MATERNAL DIETARY INTAKES IN THE THIRD TRIMESTER AND PREGNANCY OUTCOMES

BY

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DECLARATION

DECLARATION

I, Agnes Yeboah hereby declare that this dissertation is the result of my diligent research work carried out in the Department of Dietetics, School of Biomedical and Allied Health Sciences, University of Ghana, under the supervisions of Dr. Joana Ainuson-Quampah and Dr. Kwaku Asah-Opoku, and neither whole nor any part of it has been or is being or is to be submitted for another degree at this or any other university. All references cited have been fully acknowledged.

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DEDICATION

This work is dedicated to my family, especially my lovely parents and big brother in the persons of Mr. & Mrs. Ameyaw and Mr. Samuel Kwabi Ameyaw for their love, support, and encouragement that challenged me to work harder.

I also dedicate this work to my big brother Mr. Bernard Ameyaw and my lovely sister Mrs. Esther Sarpomaa Darko for their unfailing support and care.

Finally, I dedicate this work to all persons who supported me to make this work a success.

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ABSTRACT

Background: Maternal nutrition during pregnancy is a major determinant for birth outcomes and consequently, offspring health outcomes in later life. Poor maternal nutrition, particularly during the third trimester is a major cause of low birth weight (LBW) in developing countries.Inadequate intakes of specific nutrients such as iron and folate in pregnancy have been reported to lead to a variety of poor maternal and infant outcomes including anemia and preterm birth respectively. The pregnant woman is tasked to prioritize her nutritional needs and practice good dietary habits to achieve optimum birth outcomes.

Aim: To assess the dietary intake and pregnancy outcomes of women in their third trimester attending antenatal clinics at the Korle-Bu Teaching Hospital.

Methods: A cohort design was employed for this study. The cohort design recruited third trimester pregnant women (N=81) between the ages of 18-49 years from Korle-Bu Teaching Hospital in the Greater Accra Region. Dietary intake data were obtained based on a 52-item quantitative food frequency questionnaire. Daily supplement dosages of participants were recorded. Serum concentrations of iron (ferritin) and folate were respectively determined using the AccuBind ELISA microwells. Data obtained were analyzed using IBM SPSS version 25 and nutrients analysis was done using West Africa Foods Analysis (WAFUDS). One-way anova test was used to determine differences among mean weights of the participants. Spearman's rank correlation test was used to determine the strength and relationship between dietary intakes and birth outcomes as well as ferritin and folate sera levels of participants and birth outcomes. Means, median, mode and standard deviations were used to summarize continuous and categorical variables. A p-value of ≤ 0.05 was considered statistically significant.

Results: A total of 81 participants were involved in this study. Their mean age was 32.22 (±6.00) years. A greater percentage (82.7%) of them was married and almost all (92.6%) the participants were formally educated with the majority (67.9%) involved in either trading or a vocation. The vast (76.9%; 100%; 86.4%) proportion of the participants were not involved in pica practice, consuming alcohol and skipping meals in the day during the 3^{rd} trimester respectively. Majority (60.5%) of the participants ate thrice in the day with a substantial proportion (28.4%) also eating 4-5 times per day in the 3^{rd} trimester. A sizeable proportion (11.1%) experienced some difficulties in food intakes during the 3^{rd} trimester. Mean nutrients intake of dietary iron and folate were 13.54 (±8.30) mg and 331.16 (±113.97) mcg respectively. Mean intake of iron and folic acid supplement were 42.70 (±48.80) mg and 5.50 (±11.10) mg respectively. Majority (74.1%; 86.4%) of the participants did not meet recommendations for daily total iron and folate respectively. Most of the participants, however, had serum ferritin and folate levels in the normal range (82.7% and 87.7% respectively). In this study, almost all the participants obtained positive birth outcomes and the significant predictor of birth outcome was total dietary iron (p=0.041).

Conclusion: The study showed that, the participants' dietary habits were generally good. However, the amount of food consumed by majority was suboptimal which might have led to a greater percentage not meeting the dietary recommendations for both nutrients (folate and iron). Adherence to supplement intake was generally good which might have resorted to the normal serum ferritin and folate levels obtained. The good dietary habits and normal serum levels obtained could be a major contributing factor to the positive birth outcomes observed in the study.

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LIST OF ABBREVIATIONS

C.S	Cesarean Section
DRI	Dietary Reference Intake
EAR	Estimated Average Requirements
EPRC	Ethical and Protocol Review Committee
Hb	Haemoglobin
IRB	Institutional Review Board
J.H.S	Junior High School
KBTH	Korle-Bu Teaching Hospital
LBW	Low Birth Weight
NICU	Neonatal Intensive Care Unit
QFFQ	Quantitative Food Frequency Questionnaire
RNI	Reference Nutrients Intake
S.H.S	Senior High School
SD	Standard Deviation
SF	Serum Ferritin
SPSS	Statistical Package for the Social Sciences
Std.	Standard
TS	Transferrin Saturation
UL	Tolerable Upper Limit
UNU	United Nations University
WAFUDS	West Africa Foods Nutrients Analysis
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Pregnancy is marked with excitement in most sub-Saharan African cultures since it signifies an addition to the family as well as the society at large (Sholeye et al., 2014). As much as these expectant women are excited during this period, they also expect to give birth to healthy children as well as be in good health to cater for the newborns. However, this expectation does not always happen due to a variety of factors, including; poor maternal nutrition status that results in undesirable maternal and child health indices in many of these communities (Campbell et al., 2008).

During pregnancy, there are a lot of physiological changes that occur which require appropriate and balanced nutrition which are part of the key elements of a healthy lifestyle to optimize both maternal and children’s health. Similarly, during this period, a lot of women also have cravings for non-food items (pica) which affect healthy dietary practice and it has been reported that there is a high prevalence of pica cravings among pregnant women in most African countries (like Tanzania, South Africa, Kenya, and Botswana) amongst others (Nyaruhucha, 2009).

It is vital to initiate and maintain a good dietary intake (which is a healthy eating behaviour patterns) during pregnancy because; poor maternal nutrition can adversely impact both the mother and the foetus (Symonds; Ramsay, 2010). A recently published systematic review based on twelve studies showed that before pregnancy period, women in certain social gradient (such as older age and have affluence) who practice other healthy behaviours (like non-smoking and physically active) were more likely to follow a healthier dietary pattern when pregnant (Doyle et al., 2017).

In the past, the primary concern of prenatal nutrition epidemiology was the effect of malnutrition and nutrition deficiencies but current literature is now increasingly interested in the overall quality of the maternal diet (Martin et al., 2016). Supplying the developing foetus with optimal nutrition is essential in attaining optimal growth and development of the foetus (Martin et al., 2016).

Adequate intake of both macronutrients and micronutrients are needed during pregnancy. However, the macronutrients constitute a large component of our diet compared with micronutrients. Pregnancy places an increasing demand for micronutrients hence, micronutrient requirements increase more than that of macronutrients. Moreover, intakes of these nutrients have significant consequences on both mother and the developing foetus, which is backed by the physiologic role played by these minerals and vitamins (Koletzko et al., 2013).

Two micronutrients of special importance during pregnancy are iron and folate. Iron is needed during pregnancy since it is a vital constituent of haemoglobin which is essential for blood formation and oxygen supply. Maternal anaemia during pregnancy influences postnatal infant growth and it is also associated with an increased risk for low birth weight and preterm birth (Milman, 2012). This emphasizes the importance of adequate iron status during gestation.

Dietary folate also plays an important role in pregnancy as well as birth outcomes. Nutritional deficiency of folate has been associated with low birth weight, premature birth, and foetal malformations amongst others (Li et al., 2009). Neural tube defect is an example that falls under the umbrella of foetal malformations caused by the deficiency of maternal folate. This maternal folate is supplied in the period before conception and during the first month of foetal development which is the period in which the closure of the neural tube occurs (Imbard et al., 2013). A study conducted among the local Chinese population in 2015, presented data which showed that consumption of non-staple foods of the participants like milk, fresh fruits, and nuts which are good sources of folate was associated with decreasing neural tube defects in offspring (Wang et al., 2015). Methyl group donors which comprise folate and vitamin B12 affect pregnancy in situations where there are alterations in their availability and this results to an overall effect on the expression of certain genes important for foetal development as well as on the long term health of the individual (Waterland & Michels, 2007).

Dietary intakes and habits practiced by these expectant women play a crucial role in ensuring that, optimum results in terms of childbirth as well as the overall health of these women are achieved after putting to birth.

1.2 PROBLEM STATEMENT

The dietary habit formed during pregnancy globally has been found to play an important role in birth outcomes (Peristats, 2015). The dietary intake of the pregnant woman should be able to provide the nutrients needed by both the mother and fetus. Research shows that, there is a positive association between a healthier dietary pattern practiced by the expectant mother and the infant's birth weight (Grieger & Clifton, 2015). Folate and iron are nutrients of great importance during this period due to the major roles they play in many metabolic processes in pregnancy as well as birth outcomes (Khoushabi et al., 2016). Dietary iron and folate have been shown to have effects on fetal and neonatal development. If these nutrients are in sufficient amounts in the diet of the pregnant woman, it has been proven to result to optimal birth weight, reduce risk factors for prematurity and reduce fetal distress which contributes to low perinatal morbidity and mortality (Begum et al., 2012). Research has again shown that iron needs for instance, significantly increase during the third trimester (Wang et al., 2016) and similarly, there is also an increased demand for folate as well for rapid cell proliferation and tissue growth of the uterus and placenta, growth of the fetus and expression of maternal blood volume (Rando & Tomkins, 2000).

In the 2017 Ghana Micronutrient Survey report, it was shown that though anaemia prevalence among the selected urban and rural areas in which the study was conducted has reduced over the years, it is still unacceptably high (45% prevalence rate) despite supplementation given to the pregnant women (Adu-Afarwuah et al., 2017). The report, therefore, recommended the consumption of iron-rich foods in addition to supplementation during pregnancy to combat anaemia. This was mainly because; iron-deficiency appears to be the main driver of anaemia in many cases.

Dietary habits of most pregnant women have been shown to also differ within the various trimesters and among the women as they progress to the third trimester. Even though a lot of studies on nutrients intakes have been done among pregnant women, the focus has been on the earlier trimesters (Rifas-Shiman et al., 2006; Sengpiel et al., 2014). Fewer studies have looked at dietary intakes in the third trimester (Bae et al., 2010; Gennaro et al., 2011). A study conducted on dietary habits among African-American women in their third trimester is one of few studies that have focused on nutrition in the third trimester. The study showed that, food intake by these women declined from the beginning of the third trimester to the end. This was attributed to certain factors like the feeling of fullness with little consumption, fear of gaining weight, and heartburns resulting in most of the participants not meeting their recommended dietary allowance (Gennaro et al., 2011).

Anecdotal evidence suggests a similar pattern among pregnant women in Ghana. In one of Ghana's tertiary hospitals; Korle-Bu Teaching Hospital, studies conducted have focused on health conditions like hypertension, diabetes and their effects on birth outcomes (Oppong et al., 2015; Darkwa et al., 2017). It is therefore needful to focus attention on assessing maternal dietary intakes in the third trimester and pregnancy outcomes.

1.3 STUDY SIGNIFICANCE

This study is expected to provide baseline information for further research work to be done in the area, on the impact of maternal dietary intakes on birth outcomes. Findings from the study will provide data that can be used by health professionals (dieticians, doctors, nurses) in educating pregnant women. Appropriate stakeholders like the ministry of health and education can use findings from the study to implement good policies concerning expectant mothers and children. Findings will again help pregnant women by providing information on the need for these two very important micronutrients in the 3rd trimester which will lead to reduced cost of hospital bills as a result of delayed child or maternal hospital admission after delivery.

1.4 HYPOTHESIS

Maternal dietary intakes during the third trimester do not affect birth outcomes among women attending antenatal clinics at Korle-Bu Teaching Hospital.

1.5 AIM

The aim of the study was to assess the dietary intake and pregnancy outcomes of women in their third trimester attending antenatal clinics at Korle-Bu Teaching Hospital.

1.6 SPECIFIC OBJECTIVES

The specific objectives were:

1. To assess the dietary intake of pregnant women in the third trimester.
2. To assess the serum iron and folate levels of the participants.
3. To assess the birth outcomes (Apgar scores, gestational period, birth weight, maternal and neonatal survival) of the participants.
4. To find the relationship between maternal dietary intakes and birth outcomes.
5. To find the relationship between serum ferritin and folate levels (from diet and oral supplements) in the participants and birth outcomes.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 PHYSIOLOGY OF PREGNANCY

Pregnancy is the period in which a woman carries a foetus inside her body. It is expected that the foetus grows healthily in the womb. This period usually is about 40 weeks or 9 months. Pregnancy is divided into three trimesters with each trimester (3 months periods) having major developments occurring during that period. The third trimester is from week 28 to week 40. Babies born before 37 weeks are referred to as preterm, those born at 37-38 weeks are referred to as an early term, babies also born between 39 and 40 weeks are referred to as full term and those born at 41 weeks and over are referred to as post-term (American College of Obstetricians and Gynaecologists, 2013).

The placenta is a specialized organ that supports the normal development and growth of a foetus. The placenta ensures the exchange of waste products between the maternal and foetal circulatory systems, providing oxygen whilst taking away carbon dioxide. The placenta goes through many functional changes to meet the increased metabolic demands of the developing foetus throughout gestation (Gude et al., 2004; Torre et al., 2018).

Pregnancy comes with a lot of alterations to the normal physiology of the gravid woman (Barclay, 2009). In relation to pregnancy and heat adaptation, research shows that there is a considerable temperature gradient between the mother and foetus where; the foetal core temperature exceeds that of the mother by 0.5˚C. Again, the thermodynamics of heat transfer suggest that there is a relatively constant flow of heat from the foetus to the mother hence, the need for an adjustment in the maternal thermoregulatory system to permit increased heat loss to the environment (Barclay, 2009).

Also, serum progesterone levels increase which lead to an increase in the metabolic basal body temperature and changes in the smooth muscle dynamics of the uterus, vascular system, the urinary system, gastrointestinal system and the respiratory system. Progesterone acts to hyperpolarize the cell membrane, thereby depressing the resting electrical potential at the membranes to a level below the normal activation threshold. This leads to the overall decrease in the contractile function that is observed in majority of the structures (uterus, gut, ureters, respiratory system and peripheral vascular system) that depends on the smooth muscle for their action (Napso et al., 2018).

Furthermore, it is expected that the expectant woman gain some amount of weight as the trimester progresses as a result of the metabolic changes during this period. A total weight gain of 12.5-18.0kg is recommended for an underweight person pre-pregnancy, 11.5-16.0kg is recommended for a normal weight person pre-pregnancy, 7.0-11.5kg for an overweight person pre-pregnancy and 5.0-9.0kg for an obese person pre-pregnancy (Institute of Medicine, 2009). Another metabolic change experienced during pregnancy relates to the gastrointestinal system and Lawson et al. (1985) explained the mechanism of this change. They observed that, there is prolongation of the gastrointestinal transit time in the second and third trimester but did not obtain any statistical significance differences from the non-pregnant state, in the first trimester or postpartum. Another study conducted by Fisher et al. (1978) in an animal model observed a decreased activity in the circular smooth muscle of the lower oesophagus as a result of the increased level of oestrogen and progesterone. This change explains the increased emptying time of the stomach and duodenum, as well as the delay in the emptying of the gallbladder content. It was also observed that, there was decreased colonic motility which led to increase absorption of water from stool resulting in constipation.

2.2 DIETARY CONCERNS IN PREGNANCY

In recent times, the diets of expectant women have gained much attention over the period. This is due to the recognition of the increased physiologic, metabolic, and nutritional demand placed on the pregnant woman. The dietary intake of the pregnant woman should be able to provide the nutrients needed by both the mother and fetus (King, 2000). Optimal nutrition supply to the developing fetus is a key measure during this period, to obtain the appropriate fetal growth as well as development. Again, the pregnancy period requires that dietary energy and nutrients are generally increased to support increased maternal metabolism, blood volume and red cell mass expansion, and the delivery of nutrients to the foetus (Australian Government Department of Health and Ageing, 2013). Also, it should be noted that UNICEF and WHO in 2004 stated that, annually more than 20 million low birth weight (LWB) infants making 15% of all births are born in the world every year (UNICEF; WHO, 2004). Hence, the need to have optimal nutrition as well as supplementation since LBW is associated with morbidity and mortality in infancy and childhood and also has a long term effect on health in one's adult life. One of the founders of teratology in the person of Warkany saw the vital role diet play and established an experimental model to test various vitamin deficiencies, and this proved that maternal deficiencies influenced birth defects (Czeizel et al., 2013).

Macronutrients and micronutrients requirements have been shown to increase during the three trimesters of pregnancy however; there is an increased demand in the third trimester (Mousa et al., 2019). This dictates changes in basal metabolism, protein and mineral accretions and it is expected that every pregnant woman would gain some weight during this period. This varies from person to person depending on the nutritional status of the woman before pregnancy as well as the dietary habits formed during this period. In the first trimester, the Dietary Reference Intake (DRI) recommends that there should not be any additional calories for women within the normal weight before pregnancy. In the second trimester, calorie intake however increases by 340kcal/day and then increases by 450kcal/day in the third trimester (Academy of nutrition and dietetics, 2019). Also, micronutrients such as iron increases from 17-18.9mg/day in non-pregnant women to 27mg/day in pregnant women, and folate requirements also increase from 400mcg/day in non-pregnant women to 600-800mcg/day during pregnancy (Academy of Nutrition and Dietetics, 2019). In the early 1940s where human studies were done to assess maternal dietary intakes on birth outcomes and when appropriate energy and protein intakes to achieve full-term infant weight (≥ 2500g) were uncertain (Klein, 1946; Schofield et al., 1948; Smith, 1947), available evidence at the time suggested that mothers with insufficient weight gain recorded a higher rate of premature births than their counterparts that obtained appropriate pregnancy weight gain (Venkatachalam, 1962).

Several studies that aim at assessing the dietary intake of pregnant women have been carried out in sub-Saharan African countries. A study in South Africa, for instance, documented the top ten food items mostly consumed by pregnant women in descending order which is; fresh milk, tea, coffee, cold drinks, maize meal, fruit juice, bread rolls, magou (a fermented non-alcoholic drink), rice and sugar (Kersa, 2004). A study was conducted by Huybregs et al. (2009) in rural Hounde (Burkina-Faso), where they assessed the dietary behaviour, food, and nutrient intake of pregnant women, using qualitative (in-depth) interviews and 24hr dietary recall methods. Most respondents reported dietary restrictions during pregnancy, but no consistent dietary pattern of avoided food types was found. They observed that the mean nutrient intakes were found to be insufficient compared with the recommended dietary allowance.

A study conducted in Korle-Bu Teaching Hospital and Osu maternity home, to assess the dietary practice and nutrient intakes of pregnant women accessing antenatal care at these health facilities revealed, an inadequate intake of energy, vitamin B12, folic acid, iron, and zinc intakes compared with the recommended daily intakes. Among the macronutrients, carbohydrate (52.1%) was a major contributor to the total caloric intake followed by fat (34.7%) and then protein (13.3%). There was a significant association between educational level and mean protein intake ($p<0.001$) as well as between income level and mean protein intake ($p<0.001$) and also zinc ($p<0.002$). Dietary restrictions were present in 48.8% of respondents, pica in 57.3% and cravings in 67.7% of the pregnant women studied (Koryo-Dabrah et al., 2012).

Superstitions and nutrition of pregnant women in Nwangele LGA of Imo State, Nigeria, were studied and the results showed that, 15% of the participants adhered to traditional beliefs about nutrition and feeding practices in pregnancy. They held unto food prohibitions that were passed on from generation to generation including the prohibition of grasscutter meat, cassava (fufu) meals, spaghetti (pasta), cocoa beverages, eggs, and snail (Madiforo, 2010). Ojofeitimi et al. (2008) also studied the dietary intake of 840 pregnant women from rural and urban LGA's in Osun State. Inadequate dietary energy intake was noted in about 75% of the women studied, while protein intake was generally adequate for the studied participants averaging about 65%. The main source of dietary protein for these participants was from plant origin. Approximately 70% of the women had inadequate intake of dietary vitamin C, folate intake was inadequate in only 28% of the participants implying that about 71% of these women had an adequate dietary intake of folic acid.

Maternal micronutrient deficiencies are widespread in Pakistan and many countries of the Southeast Asia sub-continent. These are potentially associated with maternal undernutrition and intra-uterine growth retardation. Intervention strategies have therefore consisted of the administering of iron-folic acid supplements and other micronutrients during pregnancy (Tesfahum, 2009). A study on the energy and protein consumption of pregnant women in the Vararian district in India showed the difference in energy consumption between rural and urban women. The diet of the rural women was found to be significantly lower in energy (1842.11 ± 209.07 kcal) compared with their urban counterparts (1905 ± 253.60 kcal). This implied that rural women consumed 87.72% of the RDA, while the urban women consumed 90.75% of the RDA. Similarly, protein consumption was 77.12% and 87.38% of the RDA for rural and urban women respectively. Maximum consumption of energy and protein was noted to be during the second trimester, after which a decline was evident (Mehrotra & Tiwari, 2009). Consumption of food groups rich in a micronutrient, including pulses, vegetables, fruits, nuts, and oily seeds, as well as animal foods, was not frequent. Rural-urban differences in nutritional status, including nutrient intake and haematological parameters, are well documented in the literature (Mehrotra & Tiwari, 2009; Esmailzadeh et al., 2008).

The dietary assessment of 284 pregnant women in Maku; Western Iran revealed a higher nutrient intake among rural women than their urban counterparts. The mean consumption of grains and dairy products was much higher in rural women compared to urban respondents. Urban women consumed 140.0g of fruits compared to 248.0g from rural women. The average energy consumption as a percentage of the total calories ingested is 66.0%, 23.0%, and 11.0% from carbohydrates, fats, and protein respectively among urban pregnant women. For rural women, 68.0% carbohydrate, 20.0% fats, and 12.0% protein constituted energy consumption as part of the overall caloric intake. Vitamin D, iron, and calcium intake of rural women was again significantly higher than that of urban women. However, folate intake, vitamin A and D intake, iron intake, calcium intake, phosphorus intake, zinc intake were inadequate (Esmailzedah et al., 2008).

2.3 IRON REQUIREMENTS IN PREGNANCY

Humans at birth are born with approximately 270mg iron in their bodies. Notwithstanding, the iron requirement for pregnancy is much higher than this value (Academy of Nutrition and Dietetics, 2019). Iron requirements changes during pregnancy and this requirement increase as the pregnancy's week advance. During the first trimester, iron needs increase a bit but the cessation of menstrual flow aids the expectant mother to meet the demand. The total iron requirement of pregnancy (excluding loss at delivery) is average about 835mg for singleton pregnancy (European Food Authority, 2015). To achieve this requirement, a daily intake of 30mg is recommended for pregnant women in the second and third trimester of pregnancy since; in the last trimesters iron needs increase tremendously to meet demand of the blood volume expansion and the rapid growth of the foetus (Demuth et al., 2018). Pregnant women are more susceptible to IDA, as their body systems need for iron increases to three times the amount needed in all other populations, including both men and women. The increases in red cell mass as well as the growth of the foetal placenta are major factors within pregnancy that lead to an increased demand for more iron to sustain normal growth of the foetus (Krafft et al., 2012). The RDA value for iron in a typical non-pregnant woman aged 14 years or older is 8-18 mg. In comparison to the RDA for a pregnant woman, the value increases to 27 mg. The RDA for iron decreases somewhat again during lactation in the postpartum period to 9-10 mg for women above 14 years-old (National Institutes of Health, 2015).

Bothwell (2000) conducted a study on how iron balance can be achieved during pregnancy and concluded that**,** iron balance can be maintained only when at the beginning of the pregnancy the expectant mother had adequate iron stores. He suggested that**,** the iron stores value needs to be approximately 300mg and the expectant mother should consume a diet high in bioavailable iron during the pregnancy period. In the body, excess iron accumulated is stored as ferritin in the cells. Ferritin and transferrin are regulated by the body in an organized manner. Each of the 2 mRNAs has an iron regulatory element (IRE) at either the 5^1 (ferritin) or 3^1 (transferrin receptor) end (Rouault, 2006). This is a loop of RNA where the iron regulating protein (IRP) binds. When iron is present, it binds to the IRP and causes its release from the IRE. This release denotes different effects depending on the site where the IRP binds. Increased iron means increased iron stores, and releasing the IRP from transferrin receptor mRNA destabilizes it so that it is degraded. Whereas removing the IRP from ferritin mRNA releases it from being blocked from translation so that ferritin protein is produced (Rouault, 2006). The foetal liver regulates the whole process of iron absorption: from transfer across the maternal liver, concentrations in the plasma, and transfer across the placenta (Gambling et al., 2009).

2.3.1 Effects of dietary iron on pregnancy outcomes

Iron deficiency remains a major public health problem across the globe. Due to this fact, the WHO in 2012 recommended that all pregnant women, irrespective of their baseline Hb levels must take prenatal supplementation with iron-containing supplements (an example being iron-folic acid supplements) to reduce maternal anaemia, iron deficiency as well as improve the birth weight of infants (World Health Organization, 2012). Studies show that it affects more than two billion people globally, accounting for 60,534 deaths in the year 2010 in women of reproductive age. Pregnant women are at risk of iron deficiency anaemia due to the increased nutrient requirement during pregnancy (Rahman et. al, 2016). Particularly, the focus is on pregnant women and preschool-age children since they suffer the most. It has been found out that globally, almost half of all preschool children (47.4%), pregnant women (41.8%), and close to one-third of non-pregnant women are (30.2%) are anaemic (Benoist et. al, 2008). Though anaemia has multifaceted causes Iron Deficiency Anaemia rates the highest amongst these factors (Badham et al., 2007).

Several studies have documented the consequences of maternal anaemia which include; risk of maternal death, low birth rate, and preterm birth (Khan et al., 2006; Demuth et al., 2018). According to the World Health Organization, 3.7% death of maternal mortality in Africa is as a result of anaemia (World Health Organisation, 2012). Iron deficiency generally precedes a diagnosis of Iron Deficiency Anaemia as iron stores are first depleted, iron deficiency erythropoiesis is established and a clinical diagnosis of Iron Deficiency Anaemia (IDA) follows as the most prominent display of Iron Deficiency (Breymann, 2013). Iron deficiency anaemia during pregnancy is associated with an increased risk factor for maternal low weight gain, preterm labour, placenta previa, the premature rupture of the membrane, cardiac arrest, haemorrhage, lowered resistance to infection, poor cognitive development, and reduced work capacity.

Similarly, this iron deficiency anaemia also affects foetal and neonatal development, and these effects include; increasing risk factors of prematurity, low birth weight, foetal distress which contribute to perinatal morbidity and mortality (Begum et al., 2012). A meta-analysis indicated that the risk of maternal death can be reduced by 20% for each 1g/dl increase in population mean haemoglobin level (Stolzfus et al. 2006).

In 2011, a study was conducted in Spain to determine the effects of IDA on neonatal behaviour at different stages of pregnancy. This study followed a population of low-risk pregnant women from week 13 of gestation to childbirth. This group of women began receiving iron supplements starting in the second trimester of pregnancy. Researchers evaluated maternal iron levels throughout each woman's pregnancy by regularly drawing blood samples to measure serum ferritin (SF), serum iron, and serum transferrin. In each woman's case, these levels were used to calculate the percentage of transferrin saturation (TS) and determine her severity of ID. These blood markers help to determine serum iron levels per World Health Organization (WHO) recommendations. The results of this study reported on the prevalence of ID decreasing from 62.5% in the first trimester to 42.6% in the second trimester, and 8.3% in the third trimester. Furthermore, TS and SF levels also increased as the duration of the pregnancy increased. The researchers claim that prenatal ID and neonatal behaviour are closely associated and the trimester in which IDA is most severe does alter neonatal behaviour (Hernandez-Martinez et al., 2011).

2.4 FOLATE (FOLIC ACID) REQUIREMNETS IN PREGNANCY

Folate is a generic term for both, the originating form of the vitamin occurring naturally in food and the synthetic form found in supplements and fortified foods (Bailey1995). In different studies, results obtained shows that maternal folate levels are reduced by 50% during pregnancy as a physiological response related to, different processes that occur during this period which includes processes like haemodilution, increased renal excretion, and hormonal changes (Institute of Medicine, 1998; Molloy et al., 2008). Given this, folate needs increase during pregnancy and the EAR for pregnant women is 520µg/day and RDA is 600µg/day (FAO; WHO, 2001). World Health Organization and the Centers for Disease Control and Prevention recommend that foods are fortified with 1.4mg of FA/kg of the product since the status of folate has been strongly associated with neural tube defect (Bailey et al., 2015). In addition to fortified foods and folate obtained from dietary sources, WHO recommend a folic acid supplementation of 400µg/day to be taken 3 months before conception and in the first trimester to prevent neural tube defect (NTD) and 5mg/day if there was a record of any previous history of NTD (WHO, 2012; 2015). Increased demand for folate during pregnancy is as high as 5 to 10 folds to meet the rate of increased folate catabolism in this period (McPartlin et al., 1993; WHO, 2015).

2.4.1 Effects of dietary folate (folic acid) on pregnancy outcomes

The nutritional deficiency of B-vitamins which include folate and vitamin B12 have been related to some alterations during pregnancy and these are; low birth weight, premature birth, and fetal malformation amongst others (Li et al., 2009). However, various pieces of evidence that have been accumulated show that these effects can be reversed by adequate supplementation of folate during the preconception period as well as the first trimester of pregnancy (Wilson et al., 2007; Hoffbrand, 2014). Folate again plays a very important role in the one-carbon metabolism for physiological nucleic acid synthesis and cell division, regulation of gene expression, amino acid metabolism, and neurotransmitter synthesis (Djukic, 2007). During pregnancy, there is an increased demand for folate for rapid cell proliferation and tissue growth of the uterus and placenta, growth of the fetus, and expression of maternal blood volume (Rando & Tomkins, 2000). Research also has it that, homocysteine metabolism is influenced by many factors which folate and vitamin B12 status are inclusive and elevated levels of homocysteine have been identified through research to be treated using food folate, synthetic folic acid, and other B vitamins (Di Simone et al., 2004).

Inadequate intake of folate has been found to lead to decreased levels first in plasma and then in erythrocytes which results in an increased level in homocysteine and other clinical complications like the megaloblastic anaemia (Institute of Medicine, 1998). A study conducted by Scholl (2000) and Bukowski et al. (2009) both indicated that the rate of folate deficiency in increasing the risk of spontaneous abortion as well as birth outcomes like low birth weight, preterm birth, and perinatal mortality is clear. Another prospective cohort study that looked at homocysteine and folate concentration in early pregnancy and the risk of adverse pregnancy outcomes concluded that higher homocysteine concentration and lower folate concentration during early pregnancy were associated with lower placental and foetal size (Bergen et al., 2012).

Birth weight is one vital parameter of pregnancy outcome since, research has strongly associated it with infant mortality within the first year of life and also influences later developmental processes as well (Wilcox, 2001). Folate that is needed for growth reaches the maximal level in the last (3^{rd}) trimester due to the rapid growth of the foetus and the utero placental system and foetal accumulation of foetal stores (Higgins et al., 2000). A study that aimed at finding an association between red blood cell (RBC) folate status in the last trimester of pregnancy and birth weight concluded that low folate intake (< 187μg/day) and low RBC folate status in the late pregnancy increases the risk of small for gestational age birth in an adolescent population (Baker et al., 2009). Other studies have also supported the fact that there is a positive association between birth weight and the expectant mothers' RBC folate status (Ek, 1982; Rao et al., 2001). Again a meta-analysis that looked at the effect of folate intake on health outcomes in pregnancy using eight publications concluded that there is a significant dose-response relationship between folate intake and birth weight. Notwithstanding, the results did not indicate evidence of any effect of folate supplementation on placental weight and length of gestation (Fekete et al., 2012).

2.5 FACTORS IMPACTING MATERNAL NUTRITION STATUS AND INFLUENCING BIRTH OUTCOMES

Maternal nutritional status has also been linked to socioeconomic factors (education and income level, employment) which have been said to be important predictors of nutrient intake and diet quality of expectant mothers resulting in either positive or negative birth outcomes (Kramer et al., 2000). A way in which socioeconomic status may influence birth outcomes is its effect on the diet quality of the expectant mother. Improvement in maternal nutrition has been shown to increase foetal growth and a reduction in adverse birth outcomes in developing countries (Kamau-Mbuthia & Elmadfa, 2007). Low socioeconomic status levels do not have a direct impact on foetal growth but rather results in unhealthy exposures that increase the risk of adverse birth outcomes. A study conducted among rural Indian women showed that, the intake of dairy products was associated with the socio-economic status of the participants and was also associated with birth weight (Rao et al., 2001). Another study in northwestern Ethiopia on dietary practices and associated factors during pregnancy concluded that, the total household incomes impacted on the dietary practices of the pregnant women (Nana & Zema, 2018).

Other risk factors that have been linked to impact maternal nutrition and consequently result in adverse birth outcomes include smoking, use of alcohol and other substances, and maternal infections. Research suggests that smoking and alcohol use may interact with maternal micronutrient status and deficiencies to impair the development of the foetus (Cogswell et al., 2003).

It is globally accepted that undernutrition can have a drastic and wide-ranging effect on women and children if not managed properly. In instances where undernutrition occurred as a result of food shortage, very high levels of morbidity and mortality are recorded (Picot et al., 2012).

CHAPTER THREE

3.0 METHODS

3.1 STUDY DESIGN

A cohort design was used for this study and the duration was eight weeks.

3.2 STUDY SITE

The study was conducted at the Department of Obstetrics and Gynaecology at the Korle-Bu Teaching Hospital. This hospital is one of the major referral centres in the country and the Department serves as a tertiary referral centre for all pregnancy cases for the southern part of the country. Currently, the unit handles about 11,855 new cases, 19,709 old cases, and 15,874 postnatal cases which amount to a total number of 47,438 cases with staff strength of 779 (Korle-Bu Obstetrics & Gynaecology department report, 2017).

3.3 SAMPLING POPULATION

The study population was pregnant women attending antenatal clinics at the Korle-Bu Teaching Hospital.

3.3.1 Inclusion criteria

1. All pregnant women in their third trimesters who accepted to participate and were attending antenatal clinics at the KBTH.
2. Pregnant women with a singleton pregnancy who were within the age range of 18 to 49 years and willing to participate. This age limit falls within the reproductive age range in Ghana (Ebu et al., 2018).

3.3.2 Exclusion criteria

1. Pregnant women who had records of obstetrics complications.
2. Pregnant women who had sickle cell disease as well as those with any other health conditions like hypertension and diabetes.
3. Pregnant women who refused to give consent to participate.

3.4 SAMPLING METHOD

A consecutive sampling method was used. Patients who met the inclusion criteria and consented were selected until the sample size was achieved. Participants were recruited at the Out-Patient Division (OPD) of the Obstetrics and Gynaecology department within a period of one month.

3.4.1 Sample size calculation

The sample size proportion was calculated using Cochran's formula (Cochran, 1977)

$$No. = \frac{Z^2 \times P(1 - P)}{d^2}$$

$$No. = \frac{[1.64]^2 \times [0.19]\,[1 - 0.19]}{0.1^2}$$

No.= 41.4

Where Z = z-score of the confidence level (90%) =1.64

P = anticipated population proportion (prevalence rate of iron deficiency among 3rd trimester women in Accra metro (GHS, 2016) = 19.3% = 0.19

d = margin of error = 10% = 0.1

No. = minimum sample size without considering the finite population correction (fpc) factor.

Power = 0.80

To allow for a 5% allowance for non-responses (Osman et al., 2016), no = 43

Making 20% allowance for attrition or loss to follow-ups (Prasanth et al., 2017);

$$N = \frac{n}{1-(^{20}/_{100})}$$

$$= \frac{43}{1-(0.2)}$$

Therefore N = 54 however, the study used 81 participants.

3.5 DATA COLLECTION

Data were collected in four main parts. Structured questionnaires were adopted from Owusu (2008) and modified to suit the study. The flow diagram (figure 1) shows the divisions of the data that were collected. The first part consisted of socio-demographic details and the last part was on birth outcomes details.

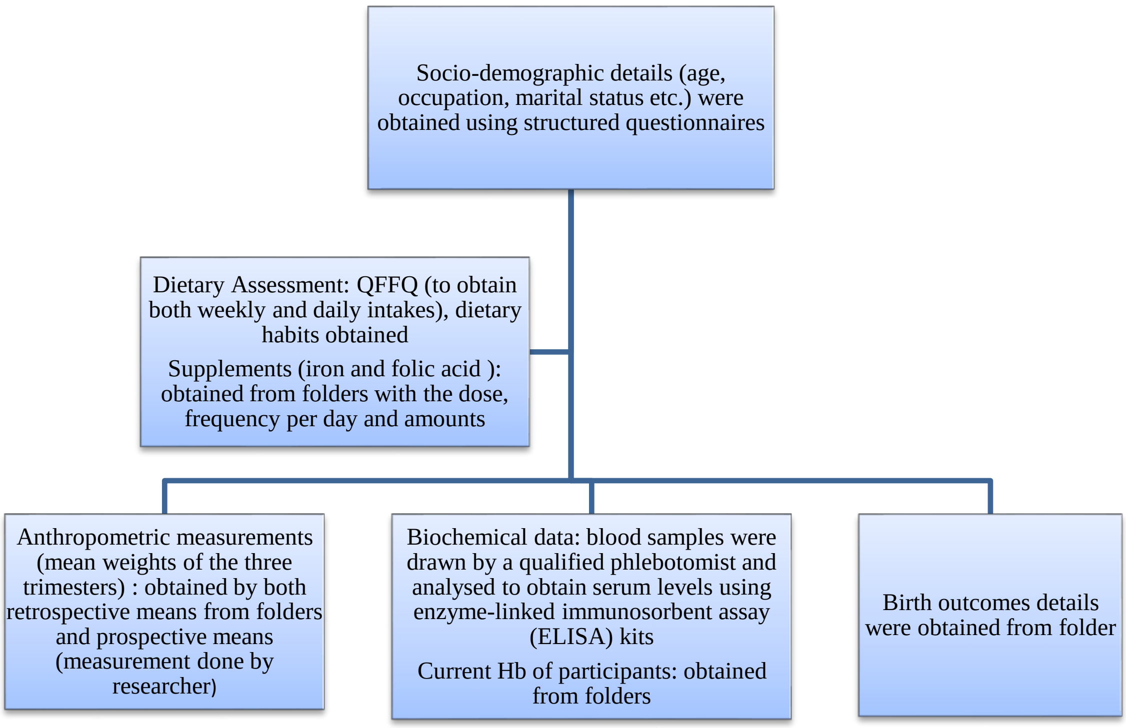

Figure 3.1: Flow diagram showing data collection parameters.

3.5.1 Procedure for data collection

A letter from the department of dietetics introducing the researcher and the purpose of the research was sent to the administration of the Obstetrics and Gynaecology department. Interactions with the pregnant women were done on two different occasions (at recruitment which is 32 gestational weeks where; their socio-demographic information and dietary intakes were taken, and at 36 weeks where; blood samples were drawn for biochemical analysis). The first encounter where the participants were recruited, took place at the Out-Patient Division (OPD) and the second happened at a designated area allocated in the OPD for taking of blood samples. There were two follow-ups after recruitment in this study; the first was on 36 weeks gestational age to obtain biochemical data (blood sample to test for serum folate and ferritin) and the second was after delivery to obtain the birth outcomes. Structured questionnaires were administered to participants to obtain the data.

Thirty-six (36) gestational week was chosen because, iron is mostly transferred to the foetus after week 30 of gestation (Allen, 2000), and a study that looked at how maternal iron status influences iron transfer to foetus did so in week 36 of gestation (Brien et al., 2003).

After delivery, birth outcomes of participants were then taken from their folders using an observational checklist (information related to birth outcomes) in the labour rooms or postpartum wards (Yakout et al., 2014) and findings were interpreted using statistics. Cases where the observational checklists were taken in the labour room, it was retrieved by the co-supervisor who is a gynaecologist and when the observational lists were taken in the postpartum wards, information was retrieved by the researcher since the due date of delivery was known by the researcher from the folders.

3.5.2Questionnaire

The questionnaires were pre-tested on five pregnant women (10% of the calculated sample size) who met the inclusion criteria and were attending antenatal clinic at Korle-Bu Polyclinic.

A modified structured questionnaire was given to the participants (Owusu, 2008). The interviewer administered questionnaires were in sections as follows: Section A of the questionnaire comprised socio-demographic characteristics of respondents which included, their marital status, age, occupation, level of education, and other personal details; section B was on dietary habits practiced by the women and section C was on nutritional supplements taken by the women as well as the actual dose of the supplements. Again, section D was on food and nutrients related history whereas a semi-quantitative food frequency questionnaire was used to obtain both daily and weekly dietary folate and iron intakes of participants. Section E gathered information on the mean weights of the mothers for the three trimesters (where 1^{st} and 2^{nd} trimesters mean weights were obtained from the folders and from the period when the study began, weights were taken by the researcher) and that of biochemical data using participants' blood samples. Section G and F gathered data on birth outcomes after delivery.

3.5.3Anthropometry measurement

3.5.3.1 Weight

Each month's weight from the time participants began attending antenatal was taken by both retrospective and prospective means. The retrospective way was achieved by taking the information from the folders and the prospective way was achieved by the researcher taking the weights of the participants considering accuracy. The mean weight for each trimester was then calculated. This was done to track changes in mean weights from the first trimester to the third trimester.

3.5.4 Dietary Assessment

The dietary intake of participants for this study was measured by a 52-item semi-quantitative food frequency questionnaire (QFFQ). Participants were asked questions on their usual weekly intakes of folate and iron-rich food sources which were used to obtain both daily and weekly intake of these nutrients. Six food groups (namely starchy roots and plantain; cereals and grains; animal products; legumes, nuts and oilseeds; fruits and vegetables, and then fats and oils) with their food items were used in this study. Consumption frequency of participants was obtained from the eight predefined categories, ranging from never to two or more times per week. Food intakes with their amounts were provided by the participants through recall and the amounts recorded in handy measures which were then converted to grams. Also, foods high in refined sugars such as beverages, soft drinks, and pastries were obtained from participants and converted to grams as well. The converted amounts were analyzed using West Africa Foods Nutrient Analyses (WAFUDS).

Participants were again asked to provide the type or brand, amount(s), and frequency of all dietary supplements they were currently taking in the third trimester. Daily iron and folic acid supplement consumptions were respectively achieved, by multiplying the iron and folic acid content of each reported supplement to the amount(s) of tablets taken daily, the total was then multiplied by the frequency of consumption in the day. Total daily iron was derived from the sum of dietary iron and oral iron supplement as well as total daily folate was derived by the same calculation. The recommended daily allowance (RDA) for dietary iron during pregnancy is 27mg/day and that of dietary folate is 0.6mg according to the World Health Organisation (WHO, 2012). The organization also recommends daily oral iron and folic acid supplementation of 30mg to 60mg and 0.4mg respectively.

3.5.5 Laboratory Data

3.5.5.1 Procedure

Five millilitres (5mls) of blood was drawn from the participants by a qualified phlebotomist into a plain tube. The samples were then centrifuged to obtain the serum part and each participant’s serum was pipetted and divided into two. The divided serum samples were placed in separate cryotubes (where one part was used to analyze the folate level and the other for ferritin level) which were then labeled with the participant’s code for identification and stored at -20˚C.

Sample preparation (folate only): One hundred microlitres (100 µl) of samples and standards were added to 50µl of extraction reagent (2-carboxyethyl phosphine/sodium hydroxide/potassium cyanide). This was vortexed and allowed to settle. An amount of fifty microlitres (50µl) of a neutralizing buffer (pH reducing agent) was then added, vortexed, and then allowed to settle. This sample treated mix was then ready for the folate test.

Accu-Bind Ferritin (or Folate) 96 microwell ELISA plate (Lake Forest, CA, USA) was used. The test was performed according to the manufacturer's instructions. In brief, the plate and reagents were brought to room temperature. Twenty-five microlitres (25 µl) of standards [(Ferritin -0, 10, 50, 150, 400 and 800 ng/ml) or (Folate -0, 1.0, 2.5, 5.0, 10.0 and 25.0 ng/ml)] and samples were pipetted into different wells. Hundred microlitres (100 µl) of the Ferritin-Biotin reagent (of Folate-Biotin reagent) was added to each well.

The plate was swelled gently for 20-30 seconds and incubated at room temperature for 30 minutes. The contents were discarded by a swift flip and the plate blotted on an absorbent paper. Each well was washed with 350 µl buffer three times (3x) with blotting on the absorbent paper in between. After the final blotting (to dryness), 100 µl of ferritin (or folate) enzyme conjugate was added to each well and incubated for 30 minutes without shaking at room temperature. After incubation, 100 µl of substrate solution [tetramethyl benzidine (TMB) in hydrogen peroxide buffer)] was again added to each well and incubated at room temperature for 15 minutes without shaking. The reaction was stopped with the addition of 50 µl stop solution (1NHCl). The plate was gently swelled and the final chromogen read on an ELISA plate reader at 450 nm with a reference filter of 630 nm within 30 minutes. A standard curve was plotted using the standard concentrations to generate an equation of the curve. Unknown sample concentrations were calculated from the standard curve equation.

3.5.5.2 Reference Ranges

The most recent results of laboratory tests for Hb (within the past month) and worm infestation information (if available) were extracted from the respondent's hospital records.

To determine anaemia based on participants' Hb levels, a reference value of <11.0g/dl in the third trimester was considered anaemic (WHO & UNU, 2001).

To determine iron deficiency based on participants' ferritin levels, a reference value of <15ng/ml was associated with iron deficiency (Abbassi-Ghanavati et al., 2009).

United Nations University's (2008) standard of measuring folate deficiency was also adopted. Serum folate deficiency value is said to be <10nmol/L (4ng/mL)

3.6 DATA MANAGEMENT

Data collected was keyed into a password protected laptop. Questionnaires collected were kept under lock and key, available to only the researchers.

Information on serum ferritin and folate levels in participants were made known to them and in instances where dietary intervention was required, they were appropriately counseled on it and where medical attention was needed, participants were told to do so.

3.7ANALYSIS OF DATA

Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 25. A $p \leq 0.05$ was considered statistically significant.

The semi-quantitative food frequency was analyzed using West Africa Foods Nutrients Analyses (WAFUDS) to help determine the nutritional intake of the participants.

Descriptive analysis (mean and std. deviation, frequencies, and percentages) were used to summarize continuous and categorical variables that were represented with tables, graphs, and charts. Spearman's rank correlation test was used to determine the strength and relationship between serum levels as well as that of dietary intakes and birth outcomes obtained.

3.8 ETHICAL ISSUES

Approval for this study was obtained from the Ethics and Protocol Review Committee (EPRC), College of Health Sciences, and the Institutional Review Board (IRB), Korle-Bu Teaching Hospital. Permission was also obtained from the obstetrics and gynaecological department, KBTH. Written consent was sought from the participants. Anonymity and confidentiality were ensured.

CHAPTER FOUR

4.0 RESULTS

4.1 BACKGROUND CHARACTERISTICS OF PARTICIPANTS

A total of 81 participants from the department of obstetrics and gynaecology took part in this study. All studied participants were females within the age range of 18 to 49 years with a mean age of 32.22 ± 6.00 years.

The background characteristics of participants are represented in table 4.1 and figure 4.1.

4.1.1 Socio-demographic & Socioeconomic Characteristics of Participants

Table 4.1 is on socio-demographic and economic characteristics of the participants. Majority (82.7%) of the participants in the present study were married. A few (7.4%) of the participants did not have any formal education, with more than half (92.6%) with formal education. Out of the formally educated ones, J.H.S was the highest educational level attained by the majority (37.0%). Majority (83.9%) of the participants were employed. Most of the participants were involved in either vocational work (34.6%) or trading (33.3%). Almost all (98.7%) the spouses in this study were employed, with the majority either being professionals (35.8%) or involved in vocational works (33.3%). Again, majority (36.8%) of the participants earned a monthly income within the range of ₵100-299 however; a quarter (25.0%) of the participants also earned a monthly income above ₵1,000. Majority (53.8%) of the spouses of the participants earned a monthly income above ₵1,000.

Table 4.1 Demographic Characteristics of Participants (N=81)

Variables	N (%)
Marital status	
Single	14 (17.3)
Married	67 (82.7)
Educational level	
No formal education	6 (7.4)
J.H.S	30 (37.0)
S.H.S	19 (23.5)
Tertiary	26 (32.1)
Occupation	
Professional	13 (16.0)
Trader	27 (33.3)
Vocation	28 (34.6)
Jobless	13 (16.0)
Occupation (spouse)	
Professional	29 (35.8)
Trader	24 (29.6)
Vocation	27 (33.3)
Jobless	1 (1.2)
Participants' Income	
100-299	25 (36.8)
300-499	12 (17.6)
500-1,000	14 (20.6)
Above 1,000	17 (25.0)
Spouses Income	
100-299	6 (7.5)
300-499	10 (12.5)
500-1,000	21 (26.3)
Above 1,000	43 (53.8)

Figure 4.1 is on total (participants and their spouses) household monthly income range. A vast (76.5%) proportion of the participants were earning total household monthly income range above ₵1,000.00 with a marginal (1.2%) proportion not having any source of monthly income.

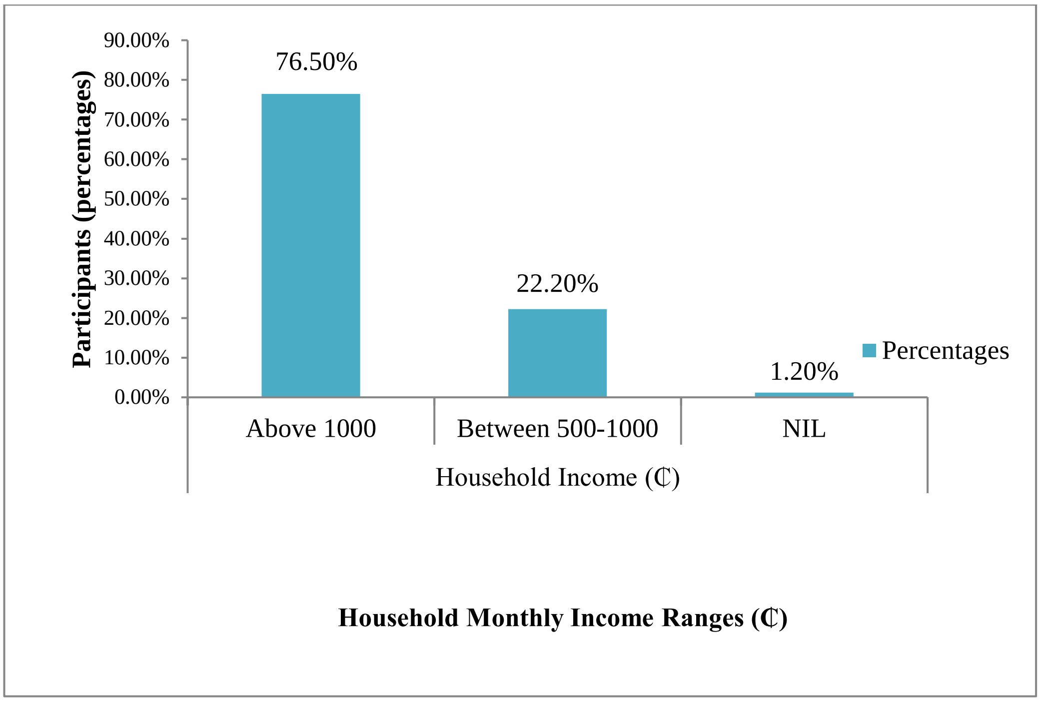

Figure 4.1: Household monthly income ranges of the participants

4.2 MEAN WEIGHTS FOR EACH TRIMESTER

Table 4.2 provides details of the mean weights for the three trimesters. The mean weight obtained for the participants during the first trimester was 75.99 ± 14.94kg, the second trimester was 77.95 ± 14.81kg and that of the third trimester was 79.88 ± 14.66kg. There was no statistically significant difference between the mean weights for the three trimesters.

Table 4.2: Mean weights change in the trimesters (N=81)

Frequencies	First trimester/kg	Second trimester/ kg	Third trimester/ kg	P-value
Mean ± SD	75.99 ± 14.94	77.95 ± 14.81	79.88 ± 14.66	
Median	77	78	78	0.248
Minimum	41	44	48	
Maximum	112	116	116	

ANOVA (One-way), significant at $p \leq 0.05$

4.3 DIETARY ASSESSMENT

4.3.1 DIETARY HABITS AND FOOD INTAKES OF PARTICIPANTS

Table 4.3 provides summary on the dietary habits practiced by the participants as well as the changes in the frequency of daily meal intakes during the third trimester. It again shows the dietary pattern of the participants, and it dwells on the difference in frequency of food intake before pregnancy and during the third trimester; food cravings experienced by the participants, and supplements consumption in the third trimester. Majority of the participants did not practice pica (76.9%). A greater proportion (36.8%) of participants who practiced pica did so in the third trimester; however, a substantial proportion (26.3%) practiced pica in their first trimester. The vast majority (86.4%) did not have food aversions in the third trimester and the minority that avoided particular foods (13.6%) did so due to reasons like: they experiencing heartburns after eating such foods or disliking the aroma. None of the participants in the present study were consuming alcoholic beverages. Again, majority (54.3%) of the participants did not experience any change in the frequency of meal intake whiles a sizeable percentage (45.7%) experienced some form of changes in the frequency of meal intake. It was also observed that before pregnancy, a greater percentage of the participants ate thrice in a day (82.7%). The frequency of food intake during the third trimester showed that, the majority (60.5%) were still eating thrice in a day however a substantial proportion (28.4%) were also eating four to five times in a day. Half (51.9%) of the participants experienced food cravings. All the participants were consuming one, two, or all of the three recommended daily antenatal supplements (iron, folic acid, and multivitamin).

Table 4.3 Dietary Habits and Patterns of Participants (N=81)

Variables	N (%)
Pica Practice by Participants	
Yes	19 (23.5)
No	62 (76.9)
Pica items consumed (n=19)	
Clay	13 (68.4)
Ice cubes	6 (31.6)
Trimester in which Pica Practice Begun (n=19)	
1st	5 (26.3)
2nd	4 (21.1)
3rd	7 (36.8)
Not sure	3 (15.8)
Reasons for pica practice (n=19)	
Feels like taking it	6 (31.6)
Satisfaction	1 (5.3)
Likes the smell/ aroma	4 (21.1)
To prevent nausea	6 (31.6)
To prevent salivation	2 (10.5)
Food aversions in the third trimester	
Yes	11 (13.6)
No	70 (86.4)
Consumption of Alcohol	
Yes	0 (0.0)
No	81 (100.0)
Changes in frequency of daily intakes	
Yes	37 (45.7)
No	44 (54.3)
Frequency of food intake before pregnancy (intake in a day)	
Twice	13 (16.0)
Thrice	67 (82.7)
Four to five times	1 (1.2)
Frequency in the 3rdtrimester (intake in a day)	
Twice	3 (3.7)
Thrice	49 (60.5)
Four to five times	23 (28.4)
Finds it difficult to eat	6 (7.4)
Proportion of the participants that experienced cravings in the 3rd trimester	
Yes	42 (51.9)
No	39 (48.1)
Proportion of the participants that were taking supplements in the 3rd trimester (Fe, B9, Multivitamin)	
Yes	81 (100.0)
No	0 (0.0)

4.3.2. Dietary iron and folate consumption and intake of supplements of participants

Table 4.4 provides the summary on iron and folate intake of the participants from the diet as well as supplements. The mean dietary iron intake obtained in the study was 13.54 ± 8.30mg and dietary folate was 331.16 ± 113.42mcg. For the supplements, the mean value obtained for iron dose was 42.70 ± 48.80mg and the folic acid dose was 5.50 ± 11.10mg. Also, the mean value obtained for total daily iron (diet + supplement) was 56.23 ± 50.28mg and total daily folate (diet + supplement) was 5.59 ± 10.92mg.

Table 4.4 Summary on participants' daily iron and folate (diet and supplements) consumptions with their recommended intakes (N=81)

	Daily Dietary Intake		**Daily Supplement Intake**		**Total Iron and Folate Intake**	
	Iron/mg	Folate/mcg	Iron dose/mg	Folic acid dose/mg	Total iron/mg	Total folate/mg
Mean	13.54 ±8.30	331.16 ±113.42	42.70 ±48.80	5.50 ±11.10	56.23 ±50.28	5.59 ±10.92
Minimum	5.53	158.51	0.05	0.007	5.88	0.17
Maximum	62.19	683.91	305	17	367.19	17.68
Recommended	27	600	30-60	0.4	57-87	1

4.3.3 Quantitative food frequencies

The summary of results on the frequency of consumption of iron and folate-rich foods by the participants is reported below. The frequencies in consumption of the foods written in the checklist (quantitative food frequency questionnaire) were discussed under the eight predefined categories, ranging from never to two or more times per week.

4.3.3.1 Frequency of consumption of starchy roots and plantain

Cassava (mainly fufu) was the least consumed food item under the starchy roots and plantain group with a small (19.7%) proportion of the participants consuming it at least 1-4 times in the week. Cocoyam was also consumed by more than half (60.4%) of the participants for at least 1-4 times in the week. Yam and plantain were the most frequently consumed items under this group with the majority (77.8%) consuming these two items for at least 1-4 times in the week. The only food item consumed everyday under this group was plantain with a marginal (1.2%) proportion of the participants and cassava was never consumed by the majority (63%) of the participants in this study.

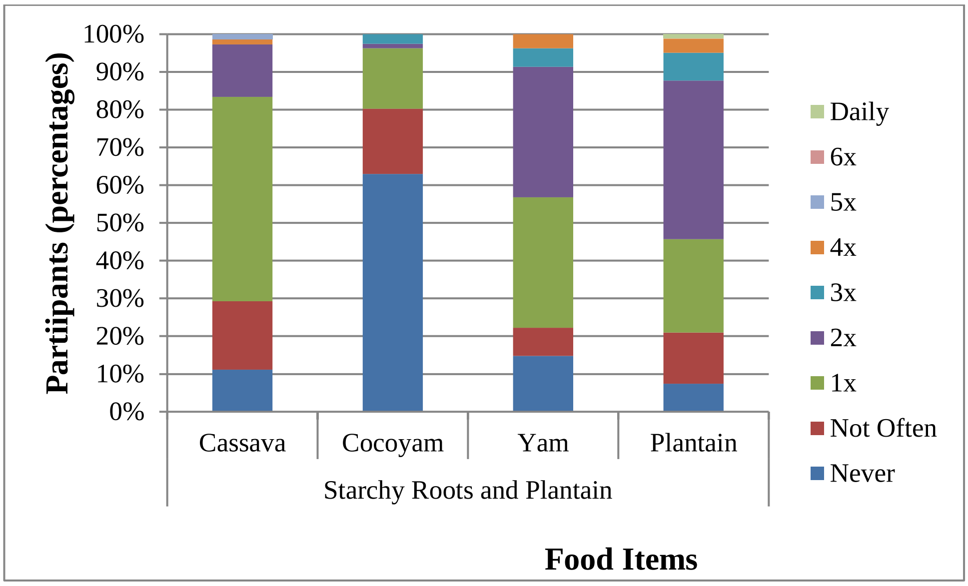

Figure 4.2a: Frequency of consumption of foods items under the starchy roots and plantain group by the participants in the week

4.3.3.2 Frequency of consumption of animal products

Goat or cow's liver and kidney were consumed at least 1-4 times in the week by the majority (60.5% and 74% respectively). Chicken and meat were also consumed daily by a marginal percentage (2.5% and 1.2% respectively) whiles the greater proportion (87.7% and 92.6% respectively) were consuming these two animal products for at least 1-4 times in the week. Salmon and tuna were consumed every day by the few (7.4% and 1.2% respectively) with the majority (80.2% and 82.8% were respectively) consuming the two foods for at least 1-4 times in the week. Crab was consumed for at least 1-4 times in the week by 32.1% of the participants and milk (mostly ideal milk) was consumed by a small percentage (2.5%) of the participants' daily whiles most (85.2%) of them consumed milk for at least 1-5 times in the week. Sardine was the least consumed animal product with majority (67.9%) of the participants not consuming it often in the week.

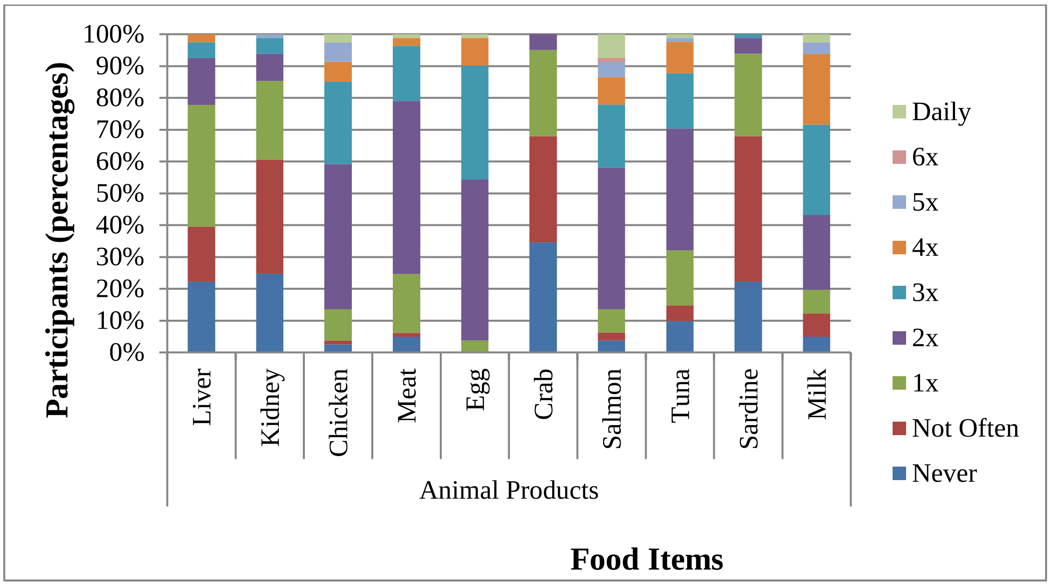

Figure 4.2b: Frequency of consumption of food items under the animal products food group by the participants in the week.

4.3.3.3 Frequency of consumption of cereals and grains

Maize (banku, kenkey, akple, and porridge) was consumed every day by the minority (3.7%) while the majority (96.4%) of the participants were consuming it for at least 1-6 times per week. Again, a small percentage (12.3%) of the participants were consuming rice daily while the greater percentage (85.1%) were consuming it for at least 2-6 times per week. Millet (tuo-zafi and porridge) was consumed every day by a few (3.7%) and almost half (44.5%) of the participants were consuming it for at least 1-6 times per week. Finally, bread (mostly sugar bread) was consumed every day by the minority (1.2%) whiles the majority (90.2%) of the participants consumed it for at least 1-6 times per week.

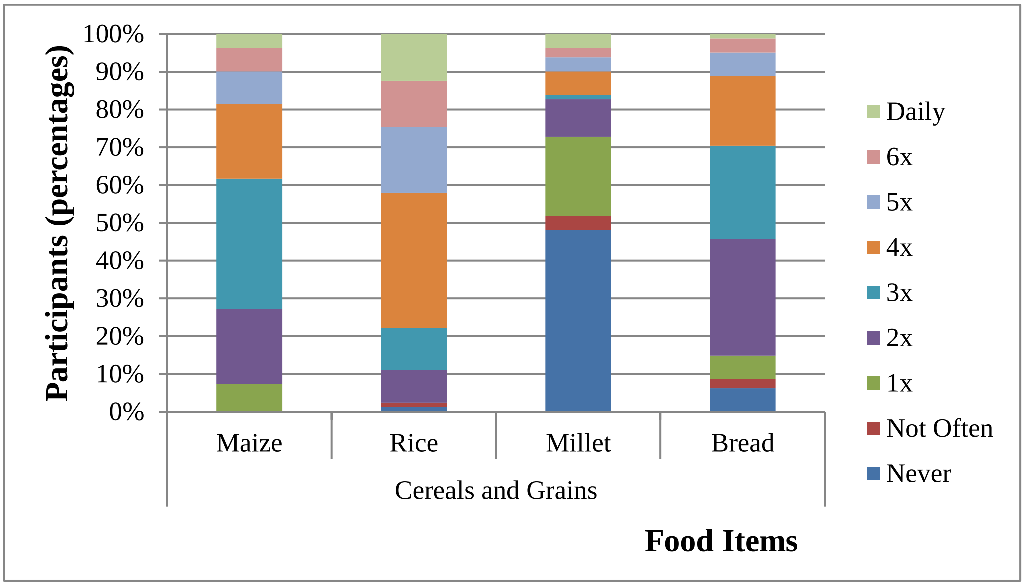

Figure 4.2c: Frequency of consumption of food items under the cereals and grains group by participants in the week

4.3.3.4 Frequency of consumption of legumes, nuts, and oilseeds

Beans and soya beans (stews and porridges respectively) were consumed for at least 1-3 times per week by 79% and 38.3% of the participants respectively. Groundnuts (soups and roasted groundnuts) were also consumed by a greater proportion (79%) for at least 1-4 times per week. Again, melon seeds (agushie) were the least consumed food item where; a sizeable proportion (28.4%) consumed it at least once a week and half (55.6%) of the participants were not consuming it at all.

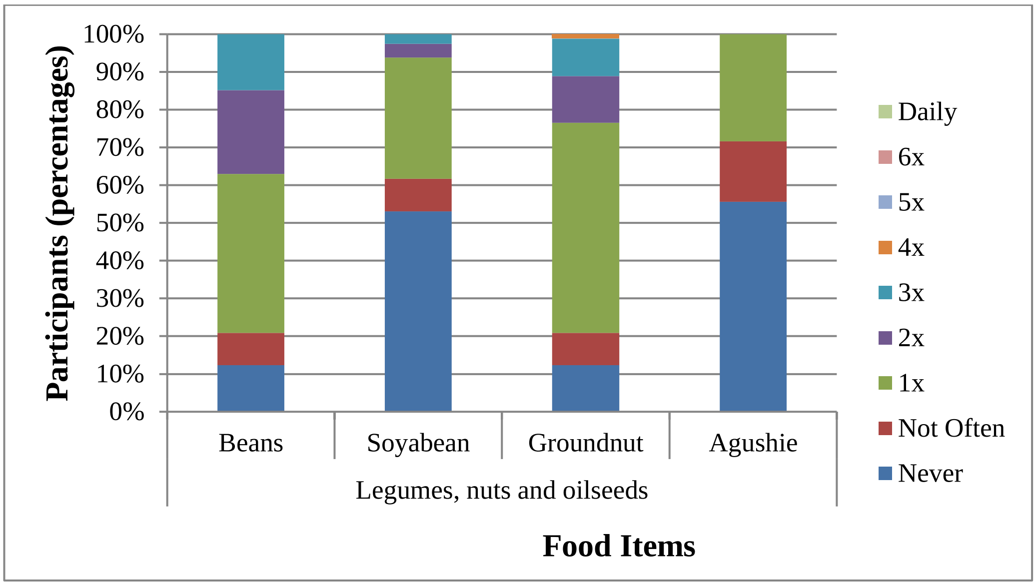

Figure 4.2d: Frequency of consumption of food items under the legumes, nuts and oilseeds group by the participants

4.3.3.5 Frequency of consumption of fruits

Banana was consumed daily by a small proportion (4.9%) while half (56.8%) of the participants consumed it for at least 1-4 times per week. Avocado was consumed by almost half (46.9%) of the participants for at least 1-5 times per week. Orange, pawpaw, and watermelon were consumed every day in the week by a few (2.5%, 2.5%, and 11.1% respectively) of the participants' whiles, quite a sizeable percentage (20.9%, 34%, and 55.5% respectively) of the participants consumed these fruits for at least 1-5 times per week. Mango was consumed every day by the minority (3.7%) and a half (53%) of the participants consumed it for at least 1-6 times per week. However, a sizeable (30.9%, 28.4%, 61.7%, 69.1%, and 49.4%) proportion of the participants were respectively not consuming mango, watermelon, pawpaw, orange, and avocado at all in the week.

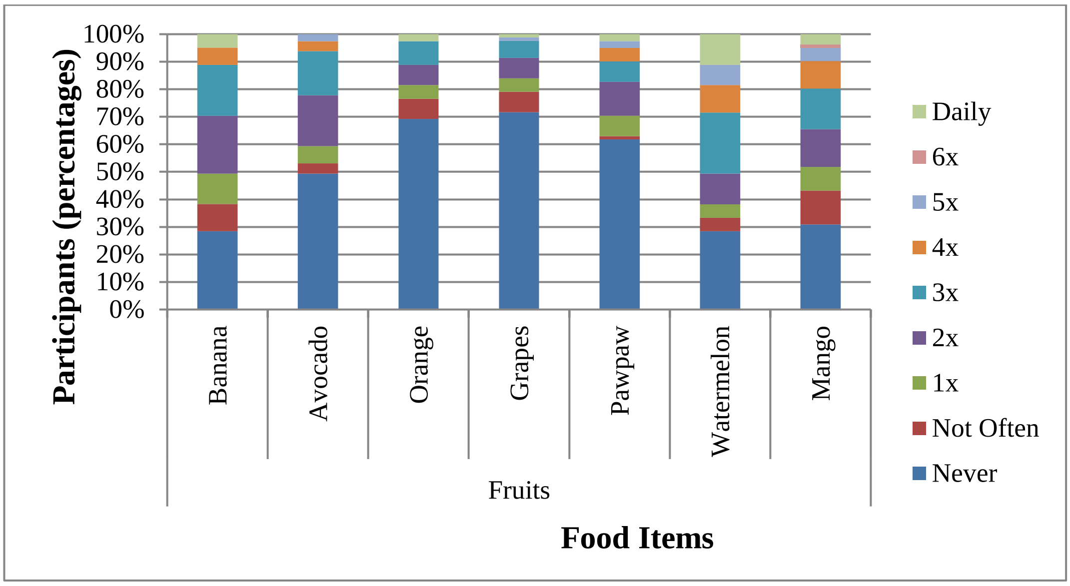

Figure 4.2e: Frequency of consumption of food items under the fruit group by the participants in the week

4.3.3.6 Frequency of consumption of vegetables

Tomatoes (stew) were consumed daily by the minority (2.5%) of the participants and almost all (97.5%) consumed it for at least 1-6 times per week. Pepper (grounded and shito) was consumed for at least 1-3 times in the week by the majority (66.7%) of the participants. Green leafy vegetables (mostly kontonmire) were consumed at least 1-5 times per week by the majority (96.3%) of the participants. Okro/ ayoyo were also consumed for at least 1-6 times per week by a greater percentage (97.5%) of the participants. Almost half (49.4%) of the participants consumed garden eggs (mostly stew) once in a week.

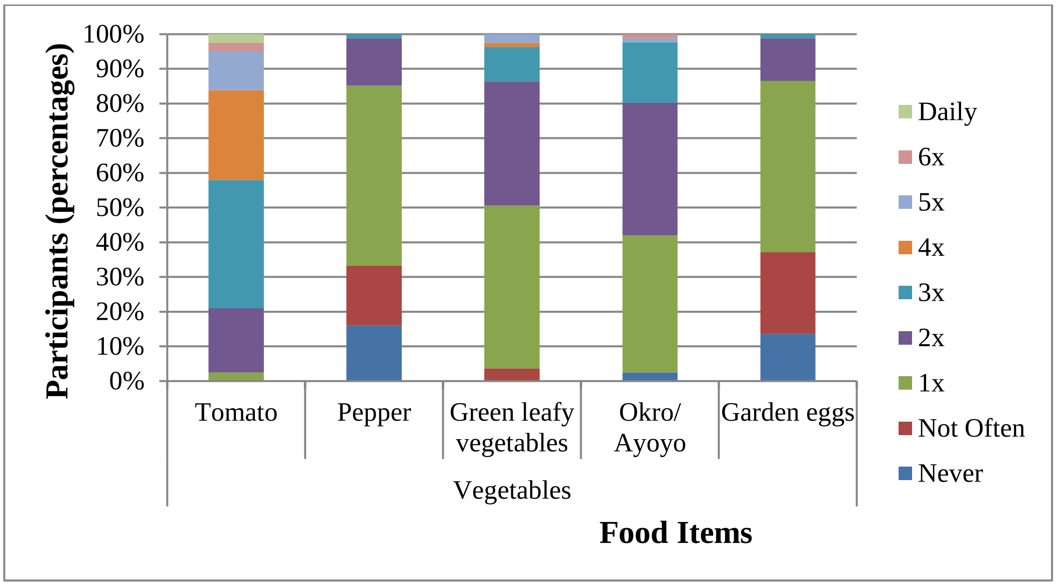

Figure 4.2f: Frequency of consumption of food items under the vegetables group by participants in the week

4.3.3.7 Frequency of consumption of fats and oils

Frytol was consumed by more than half (62.9%) of the participants for at least 1-6 times per week and a marginal percentage (1.2%) of the participants consumed it on daily basis. Soybean/canola/olive oils were also consumed every day by the minority (3.7%) of the participants; whiles a sizeable (40.6%) proportion of them consumed any of these oils for at least 1-6 times per week. Palm oil was also consumed by close to a half (40.7%) of the participants for at least 1-2 times per week whiles a little over a half (58%) were not consuming palm oil often. It should be noted that, soybean/canola/olive oils were the least consumed oils with half (54.3%) of the participants not consuming any of these oils in the week.

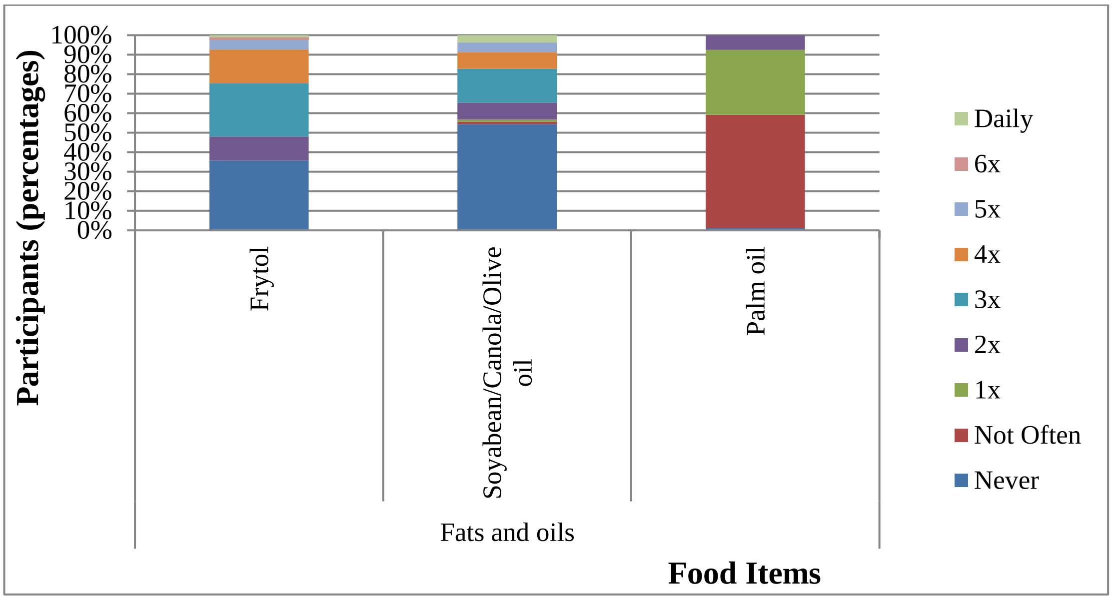

Figure 4.2g: Frequency of consumption of food items under the fats and oils food group by the participants in the week

4.3.3.8 Frequency of consumption of foods high in refined sugars

Milo beverage was consumed every day by a small percentage (1.2%) whiles a sizeable percentage (22.2%) of the participants were consuming the beverage thrice in the week. Coca-cola drink was also consumed once a week by the minority (12.3%) of the participants. Sprite, fanta, and malt drinks were consumed once a week by the minority (4.9%, 1.2%, and 18.5%) of the participants respectively. Don Simon drink was also consumed once in the week by the minority (9.9%) of the participants. Finally, the minority (1.2% and 4.9%) of the participants were consuming biscuits and cakes once a week respectively.

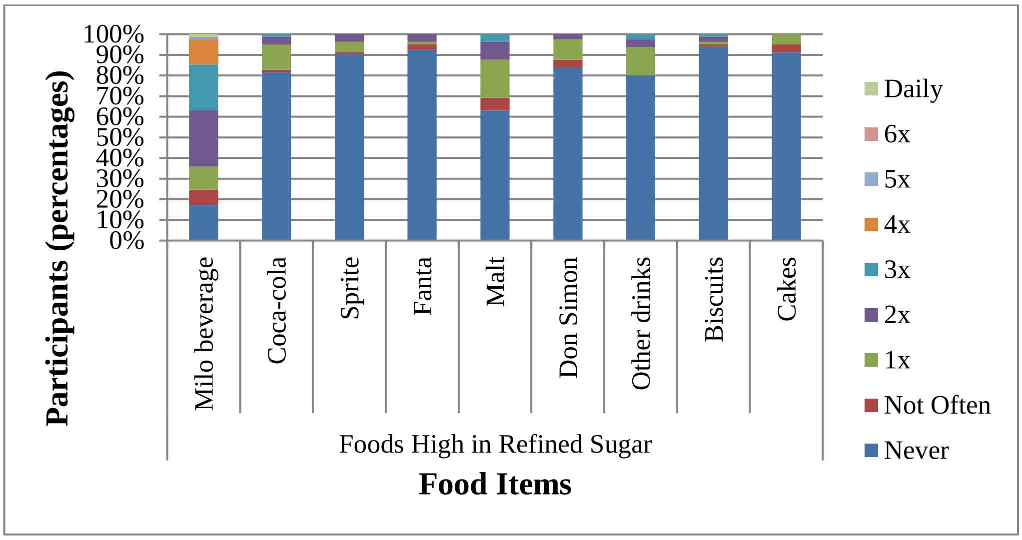

Figure 4.2h: Frequency of consumption of foods high in refined sugar by the participants in the week

4.3.4 Comparison between diet and supplements intakes with recommendations

Figure 4.3 shows the comparison between participants' daily dietary iron and folate intakes with recommendations. A minority (3.7%) of the participants met the recommended daily dietary iron allowance. Similar results were obtained with folate where; a minority (3.7%) also met the daily dietary allowance.

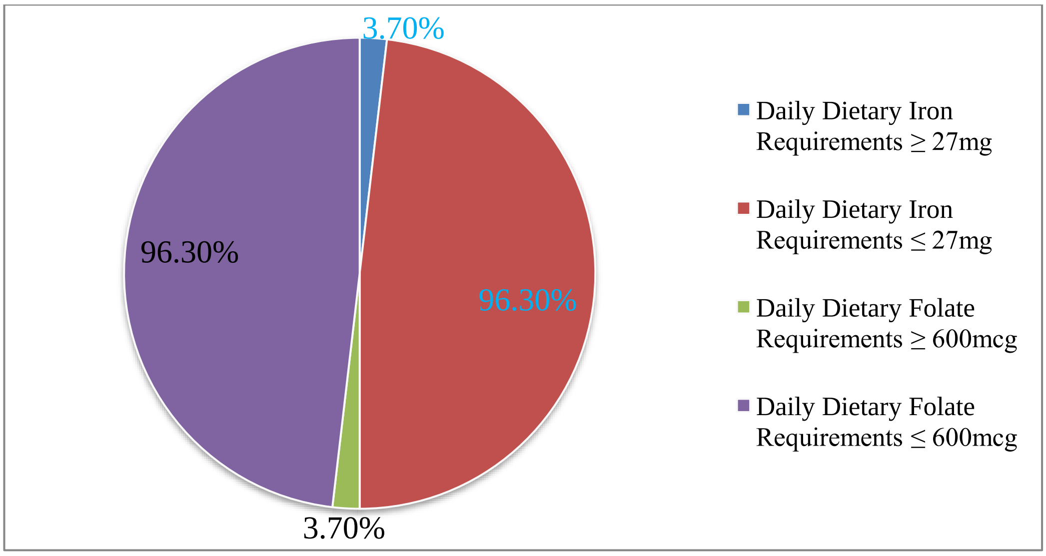

Figure 4.3: Comparison between participants' daily dietary iron and folate intakes and recommendations

Figure 4.4 shows the daily supplements (iron and folic acid dosage) consumption by the participants. For daily iron supplements intake; the minority (17.3%) of the participants fell within the recommended daily requirements (30-60mg) whiles half of them (55%) fell below the recommendation and a sizeable percentage (27.2%) also fell above the recommendation. For folic acid daily supplement intake, a greater percentage (95.1%) met the recommendation (≥4mg).

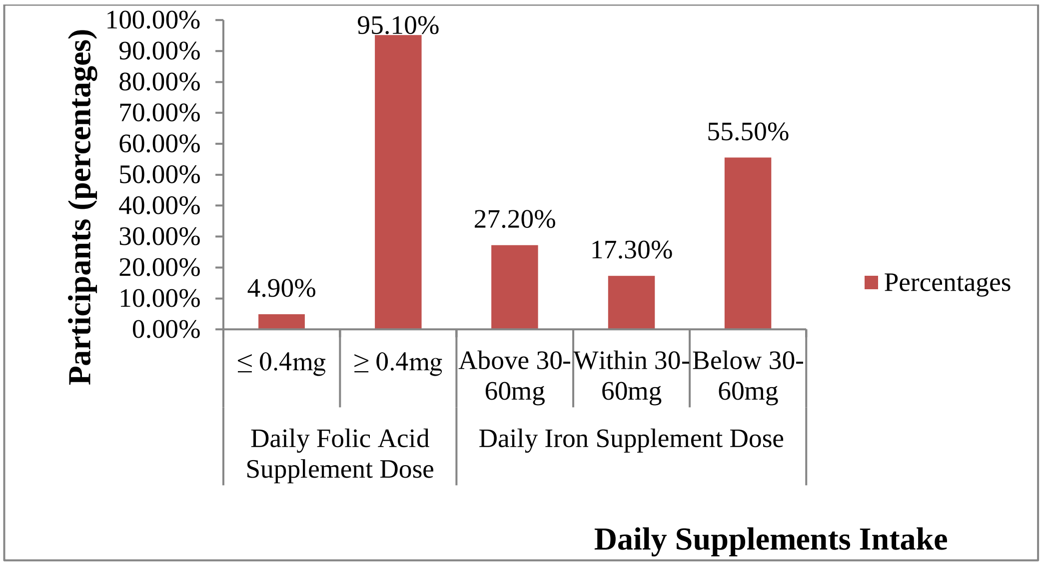

Figure 4.4: Participants' daily supplements intakes and recommendations

Figure 4.5 shows the comparison between total daily iron as well as total daily folate intake by the participants and the recommendations. The majority (74.1%) of the participants fell below the reference total iron recommendation for the day. A similar result was seen with total folate daily recommendation where the majority also fell below the recommendation (86.4%).

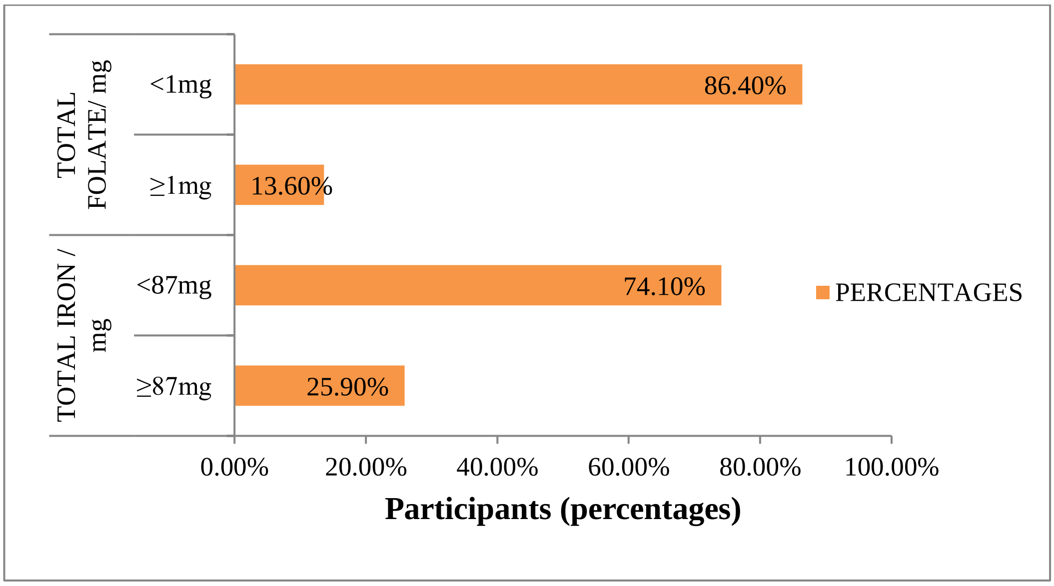

Figure 4.5: Comparison between participants' total daily iron and folate intakes and recommendations

Figure 4.6 shows the contributions of diet and supplement consumptions to the daily total iron and folate obtained in the study. Daily dietary iron intake by the participants did not contribute that much (12.05%) to the daily total iron. Hence, daily iron supplement intake by the participants were the ones that contributed massively (87.95%) to the total iron obtained. A similar observation was made for daily total folate intake where; dietary daily folate contributions to the total intake were not that much (24.69%) whereas daily folic acid intake contributed a lot (75.31%).

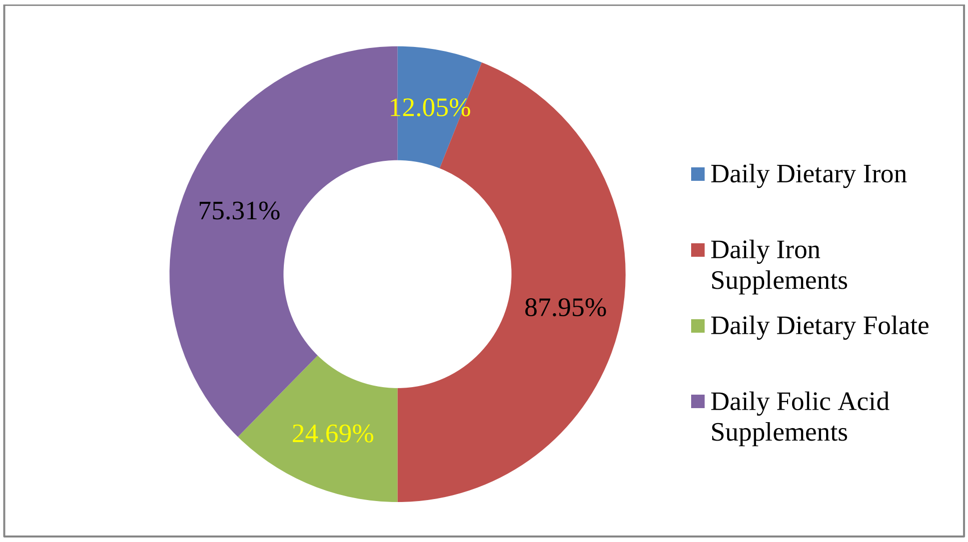

Figure 4.6: Contributions of diets and supplements consumptions to the daily total iron and folate intakes

4.4 BIOCHEMICAL ANALYSIS

Table 4.5 gives a summary on the serum levels (ferritin and folate) and the most recent Hb levels of the participants. The minimum and maximum sera levels of both nutrients are provided in the table. The maximum sera level of ferritin is 145.18ng/ml, folate is 33.14nm/ml and haemoglobin is 13.40g/dl.

Table 4.5 Descriptive Analysis of the serum ferritin, folate, and haemoglobin levels of participants

	Serum Ferritin (ng/ml)	**Serum Folate (ng/ml)**	**Hb (g/dl)**
Mean	67.13± 42.52	10.03± 7.69	10.57± 1.09
Median	71.18	8.27	10.50
Minimum	-2.69	1.48	8.20
Maximum	145.18	33.14	13.40

Figure 4.7 is on serum ferritin and folate levels in the participants. The majority (82.7%) of the participants had normal serum ferritin levels. Same outcome was observed for serum folate where, almost all (87.7%) the participants were within the normal level. Hence, the present study obtained a relatively lower deficiency rates for both iron and folate nutrients (17.3%, 12.3 respectively).

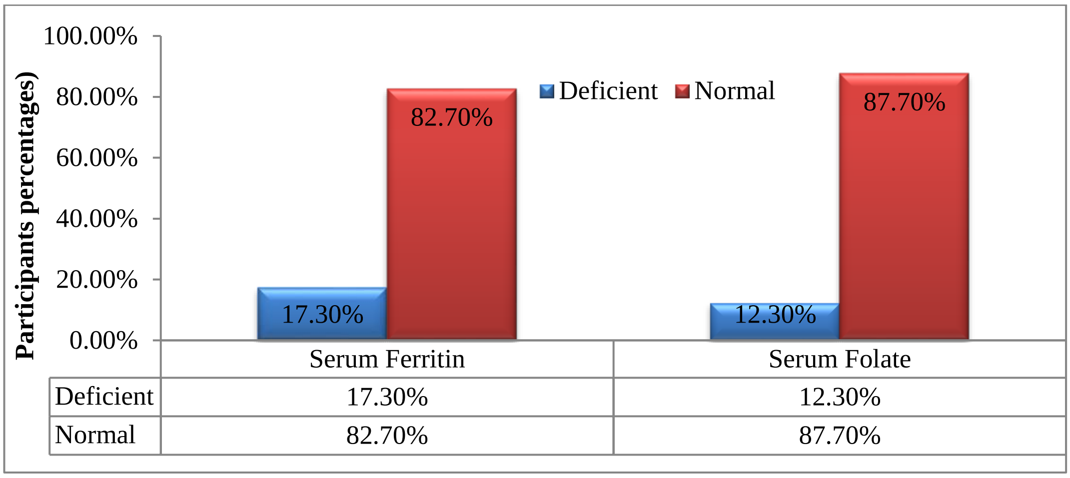

Figure 4.7: Participants' serum ferritin and folate levels

4.5 BIRTH OUTCOMES

Table 4.6 shows the means, median, minimum and maximum values of the birth outcomes obtained. A lot of the participants delivered around 39 gestational weeks with most of the babies weighing around 3kg.

Table 4.6 Birth outcomes obtained by the participants (N=81)

	Gestational age (weeks)	Birth weight (kg)	Apgar at minute 1	Apgar at minutes 5
Mean	39.07± 1.39	3.26± 0.49	6.94± 1.10	8.21± 0.90
Median	39.00	3.31	7.00	8.00
Minimum	36.00	1.98	3.00	4.00
Maximum	42.00	4.60	8.00	9.00

Figure 4.8 summarizes the categorical percentage representations of the birth outcomes obtained in the study. Almost all the participants had full term births (92.60%), delivered normal weight babies (96.30%) and the babies also recorded good Apgar scores at both minute 1 (74.10%) and minutes 5 (95.10%). More than half (61.70%) of the deliveries were through caesarean section and the greater percentage (92.60%) of the babies were not admitted at NICU for observations.

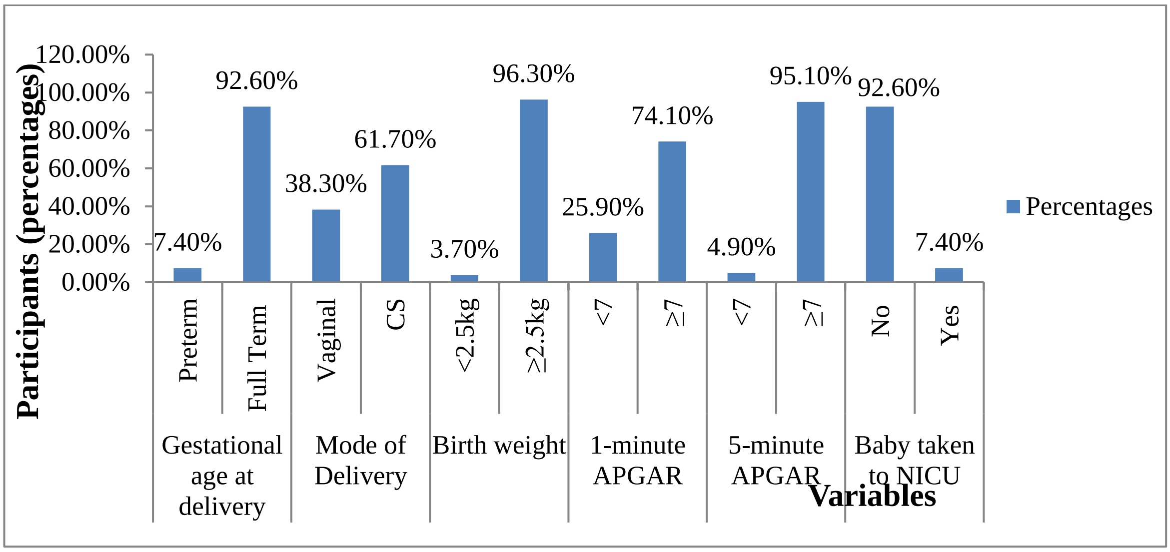

Figure 4.8: Percentage representation of the birth outcomes obtained by the participants

4.6 TEST OF RELATIONSHIPS

4.6.1 Analysis on Total Daily Iron, Folate and Birth Outcomes

Table 4.7 summarizes the relationship between total daily iron and folate intake and birth outcomes. Total daily folate consumptions did not correlate with any of the birth outcomes investigated. However, total daily iron intake correlated positively with Apgar at minute 5 with a p-value of 0.041.

Table 4.7 Correlation between Total Daily Iron and Folate Intake and Birth Outcomes

	Daily Total Iron		Daily Total Folate	
Variables	r_s	**P-value**	r_s	**P-value**
Gestational age	-0.023	0.836	0.208	0.062
Birth weight	0.043	0.163	-0.082	0.468
Apgar at minute 1	0.163	0.145	-0.028	0.802
Apgar at minutes 5	0.227*	0.041*	0.008	0.945

Spearman's ranked correlation test, significant at $p \leq 0.05$

4.6.2 Analysis on Serum Ferritin, Folate & Birth Outcomes

Table 4.8 summarizes the relationship between serum ferritin and folate levels and birth outcomes. The study however, did not obtain a statistical significant difference between any of the serum levels and birth outcomes.

Table 4.8 Correlation between Serum Ferritin, Folate & Birth Outcomes

	Daily Total Iron		Daily Total Folate	
Variables	r_s	**P-value**	r_s	**P-value**
Gestational age	0.008	0.943	0.138	0.219
Birth weight	-0.093	0.410	-0.173	0.121
Apgar at minute 1	0.003	0.979	-0.095	0.401
Apgar at minutes 5	0.037	0.745	-0.009	0.940

Spearman's ranked correlation test, significant at $p \leq 0.05$

CHAPTER FIVE

5.0 DISCUSSIONS AND CONCLUSIONS

5.1 DISCUSSIONS

The nutritional status of a woman prior to conception, during and after she puts to birth is crucial for desirable outcomes. Determinants of nutritional status are also multi-factorial which includes factors such as dietary habits (dietary intakes, pica practice, smoking, alcohol use), socio-demographic and socio-economic characteristics among others (Abu-Saad & Fraser, 2010). These factors have been linked to either impact positively or negatively on birth outcomes (Cogswell et al., 2003; Abu-Saad & Fraser, 2010). The expectant woman is therefore tasked to ensure that, her nutritional status is optimal to obtain desired outcomes.

The study aimed to assess the dietary intake and birth outcomes of women in their third trimester attending antenatal clinics at KBTH.

5.2 SOCIO-DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF PARTICIPANTS

A total of 81 pregnant women in their third trimester participated in this study with the mean age around 32years and majority of them being married. Also, majority of the participants were formally educated with most attaining junior high (37%) and tertiary (32.1%) levels. The two most common occupations the participants were involved in were trading and vocational work (33.3% and 34.6% respectively). Thus, most of the participants in the present study were matured, independent and stable in life. This is similar to findings of Ayensu et al. 2020 where; majority of the participants in that study were married, the highest educational level attained by most of the pregnant women was junior high and majority of them were traders.

A greater proportion (76.5%) of the participants had household monthly income above ₵1,000.00. This may be because, majority of the participants with their spouses were gainfully employed in the present study. Thus, most of the participants had good socioeconomic status which could have influenced their dietary intakes and habits. Findings in the present study are similar to findings of Nana & Zema (2018) where; their study concluded that, household socioeconomic (income and employment) status was a major predictor of dietary intakes and habits.

5.3 DIETARY INTAKES OF PARTICIPANTS

An optimal dietary intake as well as good dietary habit practices are crucial to meet both macro and micronutrient needs to obtain desired pregnancy outcomes. Dietary habits of the participants in the present study were generally good. The prevalence rate of poor dietary practice was relatively lower in this population in comparison with an earlier study carried out in the country to ascertain dietary habits of pregnant women (Koryo-Dabrah et al., 2012). The values [not practicing pica (76.9%), experiencing food aversions (86.4%), skipping meals (88.9%), and consuming alcoholic beverages (100%)] obtained in the present study, were again higher when compared to other studies conducted in sub-Saharan African countries. For instance, among pregnant women in north-western Ethiopia, 39.3% were found to practice good dietary habits (Nana & Zema, 2018). Also, in some selected African countries (which included Tanzania, South Africa, Kenya and Botswana) there were high prevalence of pica practice (63.7%) and food aversions (70.1%) among the participants (Nyaruhucha, 2009). The trend of good dietary habits among participants of the present study was not surprising. This is because, majority of the participants in the present study were formally educated, married and had sources of monthly income which made them more stable in life. This could have influenced their dietary practices since; educational level and socioeconomic status have been proven to have a positive impact on dietary habits practiced during pregnancy (Alemayehu & Tesema, 2014; Doyle et al., 2017). This should be encouraged since; maternal dietary habits during pregnancy have been shown to impact on the long-term health and nutritional status of the mother as well as the growing foetus and also influence birth outcomes (Nana & Zema, 2018).

Again, results obtained in this study showed that, the minority (25.9%; 13.6%) of the studied participants met the RDA for total daily iron and folate (the total value was derived from addition of the diet to the supplement taken in the day) intakes respectively. This implies that, a greater proportion of the present study's participants fell below the recommendations. This outcome is similar to studies conducted by Bailey et al. (2019) and Tayyem et al. (2019) which were studies conducted in the United States and Jordan among third trimester women respectively. Their findings concluded that, a significant number of pregnant women are not meeting the recommendations for total daily iron and folate even with the use of dietary supplements. However, findings in the study conducted among French-Canadian pregnant women contradict findings in the present study. Majority (75%) of the participants in that study met the total daily iron and folate recommendations, which were as a result of the participants exceeding the UL for supplementation (Savard et al., 2019). The outcome, on most of the participants falling below the total RDA for both nutrients in the present study could be related to majority not meeting the dietary recommendations. A reason that may have resorted to this outcome is the likelihood of the participants consuming inadequate amounts of food rather than variety, since the quantitative food frequency showed frequent consumptions from animal products; legumes, nuts and oilseeds; whole grains and cereals; fruits and vegetables which are good dietary sources of iron and folate nutrients. Again, foods high in refined sugars which have the potential of influencing food choices were suboptimal consumed. The inadequate intake of both nutrients from food in the present study, could be from the complains by some participants, on the difficulties they were experiencing with food intake which were; heartburns, feeling of uneasiness after meals and getting full with little consumption. This finding is similar to findings of Gennaro et al. (2011) where it was observed that, food consumption in the third trimester declined as the weeks advanced among African-American women. Some reasons the participants gave were; heartburns and feeling full with little consumption which resulted in inadequate micronutrient intake from food by the participants. Nonetheless, efforts should be made to encourage pregnant women especially those in the third trimester to meet their dietary recommendations, since this period increases the nutritional needs of the mother and if intakes of nutrients are not in sufficient amounts, adverse birth outcomes are obtained (Australian Government Department of Health and Ageing, 2013).

5.4 SERUM IRON (FERRITIN) AND FOLATE LEVELS OF THE PARTICIPANTS

Serum levels of participants were obtained from both diet and supplement. In contrast to the RDA not met for total daily iron and folate intakes in the present study, most of the participants recorded normal levels for serum ferritin and folate respectively. Hence, iron and folate deficiency rates (17.3% and 12.3% respectively) were low in the present study. The serum levels obtained in the study is similar when compared to a study carried out in University of Lagos Hospital, where majority (88.8%) of the participants had normal serum ferritin levels and also recorded a lower prevalence of iron deficiency among the participants (Adediran et al., 2011). However, conversely to this study, where the prevalence rate for both iron and folate deficiencies were low, the 2017 Ghana micronutrient survey recorded a higher (45%) prevalence rate (Adu-Afarwuah et al., 2017). The majority of the participants recording normal serum levels in the present study could be from the better absorption rates of supplements through the absorption pathway than diet (Milman, 2012). It should be noted that, almost all the participants met the daily recommendations for supplementation. Again, participants who fell within the maximum consumption category for the supplements were exceeding the UL for both nutrients (iron maximum dosage consumed by the participants was 305mg and folic acid was 17mg) which could all play a role in the normal serum levels obtained by the majority. Notwithstanding, efforts should be made to ensure pregnant women meet both diet and supplements needs, and not over depend on supplementation to obtain normal serum levels. This is because a diet contains multiple nutrients of benefits as compared to a supplement that contain a particular nutrient and evidence support optimum intake of nutrients from both diet and supplements to achieve optimal birth outcomes (Adu-Afarwuah et al., 2017).

5.5 BIRTH OUTCOMES OF THE PARTICIPANTS

The birth outcomes that were investigated in the present study where iron and folate levels in the third trimester could impact were; the gestational age, birth weight, preterm or full-term deliveries, and Apgar scores (taken at both minutes 1 and 5) (World Health Organization, 2012; Baker et al., 2009). Majority of the participants in the present study obtained positive birth outcomes which included no records of still births, most of the expectant women delivering at 39 weeks, almost all the babies obtaining normal weight and majority of the neonates obtaining Apgar scores greater than 7 at both minutes 1 and 5. Findings in the present study are similar to findings of Nicholson et al.(2006) where; the optimal gestational age to minimize obstetrics complications was between 39 to 40 weeks of gestation. Again according to the WHO (2012), the optimal birth weight for children is ≥2.5kg; that of Apgar scores at both minutes 1 and 5 are a score 7. As a result of the positive birth outcomes obtained by the participants, almost all the neonates in this study were not admitted at the neonatal intensive care unit (NICU) after delivery. This outcome could be related to the good dietary habits practiced by almost all the participants coupled with the normal sera (ferritin and folate) levels obtained by the majority. Research concludes on the detrimental effect of poor dietary habits and patterns which result in adverse birth outcomes such as pre-term births, neurological disorders, still births and maternal mortality (Koletzko et al., 2013). The present study findings therefore, reiterate the importance of positive birth outcomes which includes the possibility of reducing the occurrence of lifelong consequences as a result of adverse birth outcome, ensure quality of life and reduce health care costs (WHO, 2012). This need to be encouraged and expectant mothers should be educated to prioritize and meet their nutritional needs.

5.6 RELATIONSHIP BETWEEN DIETARY INTAKES AND SERA LEVELS OF THE PARTICIPANTS AND BIRTH OUTCOMES

A bivariate analysis (Spearman's correlation test) was used to investigate the relationship between daily total iron and folate intakes and birth outcomes as well as, that of serum ferritin and folate levels and birth outcomes. The present study had no statistical significant correlation between total folate and birth outcomes but obtained a positive statistical significant correlation between total iron intake and one of the birth outcomes investigated (Apgar at minute 5) with a p-value of 0.041. APGAR is an acronym that stands for Activity, Pulse, Grimace (reflex irritability), Appearance (skin colour) and Respiration of the neonates which is conducted in the 1^{st} and 5^{th} minutes after birth to check the health of the neonate. A score of seven and above is considered normal (WHO, 2012). Findings in the present study are similar to other studies and an example is the findings of Nilsen et al. (2010) where, there was no correlation between total folate consumptions and birth outcomes. Contrary to findings of the present study, a previous cross-sectional study conducted among third-trimester women in Northwest China obtained no correlation between total iron intakes and birth outcomes investigated (Yang et al., 2017). For the sera levels, no statistical significant correlation was obtained between the ferritin or folate levels and birth outcomes. A study that is similar to this finding is the study by Kalem et al. (2016) where they investigated serum ferritin, vitamin B12, and folate levels in the third trimester to ascertain anaemia of participants and their effect on pregnancy outcomes. The results obtained showed no correlation between the levels and birth outcomes (mode of delivery and birth weight).

Although it was expected that, serum levels and daily total folate intakes should have influenced the kind of birth outcomes obtained, the present study had no significant relationship between the sera (ferritin and folate) levels as well as total dietary folate consumptions and any of the outcomes investigated. Thus, intake of folate (from diet and supplements) by the participants and their sera (ferritin and folate) levels did not affect the birth outcomes obtained. Hence, the only significant predictor of birth outcome in the present study was total iron intake (from diet and supplements). This implied as total iron recommendations were met; the higher the Apgar score at minute 5 and this improved the breathing, heart rate, muscle tone, skin tone and reflexes of the neonates. These observations in turn informed the health care provider that, the neonates were fairing well outside their mother’s womb and did not require medical interventions (WHO, 2012). Expectant women should therefore be encouraged through nutritional education and counselling to meet both diet and supplementation recommendations to sustain the normal growth of the fetus and achieve optimum birth outcomes (Krafft et al., 2012).

Therefore the present study found a relationship between dietary intakes and birth outcomes investigated hence the rejection of the hypothesis.

5.7 LIMITATIONS

I. Participants may have under or over-reported their weekly food consumptions whiles recalling their intake.

II. The nutrients analysis used (WAFUDS) had some foods not available hence other foods with similar characteristics were used to replace those foods.

5.8 CONCLUSIONS

The majority of the participants in this study were not involved in pica practice as well as had food aversions in the 3rd trimester. The vast proportion of the participants consumed varied foods (animal products; cereals and grains; legumes nuts and oilseeds; fruits and vegetables) that contain food items high in iron and folate nutrients respectively. Also, a substantial proportion of the participants observed that, they experienced some difficulties to consume the right amount of food portions in the third trimester which they attributed to heartburns, uneasiness after meals and feeling of fullness with little consumption. A greater percentage did not meet recommendations for daily total iron and folate intakes which could result from recommendations for daily dietary intakes not met for both nutrients. Almost all the participants met the daily folic acid supplement requirements with close to half meeting the daily iron supplement requirements. The majority of the participants had serum iron and folate levels in the normal ranges. Almost all the participants obtained positive birth outcomes (gestational age, birth weight, Apgar score at both minute 1 and 5). The study again obtained a positive significant correlation between total iron and Apgar at minutes 5 with a p-value of 0.041. However, serum levels had no significant correlation with any of the birth outcomes investigated in the study.

5.9 RECOMMENDATIONS

With the findings of this study, the following recommendations are made to aid in decision making to improve the health of pregnant women in the third trimester:

1. Pregnant women especially those in the 3rd trimester should be encouraged to improve on their diet quality to meet the total daily iron and folate requirements to obtain desired birth outcomes.
2. Further studies should be done using a larger sample size and longer follow-up duration.

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APPENDIXES

Appendix I

CONSENT FORM

This study is investigating maternal dietary intakes (looking at dietary iron and folate) during the third trimester and relating ferritin and folate levels in the blood and birth outcomes. If I give my consent to partake in this study, I will be asked to answer questions about my dietary habits and intake of iron and folate-rich food sources and again provide some personal socio-demographic information. I will also be asked to take a test to provide information on the serum levels of ferritin and folate.

“MATERNAL DIETARY INTAKES IN THE THIRD TRIMESTER AND PREGNANCY OUTCOMES”

I ………………………………………………………………………..agree to participate in this study conducted by AGNES YEBOAH from the Dietetics Department, of School of Allied Health Sciences, College of Health Sciences, University of Ghana, under the supervision of Dr. Joana Ainuson-Quampah and Dr. Kwaku Asah-Opoku. I understand that my participation is voluntary.

The main focus of this study is to ascertain dietary intakes among pregnant women who are in their third trimester in Korle-Bu Teaching Hospital, as well as relate iron and folate levels in their diet on birth outcomes. If I volunteer to take part in this study, I will be asked to answer questions about my dietary practices and also give some personal information about myself. All these will be kept confidential.

I will also be asked to take a serum iron and folate test at the end of my last trimester before delivery. All medical and personal information will not be disclosed to any individual or group without my consent. The principal investigator will be made available to answer any further questions about the research now, or during the project.

Please understand that taking part in this research is entirely voluntary. You are also to note that you may refuse to take part or redraw from the study at any time. Again note that no incentive will be given to you, however; your partaking in the study will help us identify dietary intakes in the third trimester and serum folate and ferritin levels on pregnancy outcomes. This information will form the basis for advocacy for interventions to support the group's understudy to improve their quality of life.

I agree that the research project named above has been explained to my satisfaction and I agree to take part in the study. I understand that I am agreeing with my signature/thumbprint on this form to take part in this research project and understand that I will receive a signed copy of this consent form for my records.

Name of Investigator: AGNES YEBOAH

Signature ……………………………………

Tel No. 0279845122

Date ………………………………………….

Name of participant …………………………………….

Signature/Thumbprint …………………………………..

Date ……………………………………………………...

Mobile No ………………………………………………..

Appendix II

QUESTIONNAIRE

Date: ………………… **Participant's Name:** …………………………………… **ID No.:**

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

1. Age……………… (Yrs)

2. Marital status [1] Single [2] Married [3] Separated [4] Divorced

3. Educational background

[1] Never attended school [2] Elementary/ Junior High School

[3] Senior High School [4] Tertiary [5] others (specify)................

4. Occupation of client: [1] professional [2] trading [3] vocational

[4] Jobless [5] others (specify)..

5. Position held at work...

6. Spouse occupation: [1] professional [2] trading [3] vocational [4] jobless

7. Position held at work..

8. Monthly income of participant (GH₵)

[1] Less than 50 [2] between 50-99 [3] between 100-299

[4] Between 300- 499 [5] between 500-1000 [6] above 1000

9. Monthly income of spouse (GH₵)

[1] Less than 50 [2] Between 50-99 [3] Between 100-299

[4] Between 300-499 [5] between 500- 1000 [6] above 1000.

SECTION B: FOOD HABITS

10. Do you practice any form of pica? [1] Yes [2] No

11. If yes, what do you eat?

[1] Chewing stick/wooden sponge [3] chalk [5] ice cubes

[2] Uncooked maize dough/starch [4] clay [6] others

12. What stage of your pregnancy did you start this practice?

[1] 1-3 months [2] 4-6 months [3] 7-9 months [4] not sure

13. Why do you practice pica?

[1] To prevent nausea [2] to prevent vomiting [3] for satisfaction

[4] To prevent salivation [5] others, specify ----------------

14. Do you crave any food? [1] Yes [2] No

15. If yes, what do you crave?

[1] Chocolate [2] toffees/ candies [3] ice cream [4] fizzy beverages

[5] alcoholic beverages [6] others ----------------------------------

16. What stage of your pregnancy did you start craving?

[1] 1-3 months [2] 4-6 months [3] 7-9 months [4] not sure

17. Why do you crave it?

[1] to prevent nausea/vomiting [2] for satisfaction [3] Don't know why

[4] others -----------------------

18. Do you avoid taking any food? [1] Yes [2] No

19. If yes, what food do you avoid?

[1] meat/fish [2] eggs [3] milk [4] fruits [5] others ----------------------

20. At what time of the pregnancy did you avoid these foods?

[1] 1-2wks [2] 13-24wks [3] 25-40 wks

21. Why do you avoid these foods?

[1] taste of food [2]poor appetite [3] Don't know why [4] smell/aroma

Others -----------------------------

22. Please do you take any alcoholic beverage? [1] Yes [2] No

23. When did you start it? [1] before pregnancy [2] during pregnancy

24. What type of alcoholic beverage do you take?

[1]Pito[2] Beer/Guinness [3] Locally distilled alcohol [4]

Others……………………………………

25. How often do you take? [1] once a day [2] twice a day [3] weekly

[4] monthly [5] others……………………………………………………….

17. What quantity do you consume?

[1] 300ml beer bottle or tumble [2] large beer bottle [3] one calabash [4] a tot [5] others..

26. Do you take tea and coffee? [1] Yes [2] No

27. If yes, how often do you take it? [1] once a day [2] twice a day [3] weekly

[4] monthly [5] sometimes [6] not at all

28. Do you take supplements or any herbal preparation [1] Yes [2] No

29.If yes which of these [1] folic acid [2] iron [3] multivitamin [4] herbal.

30. What dosage(s) of the supplement do you take daily [1] folic acid...........dosage [2] iron.............dosage [3] multivitamin.................dosage [4] herbal..............dosage

SECTION C: PRECIPITANTS OF ANAEMIA

31. Have you experienced blood loss from the body in the past 2 months?

[1] Yes [2] No

32. If yes, which of these [1] injuries that result in heavy bleeding [2] blood loss in urine [3] blood loss in stool [4] coughing out blood [5] vomiting out blood [6] others (specify)…………………………….

33. Do you attend ANC regularly? [1] Yes [2] No

34. If yes how often? [1] Monthly [2] bi-weekly [3] weekly

[ ] others (specify) ……………………………………………………………..

35. Do you take your routine ANC drugs? [1] Yes [2] No27. If yes indicate [1] iron supplements [2] folic acid [3] multivitamins [4]SP [5] others (specify}……………………………………….

(You may choose more than one).

36. Have you had malaria recently? Yes [ ] No [ ]

If yes how often do you get malaria?

[1] once a month [2] twice a month [3] thrice a month

37. How often were you de-worming before pregnancy? [1] every 3 months

[2] every 6 months [3] not at all [4] others (specify)……………….

38. Results of laboratory investigations of the client?

[1] Hb level…………….. [2] sickling test………………… [3] Iron level ………….

[4] folate level ……………[5] malaria status................ [6] worm infestation status...........

39. If sickling positive then, Hb – electrophoresis…………………………

SECTION D: FOOD INTAKE

40. Please how many times do you eat in a day before pregnancy excluding snacks?

[1] Two times [2] Three times [3] Four to five [4] More than five times

41. Has it changed since you became pregnant? [Yes] [2] No

42. If Yes How many times now?

[1] Two times [2] three times [3] Four to five times [4] More than five times

[5] Find it difficult eating

QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE (QFFQ) WEEKLY CONSUMPTION

FOOD GROUPS	NOT OFTEN		1-2X	3-4X	5-6X	DAILY	Handy Measures	Converted to grams
Starchy roots and plantain								
Cassava								
Cocoyam								
Yam								
Plantain								
Cereals and Grains								
Maize								
Rice								
Iron-fortified cereals								
Wheat								
Bread								
Animal Products								
Liver								
Kidney								
Poultry								
Meat								
Egg								
Shellfish (Crab)								
Salmon								
Mackerel								
Sardine								
Milk								

Legumes, nuts, and oilseeds							
Beans							
Soybeans							
Groundnut							
Agushie (melon seed)							
Fruits							
Banana							
Avocado							
Orange							
Grapefruits							
Pawpaw							
Watermelon							
Mango							
Vegetables							
Tomato							
Pepper							
Green leafy vegetables							
Okro							
Garden eggs							
Fat and oils							
Refined vegetable oil eg. Coconut oil							
Soybean, Olive, Canola oil							
Cod liver oil							
Palm oil							

FOODS HIGH IN REFINED SUGAR	NUMBER OF TIMES PER WEEK	NOT APPLICABLE
Coca-cola		
Sprite		
Fanta		
Malt		
Don Simon/ Ceres/Minute maid		
Other drinks		
Biscuits		
Cakes		
Toffees		
ALCOHOLIC BEVERAGES		
Beer		
Guinness		
Spirit		
Wine		
Punch		
Others		

SECTION E: MEAN WEIGHTS FOR THE THREE TRIMESTERS AND BIOCHEMICAL INFORMATION

43. Mean weight for the first trimester......................

44. Mean weight for the second trimester....................

45. Mean weight for the third trimester.........................

46. Serum Ferritin Level........................... (µg/L)

47. Serum Folate Level…………………. (nmol/L)

SECTION F: MATERNAL OUTCOMES (KINDLY TICK YOUR RESPONSE)

47. Mode of delivery

[ ] Through C.S delivery [ ] Through vaginal delivery

48. Need for blood transfusion

[ ] Yes [ ] No

SECTION G: FOETAL OUTCOMES

49. Delivery outcome

[ ] Live birth [ ] Stillbirth

50. Gestation Period........................ (Weeks)

51. Birth weight........................... (Kg)

52. Apgar score at minute one............................

53. Apgar score at minutes 5...............................

54. Admission to Neonatal Intensive Care Unit

[ ] Yes [ ] No

55. If yes to question 54, the reason for admission

....

....

....

Useful Health Tips for Pregnant Women

- Foods that contain ascorbic acid like citrus, broccoli & other dark green vegetables enhance iron absorption. This is due to the ability of ascorbic acid to change iron from its ferric form to ferrous form, thereby increasing its absorption
- Some fruits although rich in ascorbic acid inhibit iron absorption due to possessing high phenol content. Examples of such fruits are banana, melon, strawberry, etc.
- Food fermentation aids in iron absorption by reducing the phytate content in the diet.
- Foods containing muscle protein enhance iron absorption due to the effect of cysteine-containing peptides released from partially digested meat which reduces ferric to ferrous salt and form soluble iron complexes
- Examples of foods with polyphenol compounds that may inhibit iron absorption are cereals like oats & sorghum, vegetables such as spinach, and beverages like tea, coffee, cocoa, and wine.
- Foods that are good sources of folate include green leafy vegetables such as cabbage, kontonmire among others.
- Factors that interfere with folic acid absorption include diseases like Celiac and Crohn's disease which affect the digestive system, drinking too much alcohol and consuming overcooked vegetables or fruits.

APPENDIX III

ETHICAL CLEARANCE

UNIVERSITY OF GHANA
COLLEGE OF HEALTH SCIENCES

ETHICAL AND PROTOCOL REVIEW COMMITTEE

Ref. No.: EPRC/APRIL/2020

April 27, 2020

Ms. Agnes Yeboah
Department of Nutrition and Dietetic
School of Biomedical and Allied Health
Korle-Bu.

ETHICAL CLEARANCE

Protocol Identification Number: ***CHS-Et/M3 –.16/2019-2020***

FWA: 000185779 **IORG: 0005170** **IRB: 00006220**

The College of Health Sciences Ethical and Protocol Review Committee (EPRC) at its April 27, 2020, full board meeting reviewed and approved your research protocol.

Title of Protocol: "Maternal Dietary Intakes in the Third Trimester and Pregnancy Outcomes"

Principal Investigator: **Ms. Agnes Yeboah**

This approval requires that you submit six-monthly review report(s) of the study to the Committee and a final full review report to the EPRC at the completion of the study. The Committee may observe, or cause to be observed, procedures and records of the study before, during and after implementation.

Please note that any significant modification(s) to this project/study must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this study to the EPRC within seven (7) days verbally and fourteen (14) days in writing.

As part of the review process, it is the Committee's duty to review the ethical aspects of any manuscript that may be produced from this study. You will therefore be required to furnish the Committee with any manuscript for publication.

This ethical clearance is valid till April 27, 2021.

Please always quote the protocol identification number in all future correspondence in relation to this protocol.

Signed: ....

Professor Andrew Anthony Adjei
Chair, Ethical and Protocol Review Committee

cc: Provost, CHS
Dean, SBAHS
Head, Department of Nutrition and Dietetic

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