UNIVERSITY OF GHANA
COLLEGE OF BASIC AND APPLIED SCIENCES

PREDICTORS OF DIETARY DIVERSITY, MICRONUTRIENTS ADEQUACY AND HAEMOGLOBIN CONCENTRATION OF PREGNANT WOMEN ATTENDING ANTENATAL CLINIC AT MAAMOBI GENERAL AND ASESEWA GOVERNMENT HOSPITALS

BY

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THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF NUTRITION AND FOOD SCIENCE, UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY NUTRITION DEGREE

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DECLARATION

I, Kamal Sumani Mumuni, hereby declare that this thesis is as a result of my own research work except references to other works which have been duly acknowledged. And that this thesis has not been presented wholly or partly to this institution or any other elsewhere for any kind of degree.

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DEDICATION

I dedicate this work to my mother, Adamu Mumuni and my late father, Abdul Mumuni Sumani for their unflinching love and support.

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ACRONYMS AND ABBREVIATIONS

ANC	Antenatal care
BMI	Body mass index
CSEntry	Census and Survey Entry
CSPro	Census and Survey Processing System
DD	Diet diversity
DDS	Diet diversity Score
DHIMS	District Health Information System
EARs	Estimated average requirements
ECBAS	Ethics Committee for College of Basic and Allied Sciences
FAO	Food and Agricultural Organisation
FHI 360	Family Health International, Global
FGDs	Focus group discussions
G6PD	Glucose-6-phosphate dehydrogenase
GDHS	Ghana Demographic and Health Survey
GSS	Ghana Statistical Service
HDDS	Household Dietary Diversity Score
ICF	International Classification of Functioning, Disability and Health
IFA	Iron and folic acid
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IYCF	Infant and young child feeding
KEMRI	Kenya Medical Research Institute
LBW	Low Birth Weight
MAR	Mean adequacy ratio
MDD-W	Minimum Dietary Diversity Score for Women
MMN	Multiple micronutrients
MND	Micronutrient deficiency
MPA	Mean Probability of Adequacy

MUAC	Mid upper arm circumference
NAR	Nutrient adequacy ratio
PA	Probability of adequacy
PCD	Partnership for Child Development
RAE	Retinol activity equivalent
RDA	Recommended Dietary Allowance
UG	University of Ghana
UWM	University of Wisconsin-Madison
UNICEF	United Nations International Children’s Fund
USDA	United States Department of Agriculture database
WDDS	Women’s Dietary Diversity Score
WFP	World Food Program
WHO	World Health Organisation

ABSTRACT

Background: Consuming low diversity diets is considered as one of the major causes of micronutrient deficiencies in low and middle income countries like Ghana. Pregnant women are vulnerable to nutritional inadequacies due to increased metabolic demands including a growing placenta, foetus, and maternal tissues.

Objective: The objective of this study was to determine predictors of dietary diversity, micronutrient adequacy and haemoglobin concentration among pregnant women attending antenatal clinics at Maamobi General and Asesewa Government Hospitals.

Method: This study was cross-sectional study in which 200 pregnant women (mean gestational age = 26 weeks) attending antenatal clinics at Maamobi General and Asesewa Government Hospitals were enrolled. A Computer Assisted Processing Interview (CAPI) questionnaire was used to collect data on the women's socio-economic and demographic characteristics. Data on dietary intakes were obtained using a single 24-hour recall. Women's dietary diversity scores were calculated based 10 food groups. The mean probability of adequacy (MPA) for the 11 micronutrients were calculated for each individual based on the estimated average requirements (EARs) and the standard deviations associated with the EARs. The MPA for the participants was calculated by taking the average of the individual MPAs. Women's anthropometric status was assessed using mid-upper arm circumference (MUAC) measurement, and haemoglobin concentration was measured using the HemoCue 301 Photometer. Multiple regression analysis was used to determine the predictors of dietary diversity, MPA and haemoglobin concentration.

Results: The mean ± standard deviation (SD) for age of the pregnant women was 27.8 ± 5.4 years with a mean gestational age of 25.7 ± 8.8 weeks. Mean ± SD for dietary diversity score of the pregnant women was 5.3 ± 1.6 and the percentage that met the minimum dietary diversity score for women (MDD-W ≥5) was 65.0%. Mean micronutrient intake of the pregnant women for each of the micronutrients was below the estimated average requirement (EAR) except for vitamin A and C. The probability of adequacy (PA) for each of the 11 selected micronutrients was below 50% except vitamin C which was 64%. Across all 11 micronutrients, the mean probability of adequacy for the study population was 22.4%. The mean ± SD haemoglobin concentration was 11.1 ± 1.4g/dL, and the prevalence of anaemia (Hb<11.0 g/dL) was 46%. Multiple regression analysis indicated that dietary diversity score was positively associated with wealth index (β = 0.83, p = 0.008) and negatively associate with renting of dwelling place (β = -0.65, p < 0.001) among the participants. The MPA was negatively associated with wealth index (β = -0.11, p < 0.001) whilst compared with farmers, the MPA was higher for artisans (β = 0.20, p = 0.013), traders (β = 0.19, p = 0.018), civil servants β = 0.31, p = 0.001) and unemployed β = 24, p = 0.006) in a multivariate analysis. Haemoglobin concentration was negatively associated with gestational age in weeks (β = -0.02, p = 0.020), rural residence (β = -0.47, p = 0.03) and positively associated with being employed (β = 0.56, p = 0.03).

Conclusion: Among pregnant women attending antenatal clinic at Maamobi General and Asesewa Government Hospitals, wealth index and renting the dwelling place significantly predicted mean dietary diversity. Wealth index and occupation significantly predicted MPA and gestational age in weeks, and being employed significantly predicted mean haemoglobin concentration. Interventions are needed to address the high prevalence of anaemia and low micronutrient intake.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Adequate maternal nutrition during pregnancy is crucial if satisfactory birth outcome and optimal health of the mother are desired (Bhutta et al., 2013). There are research evidence supporting the relationship between poor maternal nutritional status and adverse pregnancy outcomes (Abu-Saad & Fraser, 2010), poor infant survival (Black et al., 2008), risk of chronic diseases and impaired mental development in later life (Victora et al., 2008).

The most remarkable human studies indicating the adverse effects of poor nutrition during pregnancy on maternal health and birth outcomes dates back to the 1940s during the Dutch, Leningrad and German famine (Imdad & Bhutta, 2012). According to Imdad & Bhutta (2012) food intake during the period decreased as low as 590 calories per day which resulted in drastic maternal weight loss, and high rates of premature births and prenatal mortality. The data at the time and thereafter, indicated that undernutrition resulting from inadequate protein-energy clearly affect pregnancy and pregnancy outcome. Interventions then were aimed at improving caloric intake by increasing low-cost, energy dense cereal which served as the staple foods for the vulnerable populations (Gómez et al., 2013). Those interventions achieved some level of success in reducing undernutrition and improving birth outcomes (Imdad & Bhutta, 2012).

Current global reports indicate that even though there had been some appreciable reduction in prevalence of undernutrition, the rates still remains unacceptably high (11%) with women and children being the most vulnerable (FAO, UNICEF, & IFAD, 2017). Despite the high rates of undernutrition the world is equally experiencing rapid increase in adult overweight and obesity (resulting from excess protein-energy intake) with about 2 billion being affected especially in low and middle income countries (LMIC) (IFPRI, 2016). The results is not different in Ghana as available data indicates that overweight/obesity have consistently been on the rise with relatively low reduction in underweight among women of child bearing age over the past two decades (Ghana Statistical Service, Ghana Health Service, & ICF., 2015). Furthermore, it has been observed that the co-existence of undernutrition and overweight/obesity, usually termed as the "double burden" of malnutrition among Ghanaian women, has been found reflecting in the birth weight of infants where significant numbers of low birth weight and macrosomia co-exist (Abubakari, Kynast-Wolf, & Jahn, 2015; Agbozo, Abubakari, Der, & Jahn, 2016). Studies on the effect of maternal obesity and adverse maternal health and pregnancy outcome have indicated that the problem of malnutrition is beyond just inadequate intake of protein-energy but encompasses both under- and over-nutrition. Evidence from scientific studies indicate that prevalence of obesity during pregnancy ranges from 7% to 50% in Africa with adverse maternal health such as increased risk of pregnancy-induced hypertension, pre-eclampsia and macrosomia compared to non-obese mothers (Onubi, Marais, Aucott, Okonofua, & Poobalan, 2016).

A deeper understanding into malnutrition have revealed that, micronutrient deficiency exist in populations with prevalence of either forms of the aforementioned malnutrition problems (i.e. underweight and overweight/obesity), thereby widening the challenge into what is termed as the 'triple burden of malnutrition'. Micronutrient deficiency (MND) often referred to as 'hidden hunger' is a serious public health issue, affecting approximately 2 billion of the global population, with pregnant women and children bearing the most brunt of its effect. Pregnant women from resource-poor settings like Ghana, are particularly at risk of MND, due to the consumption of poor-quality, monotonous diets (Black et al., 2008; Torheim, Ferguson, Penrose, & Arimond, 2010).

Dietary diversity (DD), defined as the number of different food groups consumed over a given reference period, has been universally identified as a key element of high quality diets (Ruel, 2003). As such, local and international food-based dietary guidelines recommend dietary diversification as an important strategy in improving the intake of essential nutrients. Empirical evidence provided from multi-country studies suggests that dietary diversity scores can be a valid proxy indicator of micronutrient adequacy for women (Arimond et al., 2010). Recently, FAO & FHI360 (2016) came up with the Minimum Dietary Diversity score for Women (MDD-W) as a measure of micronutrient adequacy in women of reproductive age, especially in resource poor settings. This implies that a highly diversified diet of a pregnant woman is more likely to improve her nutritional status and hence reduce the risk of maternal and child morbidity and mortality. To support evidence of robustness of policies and interventions aimed at improving the lives of pregnant women and their off-springs, closer look at factors that determine the dietary diversity and the probability of adequacy of vital micronutrients is imperative.

1.2 Problem Statement

Micronutrient deficiency is a serious nutritional problem of which iron, vitamin A and iodine are the most reported. The complexity and cost involved in micronutrient surveillance makes it difficult to be carried out in resource poor settings like Ghana. Proxy estimates such prevalence of anaemia for dietary iron, night blindness for vitamin A and goitre for iodine deficiencies are often used in many settings.

In Ghana, intervention strategies put in place to address micronutrient deficiencies include micronutrient supplementation and food based interventions such a food fortification, bio-fortification, and dietary diversity. Available data on micronutrient supplementation and fortification indicate that about 63.0% of households in Ghana use salt that was adequately iodated (≥15ppm), 68.0% received postpartum vitamin A (Ghana Statistical Service et al., 2015) and 13.7% of non-pregnant women are iron deficient (UG, GroundWork, UWM, KEMRI-Wellcome-Trust, & UNICEF, 2017).

Due to the challenges in accessing data on the adequacy of maternal nutrition, a number of studies have sought to the use of simple indicators such as dietary diversity score (Codjoe, Okutu, & Abu, 2016; Saaka & Rauf, 2015) and calculation of nutrient adequacy ratio as a means to determine the nutrient adequacy of a given population in Ghana. Estimating the probability of nutrient adequacy has been recommended as a better indicator for population estimation of the proportion at risk.

Available literature indicate that the use of the probability of adequacy has not been explored and the available data on micronutrient deficiency is as well limited. This study therefore seek to add to available literature by determining the proportion of pregnant women with adequate micronutrient intake through the use of the probability of nutrient adequacy and the potential predictors of dietary diversity, micronutrient adequacy and haemoglobin concentration.

1.3 Justification

Even though, micronutrients are required in small amounts, deficiencies resulting from inadequate/suboptimal intakes may be associated with significantly elevated poor health and reproductive risk, ranging from infertility to foetal structural defects and long-term diseases. Among the micronutrient deficiencies, dietary iron remains one of the most common pregnancy-related complications and it can exists with or without anaemia. Prevalence of anaemia among pregnant women in Ghana still remains a severe public health concern of about 44.6% (Ghana Statistical Service et al., 2015).

A number of studies have shown positive correlation between dietary diversity and maternal body mass index (BMI) (Abubakari & Jahn, 2016; Amugsi et al., 2016) as well as pregnancy outcomes in Ghana (Saaka, 2013). The use of the minimum dietary diversity score in assessing probability of micronutrient adequacy among pregnant women in Ghana is however limited.

Considering the importance of dietary diversity in improving nutrient intake, establishing factors associated with dietary diversity among pregnant women in rural and urban settings, is indispensable and can help in policy formulation which would ultimately enhance nutrient intake. In order to get data that reflect characteristics of pregnant women in rural and urban settings, the study was conducted in Asesewa Government which serves rural communities in the Upper Many Krobo District and Maamobi General Hospitals which provides services to urban dwellers in the Ayawaso sub-metro.

1.4 Main Objective

The main aim of this study was to determine the predictors of dietary diversity, micronutrient adequacy and haemoglobin concentration among pregnant women attending antenatal clinics at Maamobi General and Asesewa Government Hospitals.

1.4.1 Specific Objectives

1. To assess dietary diversity and micronutrient intake among pregnant women

2. To determine the probability of adequacy (PA) and mean probability of adequacy (MPA) of selected micronutrients
3. To determine the predictors of dietary diversity score among pregnant women
4. To determine the predictors of micronutrient adequacy among pregnant women
5. To determine the predictors of haemoglobin concentration of pregnant women

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual framework

Factors influencing dietary diversity, micronutrient adequacy and haemoglobin status of pregnant women are illustrated in Figure 1.1 below. Adequate micronutrient status is crucial for a healthy pregnancy and birth outcome. Availability of micronutrients such as iron, folate and vitamin B_{12} play crucial roles in the formation of blood cells. The micronutrient status of the individual also depend on dietary intake among other factors such as health and sanitation. Dietary diversity is an important factor in determining the dietary intake of an individual by improving appetite. Quite apart from increasing food intake, a diversified diet also enhances bioavailability of certain micronutrients. For instance, vitamin C from fruit can improve bioavailability of iron and zinc in the diet. Socio-economic and demographic factors such as income, education, age, parity, gestation and household size influence dietary diversity in many different ways. Parity as well as the household wealth index can influence the quantity and variability of food groups that makes up the diet of the household. The gestational age can also affect appetite.

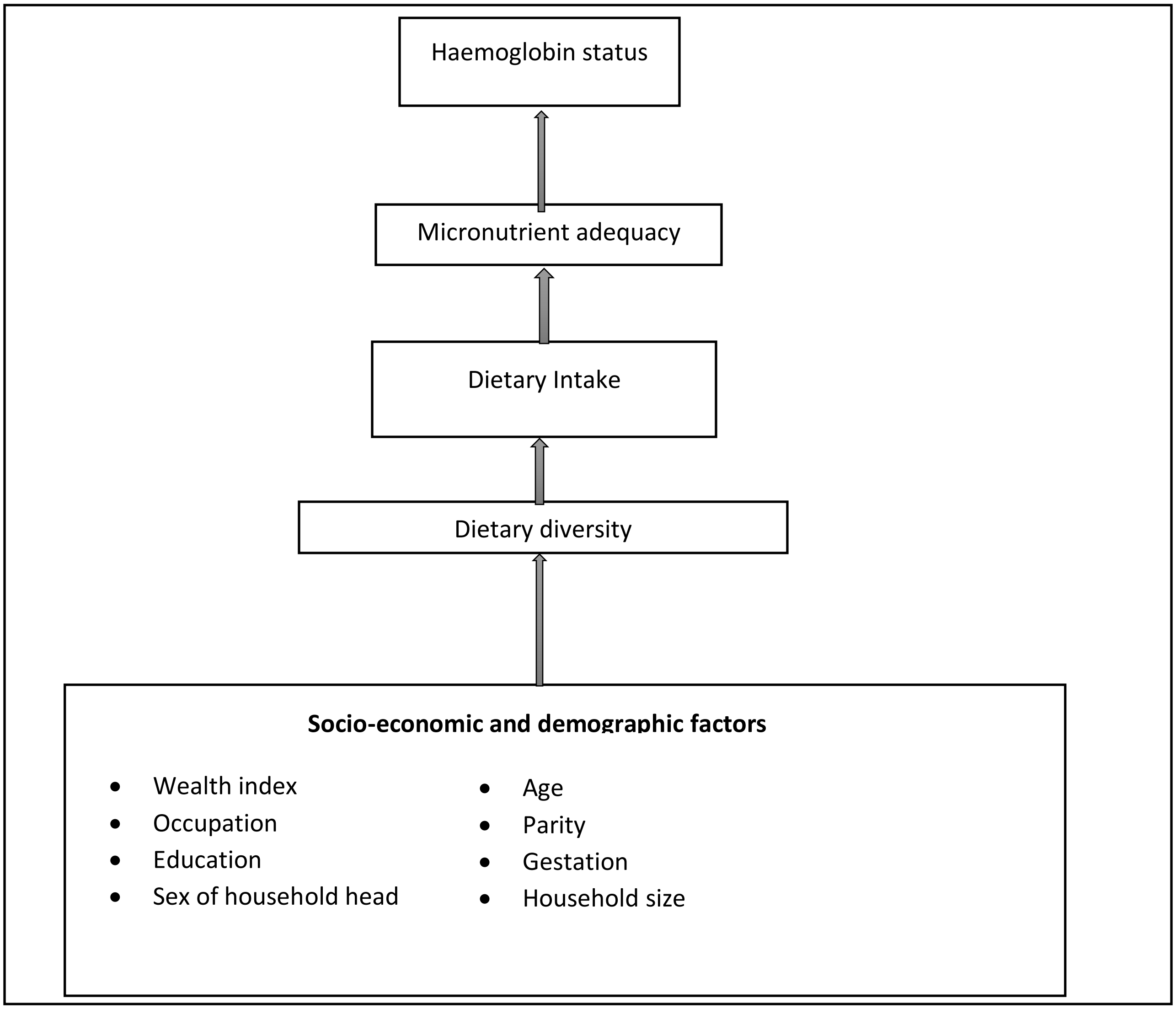

Figure 2.1: Conceptual framework of factors affecting dietary diversity, micronutrient adequacy and haemoglobin status

2.2 Nutrition during pregnancy and pregnancy outcome

Pregnancy is a critical period involving anabolic processes. Pregnant women are vulnerable to nutritional inadequacies due to increased metabolic demands including a growing placenta, foetus and maternal tissues. Numerous studies have used anthropometric measurements as a proxy for malnutrition (including under and over-nutrition) to establish the adverse effects of malnutrition on maternal health and pregnancy outcomes. In a meta-analysis of epidemiological studies it was found that women in the lowest quartile of stature (146 cm to 157 cm) had a 60% (95% CI, 50–70) increased need for assisted delivery compared with women in the highest quartile (Wynn, 1997). Analysis of 109 Demographic and Health Survey data from 54 African countries (Ízaltin, Hill, & Subramanian, 2010), revealed the effect of malnutrition on birth outcome showing that a 1cm increase in maternal height was associated with a reduced risk of child mortality (relative risk (RR),0.988; 95% confidence interval [CI], 0.987-0.988), underweight (RR, 0.968; 95% CI, 0.968-0.969), stunting (0.968; 95% CI, 0.967- 0.968), and wasting (RR, 0.994; 95% CI, 0.993-0.995). A study of about 22,000 women by Christian et al. (2008) in Nepal, also revealed that each centimetre increase in mid upper arm circumference (MUAC) during pregnancy led to 25% (95% CI 0.67−0.83) lower maternal mortality risk during pregnancy and post-partum.

Studies have also shown similar effects of malnutrition on overweight/obese (i.e. malnutrition resulting from excess protein-energy intake) pregnant women with regards to their health and birth outcomes. Onubi et al. (2016) in a systematic review and meta-analysis of studies on maternal obesity in Africa, revealed that obese mothers had an increased relative risk (RR) of 1.87 (95%CI, 1.64–2.12, 8 studies) and 1.83 (95% CI, 1.51–2.21, 9 studies) of caesarean section and giving birth to babies with macrosomia respectively compared to non-obese mothers. A recent prospective cohort study (Van Der Linden et al., 2016) in Ghana also found that obese women had a two-fold increased risk for caesarean sections (RR 2.20, 95% CI 1.21-4.02) and more than a six-fold higher risk for pregnancy-induced hypertension (RR 6.17, 95% CI 2.90- 13.13) and chronic hypertension (RR 6.00, 95% CI 1.40-25.76).

The effects of micronutrient deficiency which refers to the essential vitamin and mineral required by the body have been noted to be associated with poor maternal and birth outcomes. Micronutrient supplementation programmes among pregnant women have also indicated that improving the micronutrient status of deficient pregnant women improves maternal health during pregnancy and the outcome of the pregnancy. For instance, a Cochrane review on Multiple Micronutrient supplementation among pregnant women Haider, Yakoob, & Bhutta (2011) reported 12% reduction (RR: 0.88; 95% CI: 0.85–0.91) in low birth weight, 11% reduction (RR: 0.89; 95% CI: 0.83–0.96) in small for gestational age and 3% reduction (RR: 0.97; 95% CI: 0.94–0.99) in preterm births.

2.3 Micronutrient deficiency during pregnancy

Micronutrients are essential vitamins and minerals required from dietary sources in small amounts to sustain normal cellular and molecular functions as they play leading roles in the production of enzymes, hormones and other substances. Even though, micronutrients are need in small amounts deficiencies resulting from inadequate/suboptimal intakes, increased losses from the body, and/or increased requirements may lead to elevated poor health and reproductive risk, ranging from infertility to foetal structural defects and death if untreated. Whilst most MND disorders can be reversed with provision of missing micronutrients, some deficiency disorders result in irreversible, lifelong consequences. The severity, timing, and the extent of the deficiency will determine its sequelae. Thus, the need for information on MNDs can help countries assess their comparative importance in causing premature death, loss of health and disability, and so assist countries in deciding health policies and programs (WHO, 2009). Regrettably, global micronutrient surveillance are limited due to economic and logistic challenges that constrain the collection of micronutrient biomarkers in nationally representative surveys, as they typically involve biological sample collection, time-sensitive specimen processing, and cold chain management (Darnton-Hill, 2012). The lack of understanding the epidemiology of MNDs has given rise to the term 'hidden hunger' (Muthayya et al., 2013).

It is estimated that deficiency of micronutrients affects 2 billion of the global population, with pregnant women and children being the most vulnerable. Although global burden of certain micronutrients have been estimated for pregnant women using population data (De-Regil & Initiative, 2015), they are not delineated by age, parity, socioeconomic factors and other factors that might influence nutrition during pregnancy. The micronutrients that are commonly reported on are iodine deficiency, vitamin A deficiency, iron deficiency anaemia, and zinc (Bailey, West Jr, & Black, 2015; Bhutta et al., 2013).

Iron deficiency and iron deficiency anaemia: These are the most prevalent and the leading nutritional problems of pregnancy. A significant percent of women start pregnancy with depleted iron stores. All women having iron deficiency are at the risk of developing iron deficiency anaemia early in the course of gestation due to increased iron requirements. According to Vos et al. (2017), iron deficiency anaemia affected about 1.24 billion of the global population and was the leading cause of years lived with disability (YLD) among women in 2016. Whereas iron deficiency and iron deficiency anaemia among non-pregnant women in Ghanaian is estimated to be about 13.7% and 8.9% respectively (UG et al., 2017), there is limited data on pregnant women. However it is estimated that iron deficiency anaemia contributes about half of anaemia prevalence, which is 44.6% for pregnant women in Ghana (Ghana Statistical Service et al., 2015), and iron deficiency alone is about 2.5 times the number of the anaemic population (WHO, 2007).

Zinc: It is an essential mineral critical for immune system function, cell division, and protein and DNA synthesis. It is mainly found in animal and sea foods and like iron, absorption of zinc from plant sources is inhibited by phytates, fibre and lignin (Trumbo, Yates, Schlicker, & Poos, 2001).

Although zinc deficiency has been suggested as a risk factor with adverse long-term effects on growth, immunity, and metabolic status, yet little is known about the global status given the issues concerning the assessment of zinc status by biomarkers (Darnton-Hill, 2012). Prevalence of zinc deficiency are therefore mainly based on the prevalence of child stunting, estimates of dietary intakes, and the availability of zinc from the food supply (Bailey et al., 2015). It is estimated that about 17.3% of the world's population has inadequate zinc intakes with the highest in Africa (23.9%) (Black et al., 2013). Prevailing data indicate that as high as 21.6% of Ghanaians are at risk of inadequate zinc intake (Ritchie & Roser, 2019).

Calcium: It is an essential mineral involved in several body functions, including enzymatic and hormonal homoeostasis. A systematic review (Neal et al., 2016) of 15 studies from developing countries, suggests that hypertensive disorders, which include eclampsia and pre-eclampsia as well as pre-existing hypertension, are the major causes of morbidity and mortality (Neal et al., 2016) and are associated with increased risk of preterm birth and foetal growth retardation. Available evidence suggests that calcium supplementation during pregnancy in populations at risk, showed 35% reduction in hypertension, 52% in pre-eclamsia and 24% in preterm births (Hofmeyr, Lawrie, Atallah, & Duley, 2010).

Vitamin A: Vitamin A is a fat-soluble vitamin required for the normal functioning of the visual system, cell differentiation, growth and development of immune function and reproduction. Dietary sources of vitamin A are preformed vitamin A in animal foods occurring as retinol or retinyl esters and provitamin A carotenoids found in plant sources. Vitamin A deficiency in pregnancy is assessed either as a history of night blindness or serum or plasma retinol concentrations of less than 0·70 μmol/L. Global estimates of night blindness in pregnant women is 7.8% and 15.3% have deficient serum retinol concentrations (Ritchie & Roser, 2019). In Ghana, 7.7% of the pregnant women suffer from night blindness whilst 18.1% have deficient serum retinol concentration (Ritchie & Roser, 2019).

Folate: This is one of the B-vitamins that occur naturally in a wide range of foods, though in low density whereas folic acid is the synthetic form of the vitamin used in food fortification and dietary supplements. The folic acid is more bioavailable than the naturally occurring folate. Folate deficiency leads to megaloblastic or macrocytic anaemia and also related to increased risk of neural tube defect among babies born to mothers with folate deficiency especially during the first trimester. Folic acid supplementation during pregnancy is associated with reduced risk of 72% (RR 0·28; 95% CI 0·15–0·52) in neural tube defect (Black et al., 2013).

Other vitamins: Although FAO & WHO (2005) recommend an increased intake of vitamin B_{12} and B_6 during pregnancy, empirical evidence on their deficiencies are scanty and conflicting. Data associating the water-soluble vitamins (vitamin C, thiamin, niacin and riboflavin) to any risk of adverse health during pregnancy and pregnancy outcome are ostensibly unavailable (Darnton-Hill & Mkparu, 2015). The requirement of these vitamins however increases during pregnancy as a result of haemodilution, foetal requirements and increased urinary excretion as in the case of niacin (FAO & WHO, 2005).

2.4 Micronutrient intake during pregnancy

According to the World Health Organisation, MND remains the most vital risk factor, particularly in pregnant women and children, for morbidity and death globally (FAO et al., 2017). Food-based strategies have been recommended as the first priority to meet nutrient needs. Available studies from Africa however, have indicated that most of the problem of MND among pregnant women are due to intake of inadequate or poor quality diets in addition to pre-pregnancy deficiencies, exposure to infections, early pregnancy and short inter-pregnancy interval. In a review of studies in developing countries, Lee, Talegawkar, Merialdi, & Caulfield (2013) observed that cereals and grains provide about 59 to 81% of energy intake and also serve as a primary source of protein and iron for pregnant women in most studies from Africa. In the same review all forms of vegetables served as secondary sources of iron whereas animal sources were the predominant sources for zinc, but consumed in small amounts. Studies from other African countries have also shown that the percentage consumption of plant based diet in substantial amounts (>15gm) among women are usually more than 50% whereas diary, organ meat and egg consumption are between 0 to about 48% (Arimond et al., 2010). It has also been noted that seasonal variations affect dietary intake in developing countries (Savy, Martin-Prével, Traissac, Eymard-Duvernay, & Delpeuch, 2006).

A number of studies on nutrient intake of women living in Africa, found that intake of micronutrients from food sources fall below the estimated average intake (EAR). The EAR is the amount of a nutrient that is needed to meet the nutrient requirement of half the healthy individuals in a life-stage and sex group (Trumbo et al., 2001). For instance, a systematic review identifying all studies that had been published between 1988 and 2008 reporting on micronutrient intakes in women living in resource-poor settings showed that, except for vitamin A (29%) the reported mean/median intakes in over 50% of the studies were below the EAR, demonstrating that inadequate intakes of multiple micronutrients are common amongst women, particularly pregnant women living in Africa (Torheim et al., 2010).

In Ghana, iron or folic acid and multivitamin supplementations are respectively 73.4% and 35.5%, intake of micronutrient supplements among non-pregnant women is very rare (UG et al., 2017). The Ghana Statistical Service et al. (2015) also estimated that about 91.9% of pregnant women take iron tablets or syrup.

2.5 Dietary diversity and nutrient intake during pregnancy

Dietary diversity is defined as the number of different food groups or foods that are consumed over a specific reference period (Ruel, 2003). Diet diversification is well-recognized as an important strategy to help ensure adequate nutrient intake (FAO & WHO, 2001). Dietary diversity is a key element for ensuring the quality of diets and the recommendation to consume variety of foods can be found in many nutritional guidelines.

A number of studies, using the 24 hour recall, in Ghana have pegged the dietary diversity among pregnant women at 4-5 (Z. Ali, Saaka, Adams, Kamwininaang, & Abizari, 2017; UG et al., 2017). Other studies among pregnant women in Kenya and Bangladesh indicated a higher mean dietary diversity score of 6.84 ±1.46 and 5.1 ± 1.4 respectively (Kiboi, Kimiywe, & Chege, 2017; Nguyen et al., 2018).

Studies in low and middle income countries have found significant correlation between dietary diversity based on 12 food groups and household per capita energy intake in Ghana (r=0.41), Afghanistan (r=0.28), Bangladesh (r=0.39) and no association in Ethopia (Kennedy, 2009). A study among children in urban Mali found a significant positive correlation between dietary diversity based on 8 food groups and MAR of the nutrients studied (Pearson (r)=0.39) (Hatløy, Torheim, & Oshaug, 1998). A subsequent study among women of reproductive age in rural Mali also revealed similar association between dietary diversity score and MAR (r=0.38). Additionally, analysis of data from Mali, Burkina Faso, Mozambique, Philippines and Bangladesh showed similar significant correlations (ranging from r= 0.1 to 0.59) between dietary diversity score and MPA (Arimond et al., 2010). Despite the weak strength of association found by various studies, dietary diversity still remains the first priority in developing strategies to meet the nutritional needs of any population (FAO & WHO, 2001).

2.6 Measurement of Nutrient Adequacy

The quality of a diet can be estimated in terms of food or food group intakes and diet patterns, or in terms of nutrient intake and the level of compliance with the nutrient requirements. When evaluating the diet in terms of nutrient adequacy, diverse types of analyses are used. The method used depends on the purpose of the analysis (to assess individuals or a population), on the nutrient under study and the type of distribution of the nutrient intake (Barr, Murphy, & Poos, 2002). Various methods used include comparing the observed nutrient intake against the EAR or Recommended Dietary Allowance (RDA), nutrient adequacy ratio (NAR) or mean adequacy ratio (MAR) and the probability of nutrient adequacy (PA) or mean probability of adequacy (MPA).

The NAR is a measure that expresses an individual's intake of a nutrient as a percentage of the corresponding Recommended Dietary Allowance (RDA) of that nutrient, given the respondent's age and sex. It scales data on total nutrient intake to derive a more comprehensive understanding of dietary quality. The RDAs are estimates of the necessary nutrient intake to meet the requirement of 97.5% of healthy people (Gernand, Schulze, Stewart, West Jr, & Christian, 2016). Thus, even a MAR of 1 (meaning requirements of all nutrients are met) does not guarantee an individual's needs are met. Additionally, a MAR below 1 does not necessarily indicate an individual suffers from nutritional deficiencies, since inherent in the way that the RDAs are defined, the cut-off amount is actually above the required intake for all but 2-3% of the population (Murphy & Poos, 2002). Thus, an individual's nutritional status inferred from this measure is misleading.

The probability approach is a statistical method for estimating the expected proportion of individuals at risk of nutrient adequacy (Martin-Prével et al., 2015). This method combines the distributions of requirements and intakes in the group to produce an estimate of the expected proportion of individuals at risk for inadequacy. The PA may be particularly desirable in given locations or with given populations that are at risk of inadequate intake or have elevated nutrient needs, such as pregnant and lactating women ("Inadequacy of specific micronutrient intake (probability and cut-point method)," n.d.). It also allows for predictions of adequacy by using data from a single quantitative 24-hour dietary recall without needing to complete a second, non-consecutive recall (Barr et al., 2002). The limitation of this method is that it does not capture the dynamics between nutrient consumption and the absorption and use of other nutrients.

2.7 Measurement of dietary diversity score

In developed countries and in a small number of developing countries, quantitative dietary surveys using repeated 24-hour recalls provide rich information on micronutrient adequacy and many other dimensions of diet quality. Such surveys are expensive, time consuming and cumbersome to be undertaken by most resource-poor setting and, in the few cases where they have been conducted, are very unlikely to be repeated sufficiently to track progress on a large, national scale. To fill the gap, dietary diversity score (DDS) based on counts of individual food items or food groups consumed over a specified period have been found to be a good substitute in resource poor settings where micronutrient deficiencies are of public health concern (Kennedy, Ballard, & Dop, 2011). According to Hatløy et al. (1998), score based on counting food groups are better than those based on counting individual food items of at least 30 scores of food items compared to 4 scores of food groups will be needed to achieve a MAR of 0.75. In contrast, a review of proxy indicators for household food security found that counting the number of individual food items rather than food groups improved classifications of households falling above or below a cut-off for caloric availability per adult equivalent (Wiesmann, Hoddinott, Aberman, & Ruel, 2006). Limiting score construction to food groups rather than a count of individual food items simplifies data analysis and interpretation and also better conforms to dietary recommendations (Hatløy et al., 1998). However, variability of nutrient density of foods within food groups could be a limiting factor in meeting the adequate needs by counting food groups (Habte & Krawinkel, 2016).

The De Benoist, Cogswell, Egli, & McLean (2008) recognised the lack of feeding indicators for infant and young children as a drawback for action and therefore led a multi-stakeholder process that resulted in the adoption of a set of indictors including food group diversity indicators for assessing the quality of complementary feeding. Many different ways have since been used based research and programme objective for measuring dietary diversity. However, only a few simple food group diversity indicators have been promoted for wide population-level use in resource-poor settings. These include the Household Dietary Diversity Score (HDDS), the Minimum Dietary Diversity (MDD) for infant and young child feeding (IFYCF), the Women's Dietary Diversity Score (WDDS) and the most recent Minimum Dietary Diversity for Women (MDD-W) (FAO & FHI360, 2016). The HDDS, is recognised as a proxy for household access to dietary energy, whereas the MDD is for IFYCF, WDDS and MDD-W are proxies for nutritional quality of an individual's diets, particularly that of micronutrient adequacy of a diet. Table 2.1 spells out the differences in the various indicators.

Table 2.1: Food group diversity indicators.

	HDDS	**IYCF MDD**	**WDDS**	**MDD-W**
Population sampled/unit of analysis	Households	Infants and young children aged 6–23 months	Women aged 15–49 years	Women aged 15–49 years
Validated against	Kilocalorie availability as assessed in household-level consumption surveys	Micronutrient density compared with desirable density for complementary foods, assessed by 24-hour recall or weighed food records	Micronutrient adequacy assessed by multiple 24-hour recalls	Micronutrient adequacy assessed by multiple 24-hour recalls
Meaning	Proxy for household-level access to kilocalories (dietary energy), which is one dimension of household food security Reflects economic access to a diet with higher kilocalories per capita	Proxy for the adequacy of the micronutrient density of infant and young child diets Reflects one of several favourable infant and young child feeding practices	Proxy for the probability of micronutrient adequacy of women's diets Reflects micronutrient adequacy, which is one critical dimension of diet quality	Proxy for the probability of micronutrient adequacy of women's diets Reflects micronutrient adequacy, which is one critical dimension of diet quality
Number of food groups	12	7	9	10[e]
Threshold for dichotomous indicator	No dichotomous indicator	4 or more of the 7 food groups	No dichotomous indicator	5 or more of the 10 food groups
Indicator tabulation includes fats/ oils, sweets, and all beverages, including alcohol	Yes	No	No	No
Foods consumed outside the home	Not included	Included	Included	Included

Source: FAO & FHI360 (2016)

2.8 Anaemia in pregnancy

Anaemia is a deficiency in the size or number of red blood cells (RBCs) or the amount of Hb they contain (Kassebaum et al., 2013). Haemoglobin levels vary with age, sex, pregnancy, altitude and smoking. Different levels of Hb are considered normal for different categories of people. For pregnant women a haemoglobin of 11.0g/dL or higher is considered normal. Haemoglobin levels of 9.0-10.9g/dL, 7.0-8.9g/dL and <7.0g/dL are classified as mild, moderate and severe anaemia respectively (WHO, 2007). The WHO, uses different cut offs to categorize the severity of anaemia as a public health concern. Countries with a prevalence of anaemia <5 percent are classified as having no public health problem; those with 5-19.95 percent, are classified as having a mild public health problem; those with 20-39.9%, as moderate public health problem; and those with a prevalence ≥40 percent, as severe public health problem (WHO, 2007).

In 2011, it was estimated that 38% of pregnant women in the world are suffering from different degrees of anaemia (WHO, 2015). The most recent Ghana Demographic and Health survey conducted in 2014 estimated that prevalence of anaemia in pregnancy was 44.6% (Ghana Statistical Service et al., 2015).

There are several causes of anaemia in pregnancy. This range from micronutrient deficiency (iron, folic acid, riboflavin, vitamin A and B12), acute and chronic infections (malaria, cancer, TB, HIV) to inherited and acquired disorders such as sickle cell that affect haemoglobin synthesis (De Benoist et al., 2008). Nutritional deficiency due to iron deficiency, is responsible for close to one-half of anaemia cases in the world (WHO, 2015).

Maternal anaemia is associated with 20% of maternal deaths (Black et al., 2008), with evidence that anaemia may cause increased blood loss at delivery and put women at risk of postpartum haemorrhage (Sheldon et al., 2014). In a recent multilevel analysis, Daru et al. (2018) reported that the odds of maternal death were twice higher in those with severe anaemia compared with those without severe anaemia (adjusted OR 2·36 [95% CI 1·60–3·48], p<0·0001). Mothers suffering from anaemia are at a higher risk of delivering premature and low birth weight babies who are at a higher risk of dying (Black et al., 2008). According to Ronnenberg et al. (2004), the risks of low birth weight and fetal growth restriction were respectively 6.5 and 4.6 times greater among women with moderate anaemia compared with non-anaemic controls (OR: 6.5 [95% CI 1.6, 26.7], P = 0.009 and OR: 4.6 [95% CI 1.5, 13.5], P = 0.006, respectively).

2.9 Dietary Diversity Score and haemoglobin status in pregnancy

A number of investigators have argued that dietary diversity reflects dietary quality and as a proxy indicator of nutrient adequacy (Arimond et al., 2011; Wiesmann, Arimond, & Loechl, 2009). A high dietary diversity therefore imply adequate nutrients such as iron and folate for haematopoiesis. The presumption is in line with a study (Saaka & Rauf, 2015) in Northern Ghana where the adjusted mean haemoglobin in a high diversified group was 0.67 g/dl higher than the low diversified diets group (95 % CI: 0.39 to 0.95, p < 0.001). Similar observation was made in a multicentre cohort study (Zerfu, Umeta, & Baye, 2016) in Ethopia where pregnant women in the inadequate dietary diversity group had a 2 fold higher risk of being anaemic (ARR: 2.29; 95% CI: 1.62, 3.24) than those in the adequate group. Other studies however, did not find significant association between dietary diversity and haemoglobin status of pregnant women (F. Ali, Thaver, & Khan, 2014; Z. Ali et al., 2017).

2.10 Maternal socio-economic and demographic status factors influencing dietary diversity

There is growing interest in understanding household and individual dietary diversity due to its relevance in meeting nutrient needs (Kennedy et al., 2011). A number of studies have found significant positive association between dietary diversity and educational status (Kiboi et al., 2017; Taruvinga, Muchenje, & Mushunje, 2013; Torheim et al., 2004). In a study among pregnant women, educational status was found to be a predictor of dietary diversity as those who had at least secondary education had about 3 times greater odds of achieving the minimum dietary diversity than those who had never attended school (AOR 2.78; 95% CI 1.06, 5.32) (Kiboi et al., 2017). In the same study, odds of attaining the minimum dietary diversity among employed pregnant women was twice higher than unemployed pregnant women. It has also been argued that high income or household wealth index implies ability to acquire more diversified and quality diet (Codjoe et al., 2016; Kiboi et al., 2017; Saaka, 2013; Savy et al., 2008; Taruvinga et al., 2013). Households in the highest quantile have the highest dietary diversity score of 7.4 (Codjoe et al., 2016). In other studies however, age was found to be a negative predictor of dietary diversity (B= -0.03; 95% CI -0.04, -0.02) (Torheim et al., 2004).

Never the less other studies did not find significant associations between dietary diversity and age, marital status, household size (Kiboi et al., 2017), education (F. Ali et al., 2014), occupation (Savy et al., 2008).

2.11 Maternal socio-economic and demographic status factors influencing micronutrient adequacy

A few studies have looked at the relationship between micronutrient adequacy and maternal socio-economic and demographic status. Henjum et al. (2015) in a study of 500 lactating women, observed that the positive predictors of mean probability of micronutrient adequacy were women's age (B=1.37; 95% CI 0.30, 2.44), years of education (B=1.01; 95% CI 0.61, 1.46) and ownership of dwelling place (B=0.45; 95% CI 0.13, 0.78).

2.12 Maternal socio-economic and demographic status factors influencing haemoglobin concentration

In a study conducted by Nwizu, Iliyasu, Ibrahim, & Galadanci (2011), it was observed that the risk of anaemia was high among unmarried women (AOR= 2.02; 95% CI 1.04, 8.54) than married women, non-formal educated women (AOR= 2.13; 95% CI 1.17, 8.98) than women with tertiary education, low socio-economic status (AOR= 4.20; 95% CI 1.40, 11.23) than women of high socio-economic status. The risk of anaemia increases with increasing gestational due to increasing maternal plasma volume and foetal development (Darnton-Hill & Mkparu, 2015). This is supported in a study by Addis Alene & Mohamed Dohe (2014) who observed that pregnant women in the third and second trimesters were respectively 3.32 (95% CI 1.84–6.0) and 2.87 (95% CI 1.61–5.17) times more likely to be anaemic as compared to pregnant women in the first trimester. Glover-Amengor, Owusu, & Akanmori (2005) pointed out that malaria and intestinal parasitaemia are high in rural settings than in urban settings could therefore be a high risk factor for high prevalence of anaemia in rural areas. Kefiyalew, Zemene, Asres, & Gedefaw (2014) found that pregnant women from the rural area had about three times increased risk of being anaemic (adjusted OR =3.3, 95% CI: 1.5, 7.4) but did not find any association between anaemia and age of pregnancy, educational status and occupation.

CHAPTER THREE

3.0 METHOD

3.1 Study Design

This study was a cross sectional study conducted in Maamobi General Hospital and Asesewa Government Hospital.

3.2 Study Site

The study was conducted in Maamobi General Hospital (MGH) in the Greater Accra Region and Asesewas Government Hospital (AGH) in the Eastern Region.

The MGH is a government facility located in the Ayawaso Sub-metropolis and serve major cosmopolitan communities such as Maamobi, Nima, Alajo, Newtown and Westland. The people in these communities have diverse socio-cultural practices due to the different ethnic groups from all the regions in the country. The facility provide daily antennal services from Monday to Friday. Ayawaso sub-metro is one of the five sub-metros of Accra Metro and it is bounded to the north by La Nkwantanang-Madina Municipality, north-east by Adenta Municipal, north-west by Ga East municipal, east by La Dadekotopong municipal, west by Okai koi sub-metro and south by Osu Klotey sub-metro. It has an estimated population of about 523,842 and number of expected pregnancies of 20,954. Average monthly antenatal attendance is about 900 pregnant women (DHIMS2, 2017).

Asesewa Government Hospital is in the Upper Manya Krobo District and has an average monthly antenatal attendance of 520 pregnant women (DHIMS2, 2017). Even though the facility runs daily antenatal services, market days (Mondays and Fridays) are designated for pregnant women from the villages. The facility therefore gets a lot of attendance for antenatal services on these days than the other days of the week. The Upper Manya Krobo District was established in 2008 with its capital at Asesewa, a historic trading post, attracting a mix of cultures from all over the country. The district covers a land size of about 859 square kilometres, representing 4.6% of the total land mass of the Eastern region. It lies on Longitude 0° and Latitude 6°15′ north of the equator and shares boundary with the Afram Plains to the north, Fanteakwa district to the west, Asuogyaman district to the east, Yilo Krobo district in the south-west and Lower Manya Krobo in the south-east.

3.3 Study Population

The study participants included pregnant women of all ages from urban and rural settings attending antenatal services in the two selected health facilities. Participants from MGH were urban dwellers and those from AGH were rural dwellers. Enrolment of the study participants at MGH was done from Monday to Friday at the antenatal care unit. At the AGH, enrolment was done on Asesewa market days (Monday and Friday) which is designated for the villagers. Deductions from the study could therefore account for pregnant women from both urban and rural settings.

3.4 Sample size

Assuming an alpha level of 0.07, a power of 95% and prevalence of anaemia in pregnancy 44.6% (Ghana Statistical Service et al., 2015). The sample size was determined using Cochran (1963:75) equation for larger population:

$$N_1 = \frac{\mathrm{Z}^2\ \mathrm{p}\ (1 - \mathrm{p})}{d^2}$$

Where;

- N_1= The required sample size,
- Z= Statistical certainty of 1.96 at confidence interval (95%),
- P=Estimated Proportion of anaemia in pregnancy (44.6%)
- d = margin of error/ level of precision (7%)

$$N_1 = \frac{1.96^2 * 0.446\,(1 - 0.446)}{0.07\hat{\ }2}$$

= 194 rounded up to 200

With an average monthly ANC attendance of 900 for Maamobi, the proportionate sample size was;

$$N_m = \frac{900}{1420} \text{ x } 200$$

= 126 pregnant women (participants)

Asesewa Government Hospital had a corresponding proportionate sample size of;

=74 pregnant women (participants)

3.5 Selection of study participants and sampling technique

Pregnant women accessing antenatal services during the study period were approached during their antenatal care (ANC) visits and informed about the study. Simple random sampling was used to select the first respondent among the first seven pregnant women and thenceforth, systematically picked every third (3rd) pregnant woman. A systematic interval was chosen by dividing the average monthly coverage (1420) by the required sample size (200). Study participants were recruited upon giving their consent by signing or thumb printing the consent form.

3.5.1 Inclusion criteria

Pregnant women with no known medical, surgical, or obstetric problems, who consented to participate in the study and have resided in the study sites for at least one year prior to the period of the study was included. One year was appropriate as it covers the whole food security cycle.

3.5.2 Exclusion criteria

Pregnant women with chronic diseases such as cancer, sickle cell disease, Glucose-6-phosphate dehydrogenase (G6PD) and diabetes were excluded from the study. This is because these conditions are known to impact on the nutritional status of an individual. Those health information was obtained from the respondents, respondents' antenatal care booklet and from the hospital records.

3.6 Data collection

A structured questionnaire (Appendix IV) was administered using computer assisted personal interviewing (CAPI) on Android phones which was designed using Census and Survey Processing System (CSPro) Version 7.1 (US Census Bureau., 2018).

3.6.1 Recruitment and training of field assistants

Two field assistants each for Maamobi and Asseswa were recruited and trained for the data collection. The field assistants for Maamobi were fluent speakers of both English and Twi, whilst those for Asesewa were fluent in English and Krobo as these were the most commonly spoken languages by the pregnant women attending these hospitals for services. The field assistants were trained to administer the questionnaire in English and translate it to Twi or Krobo depending on the facility. They were taken through all the research tools involved in order to appropriately collect the data required.

3.6.2 Pretesting of data collection tools

The research tools were pre-tested on 20 pregnant women (i.e. 10% of the expected sample size) at the antenatal unit of Adabraka Polyclinic to establish whether the tools could generate the information needed and with precision. All questionnaires were reviewed for errors and inconsistencies. Feedback from the pretesting exercise helped in improving the tool.

3.6.3 Socio-demographic and household data

Information of caregivers' socio-demographic characteristics (age, marital status, ethnicity, religion, education level, occupation, and income), household characteristics were taken using semi-structured questionnaire. Information taken on household assets was used to calculate wealth index of the households using principal component analysis as described by Fry, Firestone, & Chakraborty (2014).

3.6.4 Nutritional Status Assessment

Mid-upper arm circumference (MUAC) and haemoglobin levels were used to assess the nutritional status of the pregnant women. MUAC was used as a proxy for body weight, since it is not affected by gestational age. MUAC was measured to the nearest 0.1cm, and values below 25.0cm were classified in the analyses as an indicator of low body weight as it is a preferred indicator due to its relatively strong association with low birth weight (LBW) (Ververs, Antierens, Sackl, Staderini, & Captier, 2013).

Haemoglobin levels were determined by using a portable HemoCue 301 photometer. Anaemia is said to be a severe public health problem when its prevalence is 40% or more in any group (all types of anaemia) or when severe anaemia (haemoglobin < 7g/dl) exceeds 2%.

3.6.5 Dietary assessment and nutrient intake

A single 24-hour recall was used to generate information on the dietary intake of the participants. The 24-hour dietary recall captured detailed information on all foods and beverages the respondent consumed within the previous 24 hours. Food models, pictures, household utensils and other visual aids were used to help respondents judge and report on portion sizes. The time of food consumption was also recorded. A reference period of 24-hour was used in this study as it minimizes the recall bias thus improving on accuracy.

3.7 Calculation of probability of adequacy (PA) and mean probability of adequacy (MPA)

Nutrient intake calculations were based on a food composition table specifically developed for the study. The primary data source for nutrient values of foods was adopted from the Food Composition Table use by Partnership for Child Development (PCD) for the Ghana School Feeding Programme.

The probabilities of adequacy (PA) for vitamins A (RAE), C, riboflavin, B_{12}, B_6, thiamine, niacin, folate, zinc, calcium and iron was calculated based on their respective estimated average requirements (EARs) and distributions (Martin-Prével et al., 2015). The PAs were calculated by computing PA = CDFNORM [(observed individual intake - EAR)/Standard Deviation] in SPSS.

The resulting values for probability of adequacy range, by definition, from 0 to 100%. Mean probability of adequacy (MPA) was computed as the average of PAs of all 11 micronutrients.

3.8 Dietary diversity score

The dietary diversity score was derived based on Food and Agriculture Organisation (FAO) Minimum Dietary Diversity for Women (MDD-W): A Guide to Measurement (FAO & FHI360, 2016). Every food group consumed in the previous 24 hours received a score of 1 (irrespective of number of food items eaten from the food group), when consumed in quantities of 15g or more. The total food scores for each individual were summed up to get the MDD-W. The population of women who reported consuming at least five of the 10 defined food groups in the previous 24 hours was considered to have a higher likelihood of micronutrient adequacy. The ten food groups comprised: 1. Grains, white roots and tubers, and plantains; 2. Pulses (beans, peas and lentils); 3. Nuts and seeds; 4. Dairy, 5. Meat, poultry and fish; 6. Eggs; 7. Dark green leafy vegetables; 9. Other vegetables and 10. Other fruits.

3.9 Data analysis

Data collected with the CSEntry (Census and Survey Entry) Android App were exported into SPSS version 23 statistical software and analysed. Descriptive statistics were used to summarise the data: continuous variables were summarized as mean ± SD and categorical variables as frequencies and percentages. Correlation analysis was used to determine the association between dietary diversity, mean probability of adequacy, haemoglobin concentration and sociodemographic characteristics. Multiple regression analysis was used to determine the predictors of dietary diversity and micronutrient adequacy. Results with a *p* value <0.05 were considered statistically significant to be the predictors of dietary diversity and nutrient adequacy.

Table 3.1: Summary of variables and data analysis

Objective	Dependent variable	Variable type	Independent variable	Variable type	Statistical Test
To assess dietary diversity and micronutrient intake among pregnant women					Descriptive statistics
To determine the probability of adequacy (PA) and mean probability of adequacy (MPA) of selected micronutrients					Descriptive statistics
To determine the predictors of dietary diversity (MDD-W) among pregnant women	Dietary diversity score	Scale	Socio-demographic and economic and morbidity factors	Categorical and Continuous	Multiple regression analysis
To determine factors associated with micronutrient adequacy among pregnant women	Micronutrient adequacy	Scale	Socio-demographic and economic and morbidity factors	Scale and categorical	Multivariate regression analysis
To determine the relationship between Dietary diversity (DDS) and haemoglobin (HB) concentration of pregnant women	Haemoglobin (HB)	Scale	Dietary diversity score	Scale	Multiple regression

3.10 Quality Control

Results from the pre-test was assessed to ensure that the questions solicited the information intended. Appropriate modifications were done to enhance reliability and validity of the tools by the supervisors of the study.

3.11 Ethical Clearance

Ethical approval for this study was obtained from the Ghana Health Service Ethics Review Committee and the Ethics Committee for College of Basic and Allied Sciences (ECBAS). Permission was sought from the management of Maamobi General and Asesewa Government Hospital before commencement of the study.

Privacy and confidentiality were maintained during data collection and the interviews conducted one-on one at a place quite away from where care is being provided to the other clients. No personal identifiers like names of patients was recorded. A written informed consent was obtained from the individual respondents before interviewing them (Appendix I – III).

CHAPTER FOUR

4.0 RESULTS

4.1 Background characteristics of pregnant women

The study covered a total of 200 pregnant women with mean age of (Mean (M) ± standard deviation (SD) = 27.4 ± 5.4). Majority (73.0%) of the women were married but 36% of them being *nulliparous*. Many (55.0%) of the women were renting their dwelling places with about 38.0% of them being traders. The highest level of education attained by many (41%) of the respondents was primary/junior high education. Christianity was the predominant religion practiced by most of the respondents (72.5%) and Northerners formed the highest proportion (23%) of the study population in Maamobi whilst Asesewa was dominated by Krobos (70%). Details of the demographic characteristics of the respondents are shown in table 4.1 below.

Table 4.1: Demographic characteristics of respondents (N=200)

Pregnant women's characteristics	**n (%)**
Age categories	
Mean ±SD	27.4 ± 5.4
15 – 19	21 (10.5)
20 – 24	34 (17.0)
25 – 29	74 (37.0)
30 – 35	50 (25.0)
>35	21 (10.5)
Marital status	
Married	146 (73.0)
Partner	15 (7.5)
Single/divorced/ separated	39 (19.5)
Parity	
0	72 (36.0)
1	43 (21.5)
2	45 (22.5)
More than 2 children	40 (20.0)
Residential status	
Not renting	89 (44.5)
Renting	111 (55.5)
Occupation	
Farming	9 (4.5)
Artisan	60 (30.0)
Civil servant	18 (9.0)
Trader	76 (38.0)
Unemployed	37 (18.5)
Level of education	
No Education	21 (10.5)
Primary	83 (41.5)
Secondary/SHS	20 (10.0)
Tertiary	76 (38.0)

SD = Standard deviation

(Table 4.1: Continued) Demographic characteristics of respondents (N=200)

Respondents' characteristics	n (%)
Ethnicity	
Akan	24 (12.0)
Ewe	34 (17.0)
Ga	18 (9.0)
Krobo	60 (30.0)
Kotokoli	10 (5.0)
Hausa	25 (12.5)
Northerner	29 (14.5)
Religion	
Christian	145 (72.5)
Muslim	55 (27.5)

4.2 Household characteristics

The mean Household size of the pregnant women reported was 4 ± 1.9, ranging from 1 to 15 persons (Table 4.2). The modal family size category was 4 to 6 (51%) and the least was 7 to 15. Majority of the households of women were headed by their husbands, 143 (71.5%). Most of the household heads were males (84%) with majority of them employed as Artisans (41.5%), civil servants (24.5%), traders (23.0%) and farmers (9.5%).

Table 4.2: Household characteristics of respondents (N=200)

Household characteristics	**n (%)**
Household size (Mean ±SD)	4±1.86
Head of household	
Husband	143 (71.5)
Partner	14 (7.0)
Respondent	18 (9.0)
Other relative	25 (12.5)
Sex of household head	
Male	168 (84.0)
Female	32 (16.0)
Occupation of household head	
Farming	19 (9.5)
Artisan	83 (41.5)
Civil servant	46 (23.0)
Trader	49 (24.5)
Unemployed	3 (1.5)

SD = Standard deviation

Among the 200 participants, 165 (88.5%) had electricity, 82.5% possessed colour television 70.5% had bank accounts (Table 4.3). About 60.5% of the respondents used sachet/bottled water as their source of drinking water. Nearly half (49.5%) of the respondents possessed refrigerators. Kitchen cabinet/cupboard was possessed by 57.5%, video deck (58.5%) and LPG (liquefied petroleum gas) 41.0% respondents. Wall clock (35.5%) and agricultural land (19.0%) were the items least possessed by households of the respondents. Only 57 (28.5%) of the respondents had no toilet facilities in their households but the housing quality was above average as 175 (87.5%) households had cemented floors and 139 (69.5%) had their exterior walls cemented. Many (35.5%) of the participants in this study were in the highest wealth quintile with only 8.0% being in the lowest quintile

Table 4.3: Household assets of respondents (N=200)

Household items	**n (%)**
Colour television	165 (82.5)
Agricultural land	38 (19.0)
Refrigerator	99 (49.5)
Video deck/DVD/VCD	117 (58.5)
Bank account	141 (70.5)
Electricity	177 (88.5)
Wall clock	71 (35.5)
Cabinet/cupboard	115 (57.5)
Type of fuel	
LPG	82 (41.0)
Toilet facility	
No facility / bush / field	57 (28.5)
Main source of drinking water	
Sachet water	121 (60.5)
House quality	
Cement floor	175 (87.5)
Cement exterior wall	139 (69.5)
Wealth Index	
Lowes quintile	16 (8.0)
Low quintile	28 (14.0)
Middle quintile	39 (19.5)
High quintile	46 (23.0)
Highest quintile	71 (35.5)

LPG = Liquefied petroleum gas

4.3 Maternal health

4.3.1 Maternal morbidity

Only 12 (6%) of the respondent reported sick in the previous two weeks (Table 4.4 below). Fever had the highest proportion of respondents representing 41.7% followed by diarrhoea cases (33.3%) of the 12 respondents who reported sick. The rest were anorexia, vomiting and constipation suffered by one person each. The duration of the sicknesses ranged from 1 day (5 pregnant women) to14 days (1 pregnant woman). Out of the 12 respondents who reported sick only 4 sought medical attention, 2 went to government hospital and the other 2 went to private facilities.

Table 4.4: Morbidity of respondents

Morbidity		**n(%)**
Sick in the past 2 weeks		12 (6.0)
Type of sickness		
Anorexia		1(8.3)
Vomiting		1(8.3)
Fever		1(41.7)
Constipation		1(8.3)
Diarrhoea		1(33.3)
Duration of sickness (days)		
1		5(41.7)
2		2(16.7)
3		4(33.3)
14		1(8.3)
Sought medical attention		4(33.3)
Source of medical attention		
government hospital	2	2(50.0)
Private hospital	2	2(50.0)

4.3.2 Antenatal services

More than half of the respondents had made four (4) or more antenatal visits with 37.5% taking only iron and folic acid (IFA) supplements and 49.0% taking multiple micronutrient supplements (MMN) only (Table 4.5). Only 7 (4.0%) of the respondents bought their medication from a shop, the rest had their supply from the health facility. It was observed that some of those who bought their supplements did not buy them based on professional prescription as some of them indicated that they were visiting the ANC for the first time during their current pregnancy. About 17 (8.5%)

of the respondents were not taking any medication because it was their first visit. Only 5 of the respondents did not take their medication daily due to forgetfulness. Craving for non-food substances (pica) was not very much reported, 8.5% (17).

Table 4.5: Antenatal attendance (N=200)

Variables	**n (%)**
Gestational age (weeks)	
Mean ±SD	25.74±8.8
1st Trimester	18 (9.0)
2nd Trimester	85 (42.5)
3rd Trimester	97 (48.5)
Antenatal attendance	
Once	23 (11.5)
twice	32 (16.0)
Thrice	31 (15.5)
4 and above	114 (57.0)
Haematinics	
IFA only	72 (37.5)
MMN only	98 (49.0)
IFA plus MMN	10 (05.0)
No supplement	17 (08.5)
Source of medication	
Health centre	166 (96.0)
Bought from shop	7 (04.0)
Do you take them daily?	
Yes	178 (89.0)
No	5 (02.5)
Not yet given	17 (08.5)
Reason for not taking	
I usually forget	5 (14.3)
Intake of pica	17 (08.5)

IFA = Iron folic acid supplement tablet; MMN = Multiple Micronutrient supplements tablet
SD = Standard deviation

4.4 Nutritional status

The mean haemoglobin (HB) status of the total respondents was found to be 11.13±1.4g/dl and ranging from 7.2 to 14g/dl. None of the respondents however was severely anaemic.

The nutritional status of the respondents by measurement of their mid-upper arm circumference (MUAC) revealed a mean of 28.5±3.6cm and ranging from 21.5cm to 40cm. Out of the 200 pregnant women in the study 84% of them were within the normal cut-off point for mid-upper-arm circumference (MUAC ≥25cm).

Table 4.6: Nutritional status of respondents (N=200)

Variables	**n (%)**
Severity of Anaemia	
Normal	108 (54.0)
Mild	82 (41.0)
Moderate	10 (5.0)
Severe	0 (0.0)
MUAC ≥25cm	168 (84.0)

MUAC = mid-upper arm circumference

4.5 Dietary diversity and micronutrient intake of respondents

4.5.1 Consumption frequency of food groups

The most commonly consumed food groups within the previous 24 hours were grains, white roots and tubers and plantain (100%), meat, poultry and fish (98%) and other vegetables (78%) (See figure 4.1). About half of the population took dark green leafy vegetables. Less than 50% of the population consumed vitamin A rich fruits and vegetables, eggs, pulses, other fruits, nuts and seeds, and milk and milk products. The least consumed food group was milk and milk products (27.5%).

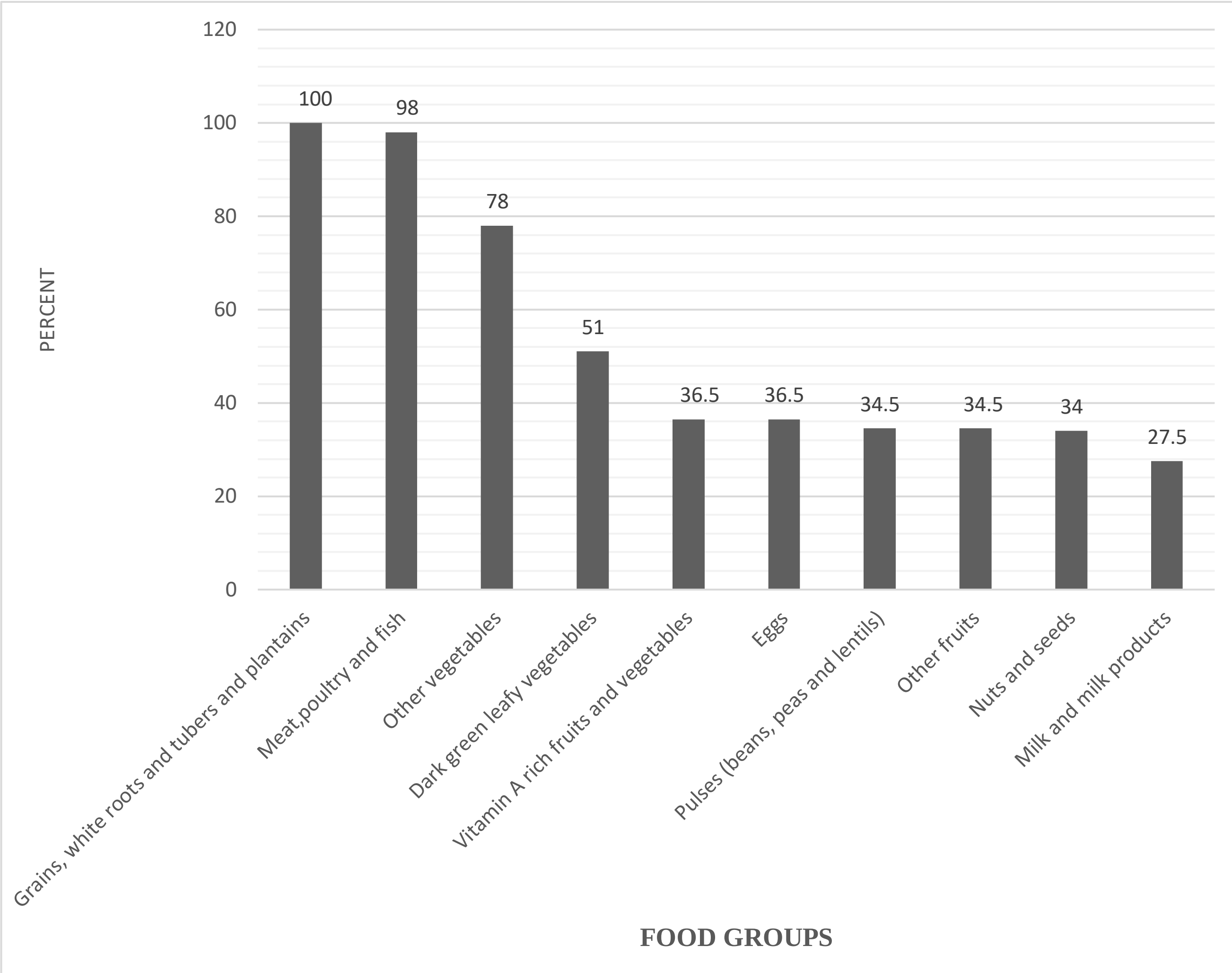

Figure 4.1: Consumption of food groups by respondents

4.5.2 Dietary Diversity Score

Out of the 10 food groups, the mean dietary diversity score (DDS) for the previous 24 hours was 5.3±1.6, ranging from 2 to 10 food groups (Table 4.7). Based on the 10 food group score, the highest proportion of the respondents scored 4 food groups (24%) followed by 5 food groups (23.50%) and the least proportion of respondents scored 10 food groups (0.5%) and 9 food groups

(1.0%). A total of 131 (65.5%) were identified to have met the minimum dietary diversity for women (MDD-W), that is those who had DDS of 5 or more scores.

Table 4.7: Dietary diversity scores by respondents for the previous 24 hours

Variables	**Total(n=200) n (%)**
Dietary diversity score	
2	5 (2.5)
3	16 (8.0)
4	48 (24.0)
5	47 (23.5)
6	36 (18.0)
7	28 (14.0)
8	17 (8.5)
9	2 (1.0)
10	1 (0.5)
MDD-W (DDS ≥5)	131 (65.5)

MDD-W=minimum dietary diversity for women; DDS =Dietary diversity score

4.5.3 Micronutrient intake

The diet intake of the respondents for the previous 24 hours was analysed for eleven micronutrients (Table 4.8). Out of the eleven micronutrients only the mean intake of Vitamin A and C were above their corresponding estimate average recommendation (EAR). The study revealed that dietary micronutrient intake of pregnant women did not meet their average requirements.

Table 4.8: Micronutrient intake of respondents

Micronutrients	WHO/FAO EAR ± SD	Mean ±SD
Vitamin A (mcg)	**370±74.00**	**378.75±574.25**
Vitamin B_{12} (mcg)	2.20±0.22	0.84±0.75
Vitamin B_6 (mg)	1.60±0.16	0.92±0.57
Vitamin C	**46.0±4.60**	**70.66±47.57**
Calcium (mg)	800±100.00	332.5±194.37
Folate (mcg)	520±52.00	220.41±190.63
Iron (mg)	24.90±2.34[a]	18.11±9.74
Niacin (mg)	14.00±2.10	12.11±6.35
Riboflavin (mg)	1.20±0.12	0.88±0.66
Thiamine (mg)	1.20±0.12	0.96±0.49
Zinc (mg)	8.00±1.00[b]	4.53±3.31

EAR= estimated average recommendation (Source: Martin-Prével et al. (2015))
[a] Based on 10% bioavailability; [b] Based on 25% bioavailability

4.6.1 Probability of nutrient adequacy (PA) and mean probability of adequacy (MPA)

The probability that intake of the 11 selected micronutrients is adequate for the total study population was analysed and presented in Figure 4.2. The highest mean probability of adequacy was vitamin C (64.5%), which was the only micronutrient with a mean probability of adequacy greater than 50%. The mean probability of adequacy for niacin, vitamin A and thiamine were respectively 31.3, 28.6% and 27.0%. The rest of the micronutrients were less than 25%. Mean probability of adequacy across the 11 micronutrients was 22.4%.

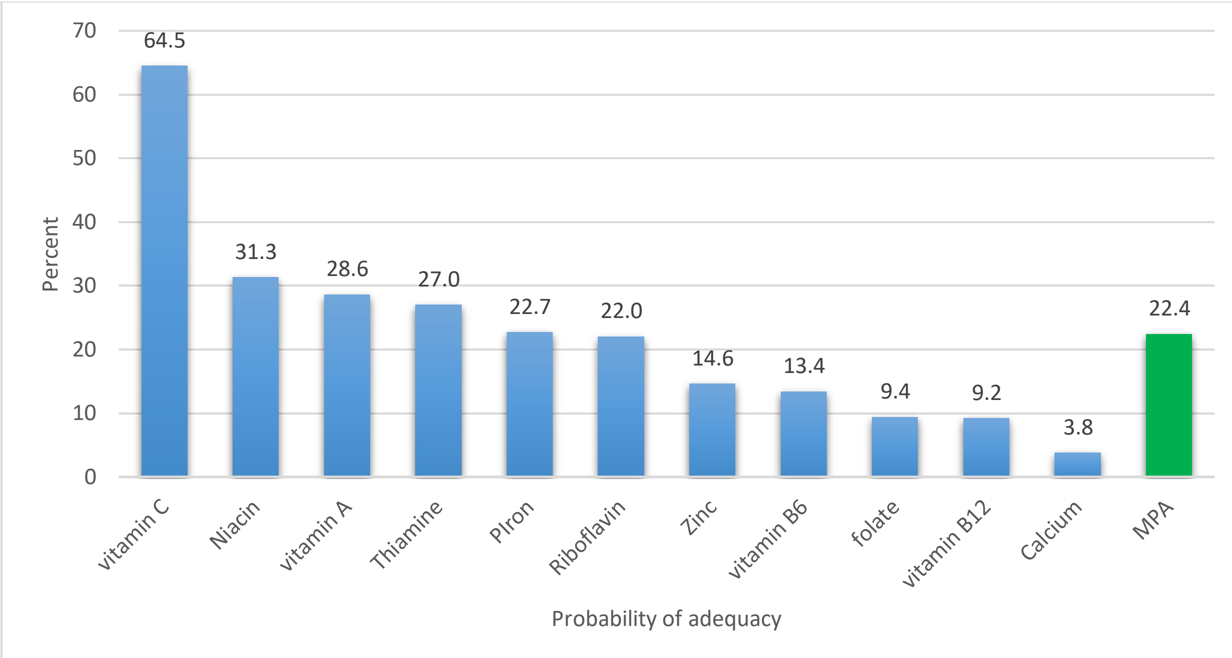

Figure 4.2: Probability of micronutrient adequacy

4.6.2 Relationship between respondents' dietary diversity and probability of micronutrient adequacy

Bivariate analysis was done to investigate the association between dietary diversity and micronutrient adequacy (Table 4.9). The study showed no significant correlation between MPA and DDS (r = 0.077, p = 0.279). A positive association existed between the DDS and the probabilities of adequacy of the 11 selected micronutrient but none of the relationships were statistically significant ($p < 0.05$).

Table 4.9: Relationship between dietary diversity and probability of adequacy

Variable	*r*	*p*
DDS		
MPA	-0.077	0.279
PA of vitamin A	-0.051	0.471
PA of vitamin B_{12}	0.127	0.074
PA of vitamin B_6	0.019	0.792
PA of vitamin C	0.138	0.051
PA of Calcium	-0.104	0.144
PA of folate	-0.065	0.363
PA of Iron	-0.115	0.105
PA of Niacin	-0.059	0.407
PA of Riboflavin	-0.096	0.175
PA of Thiamine	-0.052	0.467
PA of Zinc	-0.106	0.136

4.7 Relationship between respondents' dietary diversity and socio-demographic characteristics

4.7.1 Association between respondents' dietary diversity and socio-demographic characteristics

The association between dietary diversity and the socio-demographic characteristic of respondents were investigated and the results presented in Table 4.10. The association between dietary diversity scores and wealth index score of the pregnant women were significantly weak (r = -0.240, p =

0.001). The rest of the variables included in the analysis did not also show any significant relationship with dietary diversity.

Table 4.10: Association between dietary diversity and maternal characteristics

Variables	***r***	***p***
Dietary Diversity Score [DV]		
MUAC	0.002	0.980
Wealth Index Score	0.240	0.001**
Respondent's age	0.093	0.192
Gestation in weeks	0.013	0.851
Parity	0.023	0.748
Children <5 years in HH	0.011	0.875
Household size	0.092	0.196

[DV] Dependent variable; r = Pearson's correlation; **significant at $p < 0.01$

4.7.2 Predictors of dietary diversity

A regression analysis was performed to identify the predictors of dietary diversity and the results presented in Table 4.11. The results of multiple linear regression indicated that there was a collective significant effect between dietary diversity and Wealth Index Score, education, renting of dwelling place and household size. About 11% of the total variability in dietary diversity could be explained by the model, ($F(7, 192) = 4.511$, $p < 0.001$, adjusted $R^2 = 0.11$).

The beta (β) coefficient in the model showed that for every single increase in a respondent's wealth index score her dietary diversity increased by a score of 0.829. Respondents who were in rented dwelling places had DDS of 0.654 lower than those who were not renting. The rest of the respondent's characteristics, educational status, marital status, age and family size of the respondents were not statistically significant.

Table 4.11: Predictors of dietary diversity among respondents

Variables	Beta (β)	95%CI	*p*
Renting of dwelling place			
Renting	-0.654	- 1.136, -0.173	**0.008***
Not renting	Ref.	Ref	Ref.
Wealth Index Score	0.829	0.412, 1.246	**<0.001***
Marital status			
Married	0.325	- 0.231, 0.882	0.250
Not married	Ref.	Ref	Ref.
Household size	0.041	- 0.082, 0.163	0.514
Educational status			
Educated	0.602	- 0.093, 1.298	0.089
Non-educated	Ref.	Ref.	Ref.
Respondent's age	-0.001	- 0.043, 0.041	0.973
Employment status			
Employed	0.348	- 0.234, 0.929	0.240
Not employed	Ref.	Ref.	Ref.

$F(7, 192) = 4.511$, $p < 0.001$, Adjusted $R^2 = 0.11$; Ref. =Reference variable; * $p < 0.05$

4.8 Relationship between respondents' mean probability of adequacy and respondents' characteristics

4.8.1 Association between mean probability of adequacy and respondents' characteristics

The relationship between respondents' micronutrient adequacy and maternal characteristics was investigated and the results presented in Table 4.12 below. The results showed that wealth index was negatively related to MPA (r = -0.221, p = 0.002). The MPA of a pregnant woman was as well significantly related with age (r = - 0.158, p =0.025). The MPA of the pregnant women was not significantly associated with MUAC (p = 0.572), gestational age in weeks (p = 0.950), parity (number of births of woman) (*p* = 0.283), children <5 years in the household (*p* = 0.786) and household size (*p* = 0.663).

Table 4.12: Relationship between mean probability of adequacy and maternal characteristics

Variable	***r***	***p***
MPA ^{DV}		
Dietary Diversity Score	-0.077	0.279
MUAC	-0.040	0.572
Wealth Index Score	**-0.221**	**0.002****
Respondent's age	**-0.158**	**0.025***
Gestation in weeks	0.004	0.950
Parity	-0.076	0.283
Children <5 years in the household	-0.019	0.786
Household size	0.031	0.663

r = Pearson's correlation; HH = Household; **significant at $p < 0.0$; *significant at $p < 0.05$

4.8.2 Predictors of mean micronutrient adequacy

In assessing the possible predictors of micronutrient adequacy of the respondents, variables that were found in literature to be explanatory variables of with micronutrient adequacy were analysed by multivariate regression analysis (Table 4.13). The resulting model could explained about 10% of the total variance associated with the probability of micronutrient adequacy. The study revealed that wealth index, occupation, sex of household head and age of the respondents were predictors of micronutrient adequacy. The results indicated that for every increase in one score of wealth index, the mean probability of adequacy (MPA) decreased by 0.112. The model also predicted that the MPA of civil servants was about 31.3% higher than that of farmers. The MPA of artisans and traders were 0.203 and 0.186 respectively higher than the MPA of farmers. Respondents who were unemployed, had MPA of 0.236 higher than respondents who were farmers.

Renting of dwelling place, sex of household and age of respondent were not found to be significant predictors of MPA.

Table 4.13: Predictors of mean probability of adequacy of respondents

Variable	Beta (β)	95%CI	*p*
Wealth Index Score	**-0.112**	**- 0.174-, 0.049**	**0.001****
Respondent's age	-0.003	- 0.009, 0.003	0.300
Renting of dwelling place			
Renting	-0.045	- 0.109, 0.019	0.166
Not renting	Ref.	Ref.	Ref.
Occupation			
Artisan	**0.203**	**0.044, 0.363**	**0.013***
Trader	**0.186**	**0.032, 0.340**	**0.018***
Civil Servant	**0.313**	**0.126, 0.500**	**0.001****
Unemployed	**0.236**	**0.069, 0.404**	**0.006****
Farmer	Ref.	Ref.	Ref.
Sex of HH head	0.074	- 0.009, 0.156	0.074

$F(8, 191) = 3.668$, $p = 0.001$, Adjusted $R^2 = 0.10$
*significant at $p<0.05$; **Significant $p<0.01$
Ref. =Reference variable

4.9 Relationship between respondents' haemoglobin concentration and characteristics

4.9.1 Association between respondents' haemoglobin and characteristics

From Table 4.14, the study showed that household wealth index score and location (rural or urban) were both significantly associated with haemoglobin concentration ($r = 0.171$, $p = 0.016$ and $r =$

0.176, p = 0.012 respectively). The rest of the indicator included in the analysis were not found significantly related with haemoglobin status of the respondents.

Table 4.14: Association between haemoglobin status and respondents' characteristics

Variables	***r***	***p***
Haemoglobin status		
MPA	0.080	0.262
Dietary Diversity Score	0.100	0.161
MUAC	0.108	0.127
Wealth index score	**0.171**	**0.016***
Respondent's age	0.015	0.830
Gestation in weeks	-0.286	0.171
Parity	0.034	0.636
Children < 5 years in the HH	-0.012	0.862
Household size	-0.065	0.361

r = Pearson's correlation; *rho* = Spearman's correlation; HH =Household;
*significant at $p < 0.05$

4.9.2 Predictors of haemoglobin concentration status

A multivariate analysis revealed that the variables in Table 4.15 could significantly explain about 7% of the variability in the haemoglobin concentration. It was observed that gestation in weeks was negatively associated with haemoglobin status. For every additional week of gestation the haemoglobin concentration decreases by 0.026 gm/dL. The model also predicted that those in Asesewa had 0.469gm/dL lower concentration of haemoglobin compared to those from Maamobi. A positive association was as well observed between haemoglobin concentration among women employed (Beta (β) = 0.560 gm/dL, p = 0.025) compared with women who were not employed.

Table 4.15: Predictors of haemoglobin concentration of respondents

Variables	Beta (β)	*P*	95%CI
Sex of HH head			
Male	-0.309	0.233	-0.818 -0.200
Female	Ref.	Ref.	Ref.
Residential status			
Renting	-0.259	0.206	-0.661 -0.144
Not renting	Ref.	Ref.	Ref.
Gestation in weeks	-0.026	**0.020***	-0.048, -0.004
Location			
Asesewa	-0.469	**0.025***	-0.878, -0.060
Maamobi	Ref.	Ref.	Ref.
Dietary Diversity Score	-0.085	0.160	-0.204, 0.034
MUAC	0.040	0.134	-0.013, 0.094
Employment status			
Employed	0.560	**0.025***	0.070, 1.050
Not Employed	Ref.	Ref.	Ref.

F(14, 185) = 2.230, p = 0.008, Adjusted R^2 = 0.07

*significant at p<0.05

Ref. =Reference variable

CHAPTER FIVE

5.0 DISCUSSION

5.1 Demographic characteristics

Findings from the study suggested that the characteristics of most of the women provided conducive environment for healthy pregnancy. Most of the women were in their late twenties. Age is a very important determinant of maternal health and pregnancy outcomes as supported by Manyeh et al. (2016) who observed that women aged ≥ 20 years were about twice less likely to have low birth weight (LBW) (birth weight ≤ 2.5 kg) compared with women aged less than 20 years. Sutan, Mohtar, Mahat, & Tamil (2014) also noted in a case control study that pregnant women younger than 18 years were about 3 times likely to give birth to low birth weight baby than women older than 18 years.

In addition to the age, other favourable characteristics were the high proportion of pregnant women having occupation and either married or with a partner. As spelt out in the conceptual framework of malnutrition, maternal care is very crucial at all stages especially during pregnancy if a healthy intergenerational cycle is desired (Bellamy, 1998). Employment also plays very important role in this framework and it has been noted by Manyeh et al. (2016) in a study that mothers who were civil servants were 77 % more likely to have babies weighed ≥2.5 kg compared to those who were unemployed.

Literacy is one powerful characteristic that can facilitate learning thereby leading to positive behavioural change for a better and health life. Over 80% of the respondents and their household heads had attained at least basic education and so the use of communication media such as leaflets, mobile phone text messaging and WhatsApp could be used to facilitate health and nutrition education. For instance, analysis of data from the Ghana Multi-cluster Survey (GSS, 2011) indicated that children of educated mothers are more likely to have diversified diet than non-educated mothers. It is however worth noting that factors that influence learning are not exclusive to only literacy and so high literacy might not translate into positive health if the other factors are not addressed as Tampah-Naah, Anzagra, & Yendaw (2016) observed that non-educated mothers were about 56% less likely to give birth to low weight birth.

5.2 Maternal health, antenatal characteristics

A small proportion (6%) of the women in the study reported having fallen sick in the previous two weeks before the study. Episodes of sicknesses during pregnancy highly suggests unfavourable conditions for the pregnant women and that could also affect the outcome of the pregnancy. The period at which the study was taken could be a reason for which less episodes of sickness were reported. The burden of diseases are more often experienced among women and their children during raining seasons but the rains had not set in at the time of the study. In addition, the high access to health workers as well as television and radio indicated that pregnant women might have had adequate knowledge with regards to disease prevention.

Responds to antenatal clinic attendance was very encouraging as more than 50% of the women had received 4 or more antenatal services. The observation in the study area is similar to the national percentage (97%) of access to antenatal services by pregnant women (Ghana Statistical Service et al., 2015). Supplementation of either multiple micronutrients or elemental iron with folic acid was very high. Pregnant women therefore had other sources of making up with the dietary iron. It was observed that some of the pregnant women even bought multiple micronutrients from stores to start taking before registering for antenatal care. There was also indications that those who were taking micronutrients prescribed by health professionals also were taking other non-prescribed micronutrient supplements.

5.3 Nutritional status of respondents

The anthropometric measurement employed for determining the nutritional status of the respondents was mid-upper-arm circumference (MUAC). Only 6% of the women were below 25cm. There has not been any international cut-off range for MUAC measurement for adults but it has been reported by many studies that MUAC is a better predictor for pregnancy outcomes (Wynn, 1997). A number of studies have also indicated that pregnant women with MUAC measurements less than 25cm have higher risk of preterm births, small for gestational births and babies with low birth weight (Kruger, 2005). The high prevalence of the respondents in the normal (MUAC ≥25cm) category indicates that adverse pregnancy outcomes is more likely to be low among the study population.

The results indicate that mean haemoglobin (HB) concentration of the respondents was within the WHO (2007) cut-off for normal range of ≥11.0gm/dL for pregnant women. The results revealed that 46.0% of the study population were anaemic with most of them being mildly anaemic. This findings was similar to the national prevalence of 44.6% (Ghana Statistical Service et al., 2015) but none of the women were found to be severely anaemic. The high prevalence could be explained by the low iron intake and also confirm the low probability of iron adequacy in the study population.

5.4 Dietary diversity and micronutrient intake of pregnant women

Literature revealed that consumption of plant based foods are predominant in the diet of women in Africa (Torheim et al., 2010). The study results from the single 24-hour recall, showed that all the pregnant women had consumed grains, white roots and tubers. Almost all the women also had consumed meat, poultry and fish in the previous 24-hours prior to the day of interview. The observed dietary intake is similar to the findings of a study in the Northern Region of Ghana that revealed that the daily diet of the women was predominantly cereals, and root and tubers (Saaka & Rauf, 2015).

The study showed that the mean dietary diversity score (DDS) was 5.3±1.58. The results can be compared to the observation in Bangladesh that also used MDD-W and had a mean score of 5.3±1.58 (Nguyen et al., 2018). The mean score observed was however higher than the 4.2±1.5 gotten from pregnant women in the Northern Region using MDD-W (Saaka & Galaa, 2017). Even though the mean DDS met the MDD-W, nutrient dense food groups such as 1) vitamin A rich fruits and vegetable; 2) eggs; 3) pulses (beans, peas and lentils); 4) nuts and seeds; 5) milk and milk products, and 6) other fruits were consumed by less than 50% of the population. The low proportion of the population consuming these food groups implies that their nutrient intake might be low despite the fact that they met the MDD-W.

The mean micronutrient intake of vitamin A and C were the only micronutrients among the 11 micronutrients assessed that were above the estimated average recommendation (EAR). As might be expected, the food group consumption was skewed to mainly the grains, other vegetables and meat. With a high proportion of women consuming meat the expectation would have been than the nutrient intake values for micronutrients such as iron, zinc and folate would have been favoured. The possible explanation to this observation may be that the quantity of meat or fish consumed was small. Similarly, the overall nutrient intake values were not reflective of the food diversity score due the high consumption of grains. The findings were similar to the review of studies on diet intake of African women which showed that vitamin A and C intake were above the EAR in most African countries in the review (Lee et al., 2013). The high intake of these two micronutrients could also be associated with the high availability of yellow flesh mango during the period of the study. However it has been observed that dietary intake changes with season (Savy et al., 2006) and it is likely that the value of vitamin A and C will reduce when mangoes are off season.

The low probability of micronutrient adequacies indicate the vulnerability of pregnant women to micronutrient deficiencies. Deficiencies in micronutrient may have serious implications on the health of the mother and the foetus.

5.5 Probability of nutrient adequacy (PA) and mean probability of adequacy (MPA) among pregnant women

The probability of the study population meeting their nutrient needs was 22.4%. A 22.4% micronutrient adequacy indicates serious gap in pregnant women meeting their needs and that of the foetus. Despite a high MDD-W score of about 5 the dietary intake by the participants were based mainly on three food groups, namely; 1) grains, white roots and tubers and plantain; 2) meat, poultry and fish and 3) other vegetables. This might have contributed to the low MPA observed. Calcium, folate and vitamin B_{12} were the micronutrients with the lowest adequacy of less than 10%. The findings was below the 40% MPA observed in Bangladesh (Nguyen et al., 2018) and a similar result in Mali (Kennedy et al., 2010). Despite the high dietary diversity score, the PAs of all the micronutrients except vitamin C were less than average. The possible reason to this is that the food varieties taken from the food groups could be having very low nutrient densities and so do not actually significantly improve the nutrient intake (Habte & Krawinkel, 2016). The PA for calcium was the least (3.8%) and could be due to the low intake of pulses nuts and seeds. One other possibility could be that bones from fish are usually not consumed despite the high consumption of meat, poultry and fish food group.

5.6 Predictors of dietary diversity

In this study, the only significant predictors found were socioeconomic status (wealth index score) and renting of dwelling place. Dietary diversity was found to be associated with household socioeconomic status. Comparable conclusion was also made by Codjoe et al. (2016) suggesting that household dietary diversity is positively associated with wealth index score. The findings therefore suggests that increasing household wealth means increasing ability of households' ability to purchase more food which might lead to high diet diversity. Other studies have however, argued that the association depends on who takes decision on the amount spent on food in the household as female headed households are more likely to spend more on high quality and diversified diet (Taruvinga et al., 2013).

In this study, renting of dwelling place was associated with dietary diversity. Similar to this study results is the observation made in Nepal where lactating mothers who were not renting had 4.5% higher MPA than those renting (Henjum et al., 2015). Comparatively high proportion of the respondents in the urban setting were renting. The expectation would have therefore been that a high proportion of those from the urban setting in this study would have had a lower DDS but it was rather the opposite in this study. However, their high DDS did not reflect in their probability of nutrient adequacy suggesting that the food they consumed might have been lacking quantity and quality as these two are important elements for nutrient adequacy (Ruel, 2003). A look at the food groups consumed by the study population revealed that the whole population took cereals, grains, and roots and tuber food group which are more energy dense than micronutrients dense. Meat, fish and poultry food group, which is protein dense food group was consumed by nearly the whole (98%) but the quantity consumed might have been small as these food are usually expensive (Ruel, 2003). Food groups that are micronutrient dense were consumed by less than 50% of the population.

5.7 Predictors of micronutrient adequacy

Findings of the study indicated that the MPA of the respondents reduces by 0.112 for every increase in wealth index score. This can be explained by the fact that respondents consumed more of macronutrient dense food groups than micronutrient dense food groups. Increasing the socioeconomic status of households is likely to improve their macronutrient intake rather than micronutrient. Socioeconomic status has been noted to indirectly improve nutrient adequacy through improved dietary diversity (Arimond et al., 2011; Henjum et al., 2015; Nguyen et al., 2018). The MPA of traders, civil servants, artisans and unemployed were higher than that of farmers.

This study however, did not find the association between dietary diversity and MPA for micronutrients significant (p =0.279) and that might be explained by the fact that respondents tend to consume more of macronutrient dense food group. As proposed by Remick, Polivy & Pliner, (2009), a positive association between dietary diversity and nutrient adequacy may only exist when the diversity concerns a diet made up of healthy, low-energy and nutrient dense foods. Several other studies have however found positive correlation between dietary diversity and nutrient adequacy (Henjum et al., 2015).

5.8 Association between haemoglobin concentration and dietary diversity

Gestational age, location and employments status were the variables that showed significant association with anaemia in this study. The results indicated that a week increase in gestational age was associated with a reduction of 0.026 gm/dl haemoglobin. The finding is consistent with a study in Ethopia that showed that risk of developing anaemia increased with increasing age of pregnancy (Addis Alene & Mohamed Dohe, 2014). The increasing risk of anaemia with increasing gestational age could be partly explained by the increasing plasma volume and foetal development (Darnton-Hill & Mkparu, 2015).

Respondents from the rural setting (Asesewa) had a higher risk of developing anaemia than those from urban setting. This could be due to the fact that malaria and intestinal parasitaemia are high in rural settings than in urban settings (Glover-Amengor et al., 2005). Association between anaemia and place of residence have also been reported in Southeast Ethopia where pregnant women from rural area had about three times increased risk of being anaemic (Kefiyalew et al., 2014).

The study indicated that women who were employed had a higher haemoglobin concentration than those who were unemployed. This observation can be accounted for by the fact that women who are employed have additional income to support the family and their personal needs as compared with unemployed women.

5.9 Limitations

Dietary diversity was assessed based on responses obtained from participants (e.g., dietary recall) during the pregnancy and this depended on memory and their ability to recall accurately. Recall bias could not be ruled out completely. The 24-hour dietary recall may not truly represent the usual intake. However, methods used in assessing dietary diversity are useful for ranking individuals but do not necessarily permit exact assessments of absolute nutrient intake. The cross-sectional study design used to collect data also makes it difficult to demonstrate cause-and-effect relationships.

It was not also possible to measure all the possible predictors of anaemia such as infections, genetic factors and micronutrient interactions.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Findings of the study indicate that the MPA among the pregnant women was very low (22.4%). Prevalence of anaemia is a severe public health problem among pregnant women in this population. The low MPA and high prevalence of anaemia suggest the vulnerability of the pregnant women to micronutrient deficiencies which may have serious adverse replications on their health and that of the foetus through childhood to adulthood. The diet of the respondents were predominantly cereals, grains, white roots and tubers.

About 65% of the pregnant women met the MDD-W but was not reflective in the micronutrient intake of the participants. Wealth Index score was positively related to diet diversity and negatively associated with renting of dwelling place. Even though household size and employment status had predictive value on dietary diversity, their association was not statistically significant. Age, gestational age, household size, household head and parity were not associated with dietary diversity.

Mean probability of adequacy was negatively associated with wealth index whilst artisans, civil servants, traders and unemployed had higher MPA than farmers. The association between the probability of micronutrient adequacy and dietary diversity was not statistically significant among the study population.

Haemoglobin concentration was negatively associated with gestational age in weeks and positively associated with employment status.

There was no significant association between dietary diversity and haemoglobin concentration in the study population. Gestational age, occupation and geographical location were found statistically significant in predicting the haemoglobin concentration of pregnant women.

6.3 Recommendations

To improve the probability of adequacy of micronutrients and reduce prevalence of anaemia among pregnant women, the following recommendations are suggested;

- Pregnant women should be encouraged to incorporate vitamin A rich fruits and vegetables, eggs, pulses, other fruits and nuts and seeds in their diets in substantial amounts in order to meet their daily nutrient requirements
- Nutrition education should put emphasis on food diversity that covers a wider range than that skewed towards the staples foods
- Improving the economics status of households will help in reducing anaemia among pregnant women
- A further study that will look at health and sanitation issues influencing dietary intake is highly recommended

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APPENDICES:

Appendix I: Participant's information sheet

SECTION A: INFORMATION SHEET

Title of study:

Assessing the Determinants of Dietary Diversity and Micronutrient Adequacy among Pregnant Women Attending Antenatal Clinics in Mamobi General and Asesewa Government Hospitals

General Information

Hello, my name is **Kamal Mumuni Sumani**, a student from the Department of Nutrition and Food Science, School of Biological Sciences, University of Ghana. You are invited to participate in a study on dietary diversity, micronutrient adequacy and the nutritional status of pregnant women.

The study is expected to take about 30 to 45 minutes. During this period you will be asked personal and household characteristics such as age, household assets and possessions and your dietary intake. In addition, you will also be asked about your food intake for the past 24 hours. A two day's information is required to ascertain your usual food intake. You will therefore be called latter at your own convenient time at home or on to phone give us this information.

In addition, you will also be tested for your blood level by pricking on your finger. A tape will be put around your mid-upper arm to estimate your nutritional status.

Risk of the study

In pricking your finger for the blood test, you may feel a bit of pain. The technician will use new disposable glove, new alcohol swab and a new small pin (lancet) for you in order to avoid any possible infection. You may also be inconvenience for the time you will be spending in answering the questions.

Benefits of the study

There are no direct anticipated benefits to you for participating in this study, except for knowing your current nutritional status. However, the information gathered from the study will help in determining the dietary and nutrient intake needs of pregnant women for better inform decisions in food supply and education to improve maternal and child health.

Cost

You are not to pay for anything for participating in this study.

Compensation

You will receive a thank you gift in the form of soft drink (Malt) for your time and effort.

Confidentiality

Any information obtained from your participation in this study will be kept strictly confidential and only be used for the purposes of the research. Your name will in no way be used in any reports from the study. The record of the study will be kept at the University of Ghana.

Voluntary participation/withdrawal from Study

You are free to participate in this study or not. You can chose to withdraw from this study at any stage. It will not go against you in any way should you decide leave the study.

Funding information

There is no special funding associated with this study.

Conflict of interest

There is no conflict of interest associated with this study.

Contact for Additional Information

You are encouraged to ask any questions at any time of the study. For answers to any pertinent questions about the research, you may contact **Kamal Mumuni Sumani** (Mobile phone number: +233202557133 or +233244109655; E-mail: sumancapenter@yahoo.com) or Dr. Agartha Ohemeng (Mobile phone number: +233244862606; E- mail: agacof@yahoo.com) or Ms. Hannah Frimpong (0243235225 /0507041223; E-mail: Hannah.Frimpong@ghsmail.org)

Participant consent form

SECTION B: Participant Statement and Signature

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and I am willing to give consent for me to participate in this study. I have not waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

____

Name of Volunteer

____ ________________________

Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

____

Name of witness

____ ________________________

Signature of witness Date

SECTION C: Interviewer's Statement

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

____

Name of Person who obtained Consent

__________________________________ __________________

Signature of Person who obtained Consent Date

Appendix II: Assent information sheet

SECTION A: Assent information sheet (for participants below 18years)

Title of study:

Assessing the Determinants of Dietary Diversity and Micronutrient Adequacy among Pregnant Women Attending Antenatal Clinics in Maamobi General and Asesewa Government Hospitals

General Information

Hello, my name is **Kamal Mumuni Sumani**, a student from the Department of Nutrition and Food Science, School of Biological Sciences, University of Ghana. You are invited to participate in a study on dietary diversity, micronutrient adequacy and the nutritional status of pregnant women.

The study is expected to take about 30 to 45 minutes. During this period you will be asked personal and household characteristics such as age, household assets and possessions and your dietary intake. In addition, you will also be asked about your food intake for the past 24 hours. A two day's information is required to ascertain your usual food intake. You will therefore be called latter at your own convenient time at home or on to phone give us this information.

In addition, you will also be tested for your blood level by pricking on your finger. A tape will be put around your mid-upper arm to estimate your nutritional status.

Risk of the study

In pricking your finger for the blood test, you may feel a bit of pain. The technician will use new disposable glove, new alcohol swab and a new small pin (lancet) for you in order to avoid any possible infection. You may also be inconvenience for the time you will be spending in answering the questions.

Benefits of the study

There is no direct anticipated benefits to you for participating in this study, except for knowing your current nutritional status. However, the information gathered from the study will help in determining the dietary and nutrient intake needs of pregnant women for better inform decisions in food supply and education to improve maternal and child health.

Cost

You are not to pay for anything for participating in this study.

Compensation

You will receive a thank you gift in the form of soft drink (Malt) for your time and effort.

Confidentiality

Any information obtained from your participation in this study will be kept strictly confidential and only be used for the purposes of the research. Your name will in no way be used in any reports from the study. The record of the study will be kept at the University of Ghana.

Voluntary participation/withdrawal from Study

You are free to participate in this study or not. You can chose to withdraw from this study at any stage. It will not go against you in any way should you decide leave the study.

Funding information

There is no special funding associated with this study.

Conflict of interest

There is no conflict of interest associated with this study.

Contact for Additional Information

You are encouraged to ask any questions at any time of the study. For answers to any pertinent questions about the research, you may contact **Kamal Mumuni Sumani** (Mobile phone number: +233202557133 or +233244109655; E-mail: sumancapenter@yahoo.com) or Dr. Agartha Ohemeng (Mobile phone number: +233244862606; E- mail: agacof@yahoo.com) or Ms. Hannah Frimpong (0243235225 /0507041223; E-mail: Hannah.Frimpong@ghsmail.org)

Assent form

SECTION B: Statement and Signature (to be signed by participants under 18years)

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and I am willing to give consent for me to participate in this study. I have not waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

____

Name of Volunteer

____

____

Signature or mark of volunteer   Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

____

Name of witness

____________________________________   ______________________

Signature of witness   Date

SECTION C: Interviewer's Statement

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

____

Name of Person who obtained Consent

______________________________   ________________

Signature of Person who obtained Consent   Date

Appendix III: Parent information sheet

SECTION A: Assent information sheet (for parents of participants below 18years)

Title of study:

Assessing the Determinants of Dietary Diversity and Micronutrient Adequacy among Pregnant Women Attending Antenatal Clinics in Mamobi General and Asesewa Government Hospitals

General Information

Hello, my name is **Kamal Mumuni Sumani**, a student from the Department of Nutrition and Food Science, School of Biological Sciences, University of Ghana. You are invited to participate in a study on dietary diversity, micronutrient adequacy and the nutritional status of pregnant women.

The study is expected to take about 30 to 45 minutes. During this period your child will be asked personal and household characteristics such as age, household assets and possessions and your dietary intake. In addition, she will also be asked about her food intake for the past 24 hours. A two day's information is required to ascertain her usual food intake. She will therefore be called latter at her own convenient time at home or on phone to give us the information.

In addition, she will also be tested for your blood level by pricking on your finger. A tape will be put around her mid-upper arm to estimate her nutritional status.

Risk of the study

In pricking your finger for the blood test, she may feel a bit of pain. The technician will use new disposable glove, new alcohol swab and a new small pin (lancet) for her in order to avoid any possible infection. You may also be inconvenience for the time you will be spending in answering the questions.

Benefits of the study

There is no direct anticipated benefit to you or your child for participating in this study, except for knowing her current nutritional status. However, the information gathered from the study will help in determining the dietary and nutrient intake needs of pregnant women for better inform decisions in food supply and education to improve maternal and child health.

Cost

You are not to pay for anything for participating in this study.

Compensation

She will receive a thank you gift in the form of soft drink (Malt) and biscuit for her time and effort.

Confidentiality

Any information obtained from her participation in this study will be kept strictly confidential and only be used for the purposes of the research. Her name will in no way be used in any reports from the study. The record of the study will be kept at the University of Ghana.

Voluntary participation/withdrawal from Study

She are free to participate in this study or not. She can chose to withdraw from this study at any stage. It will not go against you or her in any way should she decide leave the study.

Funding information

There is no special funding associated with this study.

Conflict of interest

There is no conflict of interest associated with this study.

Contact for Additional Information

You are encouraged to ask any questions at any time of the study. For answers to any pertinent questions about the research, you may contact **Kamal Mumuni Sumani** (Mobile phone number: +233202557133 or +233244109655; E-mail: sumancapenter@yahoo.com) or Dr. Agartha Ohemeng (Mobile phone number: +233244862606; E- mail: agacof@yahoo.com) or Ms. Hannah Frimpong (0243235225 /0507041223; E-mail: Hannah.Frimpong@ghsmail.org)

PARENTAL CONSENT FORM

SECTION B: Statement and Signature (to be signed by parents of participants under 18years)

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and I am willing to give consent for me to participate in this study. I have not waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

____

Name of Volunteer

____

____

Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

____

Name of witness

____________________________________ ____________________________

Signature of witness Date

SECTION C: Interviewer's Statement

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

____

Name of Person who obtained Consent

Signature of Person who obtained Consent   Date

Appendix IV: Pregnant women questionnaire

STUDY QUESTIONNAIRE
DEPARTMENT OF NUTRITION AND FOOD SCIENCE
UNIVERSITY OF GHANA

TITLE: ASSESSING THE DETERMINANTS OF DIETARY DIVERSITY AND MICRONUTRIENT ADEQUACY AMONG PREGNANT WOMEN ATTENDING ANTENATAL CLINICS AT ASESEWA AND MAAMOBI HOSPITALS

Questionnaire Number |___||___||___||___| Date of Interview |___|___|/|___|___|/|___|___|

Interviewer's name______________________________________Facility___________________________

Section A: Socio-demographic and economic characteristics		
Background Information		
1.	Age of the mother in completed year's (confirm from ANC card)	
2.	Gestation in weeks	
3.	Parity	______________
4.	How many children are below 5 years of age	______________
5.	Marital status	1. Married 2. Divorced/Separated 3. Widow/Widowed 4. Partner 5. Single
6.	Which area do you reside?	__________________
7.	What is the Occupation of the respondent?	1. Farming 2. Artisan 3. Civil Servent 4. Trader 5. Unemployed 6. Others (Specify) ___________
8.	What is the highest level of education reached?	1. Primary 2. Secondary/SHS 3. College (Diploma/certificate) 4. University (1st degree) 5. University (master/Phd) 6. Adult education 7. None

9.	What is your Ethnicity?	1. Akan 2. Ewe 3. Ga 4. Krobo 5. Kotokoli 6. Hausa 7. Northerner(Specify)_______ 8. Others (Specify) ____________	
10.	What is your religion?	1. Christian 2. Muslim 3. Traditional 4. Other(Specify)______________	
Household characteristics			
11.	How many people live in your *household? *(*Household= Members living together and sharing the same pot)*	__________	
12.	How many rooms does your household occupy?	__________	
13.	Who is the household head?	1. respondent 2. Husband 3. Child 4. Others (specify)	
14.	Sex of household head	1. Male 2. Female	
15.	Occupation of household head	1. Farming 2. Artisan 3. Civil servant 4. Trader 5. Unemployed 6. Others (Specify____________	
16.	What is the relationship between the household head and the respondent	1. Respondent 2. Husband 3. Child 4. Other Relatives 5. 4. house help 6. Other	
Household Socio-economic Characteristics			
Does the household own any of the following household items?			
17.	A colour television?	1. Yes	2. No
18.	Agricultural land?	1. Yes	2. No

19.	A refrigerator?	1. Yes	2. No
20.	Video deck/DVD/VCD?	1. Yes	2. No
21.	A bank account?	1. Yes	2. No
22.	Electricity?	1. Yes	2. No
23.	A wall clock?	1. Yes	2. No
24.	Cabinet/cupboard?	1. Yes	2. No
25.	What type of fuel does your household mainly use for cooking?	LPG	Wood
26.	What kind of toilet facility do members of your household usually use?	No facility / bush / field	Other
27.	What is the main source of drinking water for members of your household?	Sachet water	Other
28.	What is the main material of the floor in your household?	Cement	Other
29.	What is the main material of the exterior walls in your household?	Cement	Other

	SECTION B: Health Information (Morbidity patterns)		
30.	Have you suffered from any disease for the last two weeks?	1. Yes	2. No
31.	If yes, specify	1. Anorexia 2. Vomiting 3. Fever 4. Constipation 5. Malaria	6. Diarrhoea 7. Anaemia 8. STI 9. Any other (specify) ____________________________________
32.	What was the duration (in days) of the disease		
33.	Did you seek medical attention?	1. Yes	2. No
34.	If yes where?	1. government hospital 2. private hospital 3. traditional medicine others (specify)	
	ANC attendance and micronutrient intake		
35.	How many times have you attended antenatal clinic?	1. once 2. twice 3. thrice 4. more than three times	
36.	Which of the following do you take during this pregnancy		
A.	Blood tonic	1. Yes	2. No
B.	Iron	1. Yes	2. No
C.	Folic acid	1. Yes	2. No
D.	Multivitamin	1. Yes	2. No
E.	Others (specify)		
37.	Where did you get them from?	1. Health facility 2. Bought from the shops	

		3. Herbalist	
38.	Do you take them daily?	1. Yes	2. No
39.	If no, why?		
40.	Do you have cravings for non-food items?	1. Yes	2. No
41.	If yes, specify		

42.	**How many times in a week do you access the following**	**CODE: 0** = None; **1** = Once**; 2** = twice**;** **3** = Thrice**; 4** =more than 3 times

Mobile phone (call)		News paper	
phone(text)		Health worker	
Radio		community gatherings	
Television		Church/Mosque	

SECTION C: Dietary Intake/Diversity			
Recording form for 24hr recall of foods and drinks consumed by the respondent Now I'd like to ask you to describe everything that you ate or drank yesterday during the day or night, whether you ate it at home or anywhere else. Please include all foods and drinks, any snacks or small meals, as well as any main meals. Remember to include all foods you may have eaten while preparing meals or preparing food for others. Please also include food you ate even if it was eaten elsewhere, away from your home. Let's start with the first food or drink consumed yesterday.			
	Confirm if the day was usual or unusual	1. usual day	2. unusual
	If unusual, explain why	1. Celebration 2. Religious activity 3. Little food in household 4. Other (specify**)**	

24-Hour dietary recall

Meal	Time	Type of food	Description/Ingredients	Amount/Handy measure	Dietary Intake (in grams)
Breakfast Did you have anything to eat or drink when you woke? If yes, what? Anything else?*					
Snack Did you have anything to eat or drink later in the morning? If yes, what? Anything else?*					
Lunch Did you eat or drink anything at mid-day? If yes, what? Anything else?*					
Snack Did you have anything to eat or drink during the afternoon? If yes, what? Anything else?*					

Super Did you have anything to eat in the evening? If yes, what? Anything else?*					
Snack Did you have anything else to eat or drink in the evening before going to bed or during the night? If yes, what? Anything else?*					

MDD-W questionnaire

Fill in the food groups based on the 24 hour recall information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

	Food categories	Description/examples	Consumed Yes = 1 No= 0
A.	Foods made from grains	Porridge, bread, rice, pasta/noodles, banku, kenkey, TZ, or other foods made from grains (sorghum, millet, oats, wheat)	
B.	White roots and tubers and plantains	White potatoes, white yams, cassava, cocoyam, fufu, konkonte or any other foods made from white-fleshed roots or tubers, or plantains	
C.	Pulses (beans, peas and lentils)	Mature beans or peas, soy beans (fresh or dried seed), lentils or bean/pea products, including hummus, tofu and tempeh	
D.	Nuts and seeds	Any tree nut, groundnut/peanut or certain seeds, or nut/seed “butters” or pastes	
E.	Milk and milk products	Milk, cheese, yoghurt, burkina or other milk products but NOT including butter, ice cream, cream or sour cream	
F.	Organ meat	Liver, kidney, heart, gizzard or other organ meats or blood-based foods, including from wild game	
G.	Meat and poultry	Beef, pork, lamb, goat, rabbit, wild game meat, chicken, duck or other bird	
H.	Fish and seafood	Fresh or dried fish, shellfish or seafood, canned fish, clams, oysters, shrimps, lobsters, crabs, octopus	
I.	Eggs	Eggs from poultry or any other bird	
J.	Dark green leafy vegetables	Any medium-to-dark green leafy vegetables, including wild/foraged leaves (dandelion, lettuce, okro green)	
K.	Vitamin A-rich vegetables, roots and tubers	Pumpkin, carrots, squash or sweet potatoes that are yellow or orange inside, sweet red pepper, squash, orange flesh sweet potato,	
L.	Vitamin A-rich fruits	Ripe mango, ripe papaya, apricot, cantaloupe melon, passion fruit, Red palm fruit,	
M.	Other vegetables	Cabbage, cauliflower, celery, cucumber, eggplant, green pepper, lettuce light green, mushroom, okro light green, onion, tomato	

N.	Other fruits	Apple, avocado, banana white flesh, cashew fruit, coconut flesh, grapefruits, grapes, guava, lemon, orange, pineapple, star fruit, sour sop, Yellow mobin (Atoa), African star fruit (Alansa)	
O.	Insects and other small protein foods	Insects, insect larvae/grubs, insect eggs, fish roe and land and sea snails	
P.	Red palm oil	Red palm oil	
Q.	Other oils and fats	Oil; fats or butter added to food or used for cooking, including extracted oils from nuts, fruits and seeds (vegetable oils); and all animal fat, margarine, mayonnaise	
R.	Savoury and fried snacks	Crisps and chips, fried dough, potato/cocoyam chips or other fried snacks	
S.	Sweets	Sugary foods, such as chocolates, candies, cookies/sweet biscuits and cakes, sweet pastries or ice cream, cadies, cookies, pastries, pie, soft/energy drinks	
T.	Sugar-sweetened beverages	Sweetened fruit juices and "juice drinks", soft drinks/fizzy drinks, chocolate drinks, malt drinks, yoghurt drinks or sweet tea or coffee with sugar	
U.	Condiments and seasonings	Ingredients used in small quantities for flavour, such as chilies, spices, herbs, fish powder, tomato paste, flavour cubes or seeds	
V.	Other beverages and foods	Tea or coffee if not sweetened, clear broth, alcohol, light soup	

SECTION D: Nutritional Status

MUAC/cm			HB/gdl^{-1}
1.	2.	3.	

Appendix: V: Ethical approval letter (GHS-ERC)

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the
number and date of this
Letter should be quoted.

Your Health - Our Concern

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com
19th June, 2018

MyRef. GHS/RDD/ERC/Admin/App/18/314
Your Ref. No.

Kamal Mumuni Sumani
University of Ghana
Nutrition and Food Science Department
Legon, Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC038/03/18**
Project Title	Assessing the Determinants of Dietary Diversity and Micronutrient Adequacy among Pregnant Women Attending Antenatal Clinics at Maamobi General and Asesewa Government Hospitals
Approval Date	19th June,2018
Expiry Date	18th June, 2019
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report **after completion** of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED...

DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

Appendix: VI: Ethical approval letter (ECBAS)

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES (ECBAS)

P. O. Box LG 1195, Legon, Accra, Ghana

Ref. No: ECBAS 030/17-18

4th July, 2018.

Mr. Kamal Mumuni Sumani
Dept. of Nutrition and Food Science
University of Ghana
Legon, Accra

Dear Mr.Sumani,

ECBAS 030/17-18: ASSESSING THE DETERMINANTS OF DIETARY DIVERSITY AND MICRONUTRIENT ADEQUACY AMONG PREGNANT WOMEN ATTENDING ANTENATAL CLINICS AT MAMOBI GENERAL AND ASESEWA GOVERNMENT HOSPITALS.

This is to inform you that the above reference study has been presented to the Ethics Committee for Basic and Applied Sciences for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	3/07/19
On Agenda for:	Initial Submission
Date of Submission:	9/01/2018
ECBAS Action:	Approved
Reporting:	Quarterly

Please accept my congratulations.

Yours sincerely,

ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES
APPROVED
04 JUL 2018
UNIVERSITY OF GHANA

Professor Daniel Bruce Sarpong
ECBAS Chairperson

Tel: +233-207684121 Email: eoghartey@ug.edu.gh / ethicscbas@ug.edu.gh