vitamin A rich vegetables such as amaranth, cassava leaves, kales, spinach, pumpkin leaves, Kunde, arrowroots leaves, managu thatha, masecondary,	
K	Vitamin A-rich vegetables, roots and tubers	Pumpkin, carrots, squash or sweet potatoes that are yellow or orange in color and other locally available vitamin A rich vegetables	
L	Vitamin A rich fruit	Ripe mangos, ripe papaya, and 100% juice made from these juices plus other locally available vitamin A rich fruits.	
M	Other vegetables	Other vegetables (e.g. tomatoes, onions eggplant)plus other locally available vegetables, cabbage,courgette ,cucumber, green peas, French beans, beetroots	
N	Other fruits	Other fruits, including wild fruits and 100% fruit juices made from passion guava, plums, pears, apple,watermelon,pineapple,ripebananas,avocado, oranges,lemon,strawberry,kiwano,tree tomato	
O	Other oils and fats	Oil, fats or butter added to food or used for cooking, margarine, including oil from nuts, fruits and seeds and animal fat	

P	Spices condiments ,beverages	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, cocoa, chocolate alcoholic beverages.	

SECTION C: PART 1: 24 hour recall

Starting from morning to evening yesterday, please name all foods and drinks that you consumed as well as the amounts that were prepared.

meal	Time	Place eaten (Home/ out)	Food or drink	Detailed description of food item and preparation method	Amount eaten	Weight Equivalent (grams)	Food code
Break -fast							
Snack 1							
lunch							
Snack 2							
supper							

snack 3							

PART 2: Food frequency table

State the frequency of the consumptions of the selected food items by week

Food items	Freq per week	Food item	Freq per week	Food item	Freq per week week	Food item	Freq per week
Maize		Sweet potatoes		carrots		Lemon	
Maize flour		Beans		Mangoes		Pineapple	
Wheat flour		Thoroko (cowpea)		Passion fruits		Kiwano	
Rice		Ndengu		Plums		Tree tomato	
Sorghum		Dried peas		Ripe bananas		Kales	
Millet		Lentils/ kamande		Oranges		Cabbage	
Irish potatoes		Groundnut s		Guava		Spinach	

Yam		Peanut		Water melon		Terere /amaranth	
Cassava		Soybeans		pears		Pumpkin leaves	
Arrowroot		Coconuts		Spices		Mathoroko(kunde)	
Green /raw bananas		Avocado		sweets		Maseconday	
Pumpkin		Pawpaw		Sugar		Arrowroot leaves	
Carrots		supplemen ts		Soda		Tomatoes	
Beet roots		omena		Sausages		Onions	
Eggs		fish		Chips		Eggplants	
Liver Meat		chicken		Cakes /doughnut		Cucumber	
Milk/milk product		herbs		Samosa		Courgette	
Tea		coffee		biscuits		French beans	

Cocoa		chocolate		Alcoholic beverage		Green peas	

SECTION D: HB levels and nutritional status (MUAC) and dietary diversity(MDD-W)

NAME	AGE	MUAC	Gestation period weeks	HB	MDD-W

1, HB Levels: >11.0 g/dl non anemic, 10.0-10.9 mild, 7.0-9.9 g/dl moderate, <7.0 g/dl severe

2, MUAC less or equal to 23; malnourished, MUAC more than 23 well nourished

3, MDD-W consumption of >5 food group meeting MDDW, consumption<5 food groups not meeting MDD-W

SECTION E: PART 1: **Antenatal clinic attendance and morbidity**

1. At what gestation period did you start attending antennal clinic?

1=first trimester, 2= second trimester, 3 =third trimester

2. How many times have attended antenatal clinic 1=once,2=twice,3= three times,4= four times,5=more than 4 times
3. Have you been sick in the last two weeks? 1=yes 2= no

4. If yes what illness were you suffering from? 1=malaria,2= worms infestation, 3=sexually transmitted illness, 5= others
5. Did you seek medical assistance? 1=yes ,2 = no
6. If yes where did you seek medical assistance? 1= government hospital/dispensary,2=private clinic, 3= bought medicine from chemist shop, 4=traditional healer ,5= others

Part 2: Micronutrient supplementation

1. Have been taking any micronutrient supplement for the last two weeks? 1=YES 2=NO
2. If yes which ones? 1 = iron and folic pills 2=multiple micronutrient tablets, =.any other specify …………………..
3. Do you take the supplement daily? 1= YES , 2= NO
4. If NO why? 1 =. Due to bad taste, 2= Forgetting, 3= I do not see the importance 4= not available in the clinic, 5=1st visit 6= Have the completed dose, 7=others specify…………………..
5. Do you have access to iron fortified food? 1=processed wheat and maize flour, 2.others specify.........

FOCUS GROUP DISCUSSION

1. Which is the commonly consumed food in this area?
2. What factors determine the food that you eat?
3. Is there special food for pregnant women in this area
4. Are pregnant women forbidden or discouraged from consuming certain foods in this area?
5. If yes which are these foods?
6. Are their beliefs and attitudes that certain foods are unsuitable for pregnant women?
7. If yes which are these foods?
8. In your opinion are the diets consumed by pregnant women diversified?
9. What do you think can be done to help the pregnant women achieve dietary diversity
10. What are the possible ways do think can be put in place to reduce malnutrition levels during pregnancy?

APPENDIX C:Food consumption of respondents based on food frequency

Meats	***(n)***	***(%)***	***Median***	***range***
Fresh meat	46	28	3	0-6
Fish	12	7.3	2	0-4
Poultry	5	3	1	0-3
Liver	30	18.3	3	0-6
Eggs	52	31.7	3	0-6
Milk	77	47	3.5	0-7
Beverages, sweets and spices	***(n)***	***(%)***	***median***	***range***
Tea	135	82.3	3.5	0-7
Chocolate	76	46.3	3	0-6
Cocoa	36	22	3	0-6
Coffee	12	7.3	2.5	0-5
Sugar	84	51.2	3.5	0-7
Soda	73	44.5	3	0-6
Alcohol	18	11	2	0-4
Sweets	21	12.8	2	0-4
Biscuits	17	10.5	2	0-4
Cakes	30	18.3	3	0-6
Spices	8	21	3	0-6
samosas	37	22.6	3	0-6
sausages	26	15.9	2	0-4
Chips	12	11	2	0-4
Fruits	***n***	***%***	***median***	***range***
Oranges	70	42.7	3.5	0-7
Lemons	4	7.8	2	0-4
Passion	54	33	3.5	0-7
Guava	54	32.9	3.5	0-7
Pineapples	17	10.4	2	0-4
Pawpaw	64	39	3	0-6
Mangoes	46	28.1	3	0-6
Ripe bananas	60	36.6	3.5	0-7
Water melon	23	14	2.5	0-5
Plum	33	21.1	3	0-6
Pears	32	19.5	2.5	0-5
Avocado	20	12.2	2	0-4
Thorn melon	15	9.2	2	0-4
Tree tomato	24	14.6	2	0-4
Legumes	***n***	***%***	***median***	***range***
Cowpeas	44	26.8	3	0-6
Beans	41	25	3	0-6

Dried peas	17	15.7	2.5	0-5
Njahi	18	11	2	0-4
Green grams	23	14	3	0-6
Soy beans	6	3.7	2	0-4
Lentils	6	3.7	2	0-4
Nuts	***n***	***%***		
Ground nuts	14	8.5%	2	0-4
Coconuts	6	3.7	2	0-4
Vegetables	***(n)***	***(%)***	***median***	***range***
Terere	61	37.2	3	0-6
Spinach	60	36.6	3	0-6
Pumpkin leaves	44	26.8	3	0-5
Kales	42	25.6	3	0-6
Kunde	21	12.8	2	0-4
Masecondary	11	6.7	2	0-4
Arrowroot leaves	7	4.3	2	0-4
Other vegetables	***(n)***	***(%)***	***median***	***range***
Tomatoes	71	48.2	3.5	0-7
Cabbage	57	34.8	3	0-6
Onions	149	90.9	3.5	0-7
Egg plant	78	47.6	3	0-6
Beetroots	6	3.7	2	0-4
Cucumber	5	3.1	2	0-4
Courgette	6	3.7	2	0-4
French beans	6	3.7	2	0-4
Green peas	6	3.7	2	0-4
Cereals	***(n)***	***(%)***	***median***	***range***
Maize	126	76.8	3.5	0-7
Maize flour	85	51.8	3.5	0-7
Millet	115	70.1	3.5	0-7
Sorghum	122	74.4	3.5	0-7
Wheat flour	57	34.8	3	0-6
Rice	109	66.5	3.5	0-7
Roots and tubers	***(n)***	***(%)***	***median***	***range***
Irish potatoes	64	58.6	3.5	0-7
Sweet potatoes	24	14.6	2	0-6

Yams	21	12.8	1.5	0-3
Cassava	21	12.8	1.5	0-3
Arrowroots	16	9.8	1.5	0-3
Green bananas	49	29.9	2	0-4
Pumpkins	46	28	2	0-4
Carrots	96	58.5	3.5	0-7

APPENDIX D: Clearance from Kenyatta university graduate school

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

OUR REF: H60/CE/26454/11

DATE: 29th May, 2014

The Permanent Secretary,
Ministry of Higher Education, Science & Technology,
P.O. Box 30040,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MS. NICOLETA M. MWANIKI REG. NO. H60/CE/26454/11

I write to introduce Ms. **Mwaniki** who is a Postgraduate Student of this University. She is registered for M.Sc. Degree programme in the **Department of Foods, Nutrition & Dietetics in the School of School of Applied Human Sciences.**

Ms. **Mwaniki** intends to conduct research for a proposal entitled, **"Dietary Diversity, Iron Intake and Iron Status among Pregnant Women in Embu County, Kenya".**

Any assistance given will be highly appreciated.

Yours faithfully,

KENYATTA UNIVERSITY OFFICE OF DEAN 29 MAY 2014 GRADUATE SCHOOL P.O. Box 43844-00100 NAIROBI

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL

JMO/cao

Committed to Creativity, Excellence & Self-Reliance

APPENDIX E: Clearance from ethics review committee

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Email: chairman.kuerc@ku.ac.ke
secretary.kuerc@ku.ac.ke
ercku2008@gmail.com
Website: www.ku.ac.ke

P. O. Box 43844 - 00100 Nairobi
Tel: 8710901/12
Fax: 8711242/8711575

Our Ref: KU/R/COMM/51/357

Date: 29th September, 2014

Nicolete Muthoni Mwaniki
Kenyatta University,
P.O Box 43844, Nairobi.

Dear Muthoni,

RE APPLICATION NUMBER PKU/226/I 202- "DIETARY DIVERSITY, IRON INTAKE AND IRON STATUS AMONG PREGNANT WOMEN IN EMBU COUNTY, KENYA", VERSION 2.

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic **"Dietary diversity, iron intake and iron status among pregnant women in Embu County, Kenya"**, version 2, received on 24th September, 2014.

2. APPLICANT
Nicolete Muthoni Mwaniki, Department of Food, Nutrition and Dietetics.

3. STUDY SITE
Embu County, Kenya.

4. DECISION
The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines **AND APPROVED that the research may proceed for a period of ONE year from 29th September, 2014.**

5. ADVICE/CONDITIONS
   i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
   ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
   iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
   iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

KENYATTA UNIVERSITY
OFFICE OF THE CHAIRMAN
29 OCT 2014
ETHICS REVIEW COMMITTEE
P. O. BOX 43844 - 00100 NAIROBI

PROF. NICHOLAS K. GIKONYO
CHAIRMAN ETHICS REVIEW COMMITTEE

I NICOLETA MWANIKI ...accept the advice given and will fulfill the conditions therein.

Signature........................ Dated this day of 21/10/2014 ...... 2014.

cc. Vice-Chancellor
Director: Institute for Research Science and Technology

APPENDIX F: Research Authorization from NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/15/1901/4761**

Date: **16th February, 2015**

Nicoleta Muthoni Mwaniki
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Dietary diversity and iron intake status among pregnant women in Embu County, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Embu County** for a period ending **31st December, 2015.**

You are advised to report to **the County Commissioner, the County Director of Education and the County Coordinator of Health, Embu County** before embarking on the research project.

On completion of the research, you are required to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Embu County.

The County Director of Education
Embu County.

APPEDEIX G: Research permit

CONDITIONS

1. You must report to the County Commissioner and the County 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 without 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) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 4260

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MS. NICOLETA MUTHONI MWANIKI
of KENYATTA UNIVERSITY, 0-60100
EMBU,has been permitted to conduct
research in *Embu County*

on the topic: *DIETARY DIVERSITY IRON INTAKE AND IRON STATUS AMONG PREGNANT WOMEN IN EMBU COUNTY KENYA*

for the period ending:
31st December,2015

Permit No : NACOSTI/P/15/1901/4761
Date Of Issue : 16th February,2015
Fee Recieved :Ksh 500

....
Applicant's Signature

....
Secretary
National Commission for Science, Technology & Innovation

APPENDIX H: Research Authorization from county director of health

MINISTRY OF HEALTH

OFFICE OF EMBU COUNTY DIRECTOR OF HEALTH

Telephone: 068-31883
Fax: 068- 31791

Email : cdhembu@gmail.com

When replying please quote our reference

COUNTY DIRECTOR OF HEALTH
EMBU COUNTY
P.O. BOX 273
EMBU

Ref: ECH/ADM/17/VOL.I/14

Date: 4th February 2015

To: Medical Superintendent
Embu Level 5 Hospital

12/02/2015
Noted and approved
Dr Mwaniki

RE. RESEARCH AUTHORIZATION
NICOLETA MUTHONI MWANIKI

The above named person is a student of Kenyatta University Reg. H60/CE/26454/2011.

Having been cleared by the Institutional Ethics committee Ref. KU/R/COMM/51/357, she is hereby authorized to collect data at MCH, Embu level 5 Hospital on here research titled "*Dietary Diversity, Iron intake and iron status among pregnant women in Embu County – Kenya*".

Advice/Condition

To submit a copy of final report to the Medical Superintendent/County Director upon completion of her research.

Kindly accord her necessary support

COUNTY DIRECTOR OF HEALTH
EMBU COUNTY
P O Box 273, EMBU
Fax: 068 - 319791
Tel: 068 - 31883 / 31081
Email: cdh embu@gmail.com

DR. PHILLIP MASAULO
COUNTY DIRECTOR OF HEALTH
EMBU COUNTY