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DETERMINANTS OF MICRONUTRIENT DEFICIENCIES IN PREGNANT ADOLESCENTS IN ACCRA

BY

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DECLARATION

DECLARATION

I, Donkor-Adjei Eunice hereby declare that this thesis is the result of my own research work carried out in the Department of Dietetics, School of Biomedical and Allied Health Sciences, University of Ghana, under the supervision of Dr. Freda Intiful, Dr. Rebecca Steele- Dadzie and Dr. Kwame Adu-Bonsaffoh. All references cited in this work have been fully acknowledged.

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DEDICATION

I dedicate this work to the Almighty God whose grace has seen me through this work and to my parents Mr. and Mrs. Philip Donkor whose support and guidance have earned me this success. Also, to my siblings Phyllis, Samuel, Keziah, Jeremy, Benny, Ohemaa and Nana for all your love and support.

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ABSTRACT

Background: Adolescent pregnancies have been shown to have poorer outcomes compared to pregnancies in adult women. Nutritional status may play an important role in improving the health of pregnant adolescents. However, little is known about micronutrient status and the factors that influence the adequacy of the diets of the Ghanaian population particularly among pregnant adolescents.

Aim: To identify the determinants of micronutrient deficiencies in pregnant adolescents.

Method: A cross-sectional design was used in this study. Eighty three (83) pregnant adolescent girls were recruited from three (3) health facilities; Ussher Polyclinic, La General Hospital and Mamprobi Polyclinic. A semi-structured questionnaire was used to obtain the socio-demographic data. Participants' dietary micronutrient intakes and food consumption pattern were assessed using the 24-hour dietary recall and the food frequency questionnaire method respectively. Participants' haemoglobin status were also obtained from their maternal records books. Statistical Package for Social Sciences (SPSS) Version 20.0 was used to analyse data obtained. A one sample t-test was used to compare mean nutrient intake to the EAR/RDA. Pearson Chi square tests was used to determine the relationships between socio- demographic variables and dietary intakes of micronutrients and socio-demographic variables and haemoglobin status. ANOVA was used to compare the mean dietary intakes of the girls between trimesters of pregnancy. Statistical significance was set at $p<0.05$.

Results: The results showed that the mean intakes of micronutrients (iron, folate, calcium, phosphorus, zinc and vitamin C) were below recommended levels. Vitamin B_{12} and phosphorus were however above 50% of the EAR. A low consumption pattern of the micronutrient source foods was observed. There was no significant association between dietary intakes of iron, vitamin B_{12}, calcium, zinc and vitamin C and socio-demographic variables except for phosphorus which was significantly associated with occupation ($\chi 2$ 8.185, p=0.017). Folate intake was inadequate for all the girls. There was also no significant association of the mean dietary intakes of selected micronutrients between trimesters of pregnancy. Further, no significant association was observed between haemoglobin status and socio-demographic variables of the pregnant adolescent girls. Anaemia prevalence was found to be 62.7%.

Conclusion: There was inadequate dietary micronutrient intakes among the participants. A generally low consumption pattern of micronutrient source foods was observed among the participants. Socio-demographic variables had no significant association with dietary intakes and anaemia except dietary phosphorus which was significantly associated with occupation. There is a need for nutrition intervention to help improve dietary micronutrient intakes in this population.

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LIST OF ABBREVIATIONS

EAR- Estimated Average Requirement

EER- Estimated Energy Requirement

GDHS- Ghana Demographic and health survey

GSS- Ghana Statistical Service

Hb- Haemoglobin

IOM- Institute of Medicine

MOH- Ministry of Health

RDA- Recommended Daily Allowance

UNICEF- United Nations Children's Fund

UNPF- United Nations Population Fund

WHO- World Health Organization

WRA- Women of Reproductive Age

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Child birth during adolescence is perceived as a societal problem. Young women who have children during this period are more likely to suffer from social isolation, poverty, lower education attainment and may be unemployed or work in low salary jobs (Cook & Cameron, 2015). In developing countries, about 21 million teenage girls aged 15–19 years are estimated to get pregnant (Darrock et al., 2016; United Nations Population Fund, 2015). The United Nations Population Fund in 2013 reported that Sub-Saharan Africa had the highest prevalence (95%) of adolescent pregnancies globally, a rate of 143 pregnancies per 1000 pregnancies (United Nations Population Fund, 2013; Treffers, 2002). According to the Ghana Statistical Service (GSS, 2014), adolescent pregnancies in Ghana accounted for about 14% of all pregnancies recorded in Ghana. According to the records, adolescent girls aged between 15 and 19 years had already started childbearing and 30% of all births registered in Ghana were from adolescent mothers.

Micronutrients are essential vitamins and minerals accessible from diet to sustain virtually all biological activities and physiological functions (West et al., 2012). Their basic biological roles in early life, enable the foetus to develop and mature into a healthy neonate. Although important, they are required in very small amounts and their requirement vary widely throughout pregnancy and across populations. Globally an estimated two billion people, which is one-third of the global population suffer from micronutrient malnutrition (WHO, 2006). Unlike energy-protein malnutrition, the health complications of micronutrient deficiencies are not always visible, hence it is sometimes referred to as ‘hidden hunger’. Micronutrient deficiencies are a significant public health problem, particularly in women of reproductive age in developing countries (Salam et al., 2014; Jiang et al., 2005). In many developing countries, societal norms and gender-based discrimination put women at a disadvantage in terms of nutrition and health. This puts them at an increased risk of micronutrient malnutrition (Darnton-Hill, 2012; Darnton-Hill et al., 2005). Consequently, these women often enter pregnancy malnourished and any additional nutritional demands in pregnancy further increase their risk of nutritional deficiencies (Grieger & Clifton, 2014; Black et al., 2013).

Women are at increased risk of micronutrient deficiencies due to inadequate dietary intakes, lack of food availability, unequal intra-household food distribution, lack of nutritional knowledge on importance of having diversity in the diet and frequent occurrences of infectious diseases (Darnton-Hill, 2012). A systematic review report from 62 studies conducted among pregnant women in Africa, Caribbean, Asia and Latin America concluded that inadequate macronutrients and micronutrients intakes were observed to be prevalence in the study participants (Lee et al., 2013). The inadequate nutrient intakes were attributed to their diets being monotonous, basically plant and cereal based. Their dietary intakes were not from micronutrient rich foods such as vegetable, fruits, and animal products (Lee et al., 2013). Nine studies reviewed in developed countries with a focus on pregnant adolescent girls reported average intakes of energy, fibre and other important micronutrients to be lower than recommended level (Marvin et al., 2016).

The adolescent population is considered to be nutritionally vulnerable due to this unique period characterized by rapid growth. This period of enhanced growth rate combined with suboptimal nutrient intake increases the risk of nutritional deficiencies in this special population (World development report, 1993). The consistency of the diet as well as the amount of food consumed is of a particular significance during pregnancy. Evidence indicates that insufficient intake of nutrients during pregnancy can contribute to poor obstetric outcomes, particularly foetal growth retardation and preterm delivery (Chen et al., 2007; Jolly et al., 2000). Thus an adequate nutrient intake coupled with an appropriate food consumption pattern is of great importance to ensure a safe pregnancy (Pickel et al., 2005).

Common micronutrient deficiencies in pregnancy identified as crucial for both maternal and child health include iron, iodine, zinc, folic acid and vitamin A (WHO, 2012). Deficiencies in these nutrients have shown to be common among women of reproductive age (WRA) and are associated with increased risk of adverse consequences including anaemia in pregnancy, maternal mortality, preterm birth, low birth weight infants (Ramakrishnan et al., 2008), birth defects (WHO, 2012), increased mortality, suboptimal health and cognitive development in the offspring (Ramakrishnan et al., 2012).

1.2 Problem Statement

In Ghana, adolescents represent 22.4% of the total population (GSS, 2014). Adolescent pregnancies account for about 14% of all pregnancies (GSS, 2014). World Health Organization fact sheet states that pregnancies and deliveries associated with adolescents have more risks as compared to older women (WHO, 2016). Globally, approximately two billion people are affected by micronutrient deficiencies, majority being women and children (WHO, 2006). The physiological demands of gestation and adolescence can complicate micronutrient deficiencies as nourishment is not only needed for the mother but also the growing foetus (Parisi et al., 2014; Moore et al., 2012). The young pregnant woman may be malnourished in one or more micronutrients (Duggan et al., 2014; Christian et al., 2010; Allen et al., 2009; Black, 2003). For both mother and infant, this can cause adverse health effects, including anaemia, maternal and perinatal mortality, low birth weight, preterm delivery, intrauterine growth retardation, altered immune response and newborn cognitive deficits (Gernard et al., 2016; Darnton-Hill et al., 2015). In Ghana, about two thirds of adolescent girls have been reported to be anaemic with anaemia in pregnancy contributing to at least 12% of all maternal deaths (Abizari et al., 2017; UNICEF, 2012; MOH, 2008). Adolescent pregnancies and related nutritional issues are well documented in Ghana and globally (Yussif et al., 2017; Nguyen et al., 2017; Marvin-Dowle et al., 2016). However, studies determining the factors peculiar to micronutrient deficiency in Ghanaian pregnant adolescent girls is scare. Thus, this has informed the decision to investigate the determinants of micronutrient deficiencies in pregnant adolescents.

1.3 Significance of Study

This study would assess and provide information on nutritional status, adequacy of micronutrient intake and its health impact on adolescent pregnancies. It will add to existing knowledge in this area, and also inform dietary management of adolescent teenagers by dieticians and other health workers.

1.4 Aim and Specific Objectives

1.4.1 Aim

To identify the determinants of micronutrient deficiencies in pregnant adolescents.

1.4.2 Specific Objectives

1. To estimate micronutrient (iron, folate, vitamin B_{12}, vitamin C, Calcium, Phosphorus and zinc) intakes of adolescent pregnant girls to ascertain their adequacy.
2. To determine the pattern of consumption of micronutrient source foods among pregnant adolescents.
3. To determine the relationship between socio demographic variables and dietary intakes of micronutrients.
4. To determine the relationship between socio demographic variables and haemoglobin status.

CHAPTER TWO

2.0 LITERATURE REVIEW

2. 1 Adolescence and Nutrition

Although, there is no widely recognised definition of adolescence, the World Health Organization defines an adolescent as a young person aged 10-19 years (WHO, 2015). Adolescence is not only a critical stage in the human life but also a period of rapid development and changes in body composition. Developmental process of adolescents increase demands on both macro and micro nutrients significantly (Das et al., 2017). Physiologically, this increase in nutritional demands is to cater for the increasing body size and sexual maturation including menarche in girls. Socially, this period affords the adolescent the opportunity for food choices independent of parental guidance. Consequently, adolescents' may tend to develop unhealthy eating habits that may influence their food choices, nutrient intake and thus affect their nutritional status (Katz & Friedman, 2008).

Food habits that influence food preferences and consumption are developed in early childhood and particularly during adolescence. Thus dietary behaviours acquired in the adolescent stage tend to persist into adult life. Also, dietary pattern adopted during this stage of life may contribute to an individual's health status later in life. (Das et al., 2017; Reilly & Kelly, 2011). Nutrition influences growth and development through infancy, childhood and adolescence (WHO, 2004) and failure to achieve optimum nutritional status during these different lifecycle phases can lead to growth retardation, impaired organ remodelling and micronutrient deficiencies (Das et al., 2017).

Several studies have highlighted inadequate macronutrients and micronutrients intakes among adolescents (Teferi et al., 2018; Nguyen et al., 2018; Primalavalli et al., 2011). In many developing countries, including Ghana, there is a shift in dietary intakes and behaviours among teenagers (Adamu et al., 2012). These changing dietary habits are more related to the gradual substitution of conventional diets (mainly cereal and tubers, fresh fruits and vegetables, and low- fat foods) with more western diets. These diets are mostly processed foods, have low dietary diversity and are also high in ʿemptyʾ calories. (Ochola & Masibo, 2014). Many factors interrupt with the adolescent nutrient intake. These include peer acceptance, independence, increased mobility, job interests, self-image concern, regular media marketing advertisement, high availability of foods, self-concept, and personality may contribute to the adolescent's unhealthy eating habits. (Amos et al., 2012; Demory-Luce & Jensen, 2009; Rea, 2007). Adolescent poor nutritional status has also been associated with low meal consumption frequency, frequent consumption of sugary foods and beverages, increased consumption of foods away from home and skipping meals, particularly breakfast (Moreno et al., 2010; Li et al., 2010; Burgess-Champoux et al., 2009; Briefel et al., 2009).

Food intake among many adolescents do not meet dietary guidelines. Findings from developed countries such as United Kingdom and Australia have reported that adolescent dietary intakes were below recommended levels. Many of the adolescents from these countries consumed energy-dense, nutrient poor foods and low intakes of fruits and vegetables (Zahra et al., 2014; Zapata et al., 2008; Diethelm et al., 2012). During the period of adolescence, milk and milk products are important sources of calcium. Evidence from a study conducted in the United States of America showed that the consumption of dairy products among adolescents was significantly lower than recommended intakes (Kranz et al., 2007). The primary sources of micronutrients in the diet are from fresh fruits and vegetables. A study conducted in a Polish population found that only 5.6% of the adolescent girls ate fruits and vegetables more than three times per day (Przyslawski et al., 2011) which did not fulfil the recommendations by World health organization of at least a daily 400 g consumption of vegetables and fruits (WHO, 2003). Many nutrients that support adolescent development is lacking in diet of Ghanaian adolescents. Owusu et al., (2007) in a study conducted in the Greater Accra and Eastern regions of Ghana reported that Ghanaian adolescents consumed an average of 3 servings of fruit, 2 servings of vegetables and 3-4 servings of milk per week which were below recommended intakes. A study conducted among adolescents in India also reported low intakes of animal and animal products, pulses and legumes (Rathi et al., 2017). Findings of these studies show the lack of a well-balanced diet, adequate nutrient intake and low intake of micronutrient rich foods by adolescents. Improving adolescents' food behaviours is an avenue to reduce the prevalence of health problems, nutrient inadequacies and nutritional deficiencies (Kotecha et al., 2013; Gharib & Rasheed, 2011).

2.2 Determinants of Nutritional Status

Adolescence is a vital stage of life in terms of sufficient nutrient intake. Nonetheless, a high proportion of adolescent girls in developing countries are underweight and suffer from micronutrient malnutrition which can negatively impact adolescents' pregnancy outcomes. (Goonewardene, 2005).

2.2.1 Gender

The nutritional needs of the adolescent female in many developing countries is of a lower priority compared to their male counterparts. In some low and middle income countries, girls are the last to receive food in both quality and quantity. This compromises the adolescent girl's nutritional status and increases the risk of nutritional deficiencies. Some studies among adolescent girls have often attributed undernutrition in adolescent girls to gender discrimination and unfavourable intra-household food distribution practices, especially in homes with low income or were food insecure (Harris-Fry et al., 2017; Madjdian et al., 2016; Duflo, 2012; DeRose et al., 2000;). Regarding micronutrient deficiencies, Kurz et al., (1994) found that being female increases an individual's risk, particularly for low iron status and anaemia. This is due to increased iron requirements in adolescent girls triggered by growth spurt, menarche and menstruation. (Black et al., 2008; Chaparro & Lutter, 2008; WHO, 2004). A cohort study among adolescents in India also found disparities in individual dietary intakes where food allocation was more pro-male with an increased likelihood of girls being allocated fewer micronutrient rich foods whereas the boys consumed more protein and vitamin-rich foods (Aurino, 2017).

2.2.2 Income

Socioeconomic class and income have been shown to be associated with adolescent nutritional status (Musa et al., 2012; Maiti et al., 2011). These factors are proxies of access to food of appropriate quality and quantity. Also, the socio-economic status of the household signifies the extent to which the individual's nutritional status may be influenced by other factors that impact nutritional outcomes. Anderson et al., (2010) in a study among children suggest that family owned property, as well as resources available to them, can influence the household's nutritional status. Individuals from low income households are more likely to have suboptimal dietary intakes of macronutrients and micronutrient such as protein, folate, calcium, iron, vitamin A and B vitamins (Bucholz et al., 2011). Adolescents from these low income households are more likely to miss meals due to affordability and access to food, hence make fewer food choices.

2.2.3 Education

Educational status has shown to a strong positive association with good nutritional outcomes. Better educated women are more health conscious, have better access to nutrition information and are knowledgeable in utilizing available resources to improve their nutritional status and that of their household members. A study by Finger et al., (2013) among German adult population reported that individuals with low levels of education consumed more sugar and fat rich foods as well as low fruits and vegetables in their diet than those with higher education levels.

2.2.4 Occupation

Occupation has also been shown to influence nutrient intakes in the adolescent which is mainly through the income earned. Adolescent girls who are engaged in hard labour jobs may have a higher nutritional demand due to the heavy work load. In addition to this, a low salary job due to unskilled labour, long working hours with little monetary benefits may impact on their nutrition status as they may not be able to afford nutritious foods (Roggero et al., 2007). The cost of food plays a significant role in dietary habits of individuals in low socioeconomic groups (Monsivais, Aggarwal & Drewnowski, 2012). Sometimes the amount spent on food is cut down to be able to provide for other household expenditures such as housing and utility bills (Kirkpatrick & Tarasuk, 2007) thus decreasing food availability and accessibility (Law, Ward & Coveney, 2011).

2.3 Micronutrients in Pregnancy

Maternal nutrition is vital for the course and outcome of pregnancy. During pregnancy, the demand for micronutrients increases more than dietary energy requirements (Marangoni et al., 2016; Koletzko et al., 2013). A diet sufficient in energy and micronutrients is regarded important to reproductive life (Kaiser & Allen, 2008). Evidence suggests that adequate nutrient intake is an important component of an individual's health and well-being, especially during pregnancy (Daba et al., 2013). Furthermore, there have been some indications that maternal malnutrition may result in increased incidences of low birth weight, preterm birth, intra uterine growth retardation, prenatal and infant mortality and morbidity (Akgun et al., 2017). On the other hand, nutrient intakes in excess in pregnancy may result in some complications including, preeclampsia, gestational diabetes, macrosomia, and higher prevalence of caesarean section (Daba et al., 2013). During pregnancy, suboptimal nutrient intakes may result in reprogramming within foetal tissues which is associated with an increased risk for non-communicable chronic diseases in adulthood (Canani et al., 2011; Procter & Campbell, 2014). Concurrent deficiencies of micronutrients such as iron, folate, zinc, vitamins A, B_{12}, B6, C, E and riboflavin are well documented among pregnant women (Black et al., 2008). These deficiencies can occur due to disease-related losses, poor food absorption, insufficient nutrient intakes, lack of awareness about adequate prenatal nutrition and pregnancy-related dietary taboos. These factors have adverse consequences for both mother and new born infant.

A healthy and varied diet is considered to be the preferred means of fulfilling nutritional needs. However, some of these nutrient requirements in pregnancy cannot be met with dietary intake alone. As such, supplementation and food fortification programs have been implemented as dietary interventions to support pregnant women to meet the increased nutritional demands during pregnancy (Gernand et al., 2016). WHO guidelines on supplementation recommends a daily iron (60 mg) and folic acid (400 µg) intake as a measure of reducing the incidences of anaemia in settings where anaemia prevalence (>40%) among pregnant women is high (WHO, 2016).

Studies on micronutrient deficiencies in pregnancy are well documented in low and middle income countries (Allen et al., 2009; Christian et al., 2010). During pregnancy, women in these resource-poor countries often are not able to meet their micronutrient requirements due to inadequate intake or persistent poor quality diet (Torheim et al., 2010). The average diets among populations of low and middle income countries fall below recommended intakes of fruit, vegetables, dairy and other protein-rich foods (Keats & Wiggins, 2014). A systematic review that combined all studies published between the years 1988 and 2008 reported that micronutrient intake among women in resource poor settings were below the estimated average requirement (EAR) for over 50% of the studies with the exception of vitamin A (29%), Niacin (34%) and vitamin C (34%) (Torheim et al., 2010; Matthews et al., 2010). Another study investigating micronutrient status among rural adolescent girls in Bangladesh reported poor micronutrient intakes and status (Ahmed et al., 2010).

Iron deficiency is the commonest form of micronutrient malnutrition and globally an estimated 2.36 billion were affected by anaemia in 2015 (Voss et al., 2013). According to the global burden of the disease study, the estimated prevalence of anaemia in young children, non-pregnant women and pregnant women was 71%, 48% and 56% respectively. High values were reported in Central and Western Africa (Stevens et al., 2013). Developing countries accounted for more than 89% of the cases of anaemia in 2013. An estimated 11 million people are affected in Ghana, which corresponds to over 40% of the population (Voss et al., 2013). The 2014 Ghana Demographic and health survey (GDHS) recorded the prevalence of anaemia among women of reproductive age (15-49 years) to be 42%. The highest prevalence (48%) was recorded among adolescent girls (15-19 years) and anaemia in pregnancy was reported to be 56% (GSS, 2015).

Data on the estimated global prevalence of other micronutrients is scarce. Population-based studies in pregnancy in South Asia, including India, Bangladesh and Nepal have reported deficiencies in zinc (15–74%), vitamin B_{12} (19–74%), vitamin E (50–70%), and folate (0–26%) (Akhtar, 2013; Shamim et al., 2013; Pathak et al., 2007). In high income countries, particularly United States, few micronutrient deficiencies occur in pregnancy. This has been linked to diversity in food consumption pattern, dietary counselling during pregnancy, frequent intake of fortified foods and a mandatory anti-natal micronutrient supplementation. (Berner et al., 2014; Branum et al., 2013).

2.4 Iron

Iron is a significant trace mineral important to the body. It is involved in haemoglobin and myoglobin synthesis as well as several cellular activities including oxygen transport, growth, gene regulations and components of several proteins including enzymes (Cairo et al., 2006; Milman, 2006). Iron is required from conception through to lactation. Iron deficiency is due to suboptimal dietary intake of absorbable iron from iron rich foods, insufficient intake to meet the increased demands in pregnancy, and iron loses through parasitic infection or general blood loss (Peña-Rosas et al., 2015). Maternal iron deficiency is associated with anaemia, intrauterine growth retardation, preterm delivery and low birth weight in infants (Shill et al., 2014; Zimmerman & Hurrell, 2007). Iron is present in many foods, used in fortification of food products and available as dietary supplements. About 3-4 g of iron in an adult human is in the form of haemoglobin. The remaining iron is stored as ferritin or hemosiderin (Aggett, 2012). Current daily iron recommendation for pregnant women has been set at 27 mg/day (WHO, 2012). Good sources of dietary iron include beef, fortified cereals, baked beans, cashew nuts and liver.

Dietary iron is in two main forms; haeme and non-haeme iron (Wessling-Resnick, 2014) which are absorbed through different pathways in the small intestines. Non-haeme iron makes up a major proportion of dietary iron and found in mainly plant-based foods including nuts, cereals, pulses, legumes, seeds and some vegetables. Only 2-20% of non-haeme iron is absorbed by the body (Beck, 2015). Vitamin C, meat, fish or poultry are known to enhance non-haeme iron absorption. Inhibitors of non-haeme iron absorption include phytate and polyphenol. Haeme iron comes mainly from meat, fish and poultry and contributes about 10-15% of dietary iron (Beck, 2015). Haeme iron is well absorbed and highly bioavailable, making it the main source of dietary iron (Cairo et al., 2006; Milman, 2006). Enhancers of haeme iron include meat and soy protein, while calcium has been shown to inhibit it (Beck, 2015).

Many studies have reported inadequate dietary iron intake among women of reproductive age, adolescent girls and pregnant women (Jiaomei et al., 2017; Alzaheb et al., 2017; Milman, 2020; Alwan et al., 2011). Azadbakht et al., (2012) conducted a study among female Iranian students and reported a mean daily iron intake of 13.0±5.0 mg/day, an average which was 76% less than recommended intake (18 mg/day). Another study in pregnant women in a review by Abbaspour et al., (2014) found that most of pregnant women were not receiving adequate amounts of iron from diet despite consuming fortified food and being on iron supplements. In Ghana, a study conducted by Ayensu et al., (2020) established inadequate dietary iron intakes among Ghanaian pregnant women living in rural and urban areas. The findings of the study reported that, over 50% of the pregnant women had inadequate daily intakes of zinc, folate, calcium, iron and protein.

2.5 Folate and Vitamin B_{12}

Folate and vitamin B_{12} are water soluble vitamins which depend on each other to perform numerous functions. They work together to enhance cell division as well as DNA synthesis (Schernhammer et al., 2007). Due to their importance in DNA synthesis, it is very crucial at the early stage of development. Foods rich in folate include, nuts, fruits, berries, green leafy vegetables and legumes (Suliburska et al., 2019). Folate is required for the growth of placenta tissues and important in neural tube formation (Castillo-Lancellotti et al., 2013). Vitamin B_{12} is also found mainly in animal food sources such as fish, meat, poultry, eggs, and dairy products. Folate naturally occurs in foods. Folic acid is the form of folate that is used in fortified foods and taken as dietary supplements. Both vitamins function in erythrocyte and leucocyte formation which helps to prevent nutritional anaemias. Furthermore, adequate intake of folate and vitamin B_{12} are necessary to prevent pernicious, megaloblastic anaemias and certain cancers such as breast and cervical cancers (Castillo et al., 2012; Johnson, 2007; Ericson et al., 2007).

Folate and vitamin B_{12} deficiencies in pregnancy are associated with various adverse pregnancy outcomes such as low birth weight, premature births and foetal malformations (Tamura & Picciano, 2006), including a well-established association of folate insufficiency and development of neural tube defects (Pitkin, 2007). A 600 µg of daily folic acid intake is recommended for pregnant women (Peake et al., 2013) whereas institute of medicine (IOM) recommends a daily intake of 2.6 µg of vitamin B_{12} (IOM, 2001).

In developing countries, it may be difficult to meet the dietary requirement for folate and vitamin B_{12} through dietary intakes alone because of the high cost and limited availability of foods from folate and vitamin B_{12} sources. As part of antenatal care, the WHO recommends a daily supplementation for pregnant women (WHO, 2012). A mandatory food fortification policy may also be required to avoid the prevalence of inadequate intakes.

2.6 Zinc

Zinc is an essential micronutrient required for the catalytic activities of over 200 enzymes, plays an important role in protein synthesis, cell division and nucleic acid metabolism (King et al., 2006). Zinc is present in many food sources including, seafood (crab, lobsters, and oysters), whole grains, fortified breakfast cereals, dairy products, meat and meat products (meat, poultry), legumes (beans) and nuts (U.S Department of Agriculture, 2019). Zinc deficiency could be the result of inadequate intake of foods rich in zinc, increased loss due to malabsorption and infection, food insecurity, poor household food allocation, presence of fibre or phytate in the diet, inappropriate food preparation and storage (de Benoist et al., 2007). The demand for zinc intake increases during pregnancy to 11 mg/day (Otten et al., 2006). Studies have reported a positive correlation between inadequate zinc intake in pregnancy and higher risk of poor birth outcomes including preterm birth, low birth weight and foetal developmental defects. Deficiency in pregnancy has also been associated with increased risk of hypertension, eclampsia, infection and prolonged labour (Maduray et al., 2017; Shrivastava et al., 2015; Mori et al., 2012). Two separate meta-analyses studies found that intake of zinc supplements in pregnancy reduced the occurrences of preterm delivery by 14%. However, no effects on birth weight, hypertensive disorders or neonatal mortality was observed (Ota et al., 2015; Chaffee et al., 2012).

2.7 Calcium

Calcium is a vital nutrient needed for bone mineralization. It is also an important intracellular component for maintaining cell membranes. Dairy products are the main dietary sources of calcium. Other food sources of calcium include green leafy vegetables, fish, nuts and fortified foods including flour and dairy alternatives (Mousa et al., 2019; de Assumpç~ao et al., 2016). The impact of these food sources of calcium on total calcium intake depends on the pattern of food consumption of the individual or population. In developed countries, 14% of total energy intake is obtained from dairy products, whereas milk and milk products constitute only about 4% of total energy intake in developing countries (Silanikove et al., 2015). Child bearing increases the demand for calcium in order to accommodate the needs of the growing foetus and to enhance adequate foetal development and perinatal outcomes (Mousa et al., 2019). Deficiencies of calcium in pregnancy result in low maternal and infant bone density. Also, insufficient dietary calcium intake in pregnancy has been associated with hypertensive disorders in pregnancy, thus increasing the risk of preterm birth and infant mortality (McMaster et al., 2017; Mosha et al., 2017).

A systematic review of 105 studies, among 73,958 pregnant women in 37 countries reported that dietary calcium intake of the pregnant women were consistently found to be inadequate across Africa, Asia and Latin American countries (Lee et al., 2013). In low- and middle-income countries, the average dietary calcium intake (648 mg/day) of the pregnant women was lower compared to the intake of pregnant women in high income countries (948 mg/day) (Cormick et al., 2019; Bauer, 2013; IOM, 2011). A cross sectional study conducted by Nti, (2008) involving 400 mothers in Manya Krobo district of Ghana showed mean calcium intake (594 mg/day) of the mothers was lower than recommended levels of intake. The low dietary calcium intake reported was attributed to low consumption of dairy products which are primary sources of calcium in the diet. The institute of medicine recommends a 1,300 mg/day intake of calcium in pregnancy (IOM, 2011) and a maximum tolerated dose set at 2500 mg/day (Ross et al., 2011).

2.8 Vitamin C

Vitamin C is a vitamin that is water soluble, an antioxidant and a co-factor for enzymes involved in the production of collagen, carnitine and neurotransmitters. (Burri & Jacob, 1997; Tsao, 1997). It is involved in vitamin E recycling and also improves the absorption of dietary non-haeme iron, thus aiding in preventing megaloblastic and iron-deficiency anaemias (Gernand et al., 2016; Rumbold et al., 2015). Vitamin C is found in many fruits and vegetables. Citrus fruits and juices, guava, tomatoes and broccoli are rich sources (Rumbold et al., 2015), including brussels sprouts, green pepper and strawberries (U.S Department of Agriculture, 2019). Humans, unlike most animals, are unable to synthesize ascorbic acid endogenously, thus diet is essential for its availability. A lack of dietary vitamin C intake causes the deficiency disease, scurvy (Li & Schellhorn, 2007). Few studies have linked vitamin C deficiency to poor obstetric outcomes especially in the third trimester (Kalaiselvi et al., 2014; Klemmensen et al., 2009; Olayaki et al., 2008). A safe dose of vitamin C intake in pregnancy as recommended is 80-85 mg/day (Otten et al., 2006).

2.9 Phosphorus

Similar to calcium, phosphorus supports physiological functions and bone mineralization (Koletzko et al., 2014). Many different types of foods contain phosphorus such as grains, meat, poultry, fish, egg, dairy products, nuts and beans (Ross et al., 2014; Haider et al., 2012). Deficiency of this mineral rarely occurs but if it does, bone health is compromised (Ross et al., 2014). In pregnancy, the recommended daily intake of phosphorus is 700 mg per day (Otten et al., 2006).

CHAPTER THREE

3.0 METHODS

3.1 Study Design

A cross-sectional design was employed in this study.

3.2 Study Site

The study was carried out in the Accra Metropolis of the Greater Accra region of Ghana. According to the Ghana Statistical Service (GSS, 2015), the population of the Metropolis is about 1, 665,086. Adolescent girls (15-19 years) form about 10% of this population. Many of the adolescents in this population are unemployed with about 5% being married. The study participants were recruited from three health care facilities in the Accra Metropolis. The selected health facilities included the Ussher Polyclinic, La General Hospital, and Mamprobi Polyclinic, all located at Ga South, La Dade Kotopon Municipal and Ablekuma South Municipal Assemblies respectively. The healthcare facilities serve communities such as Nungua, Osu Labone, Teshie, James Town, Accra Central, Mateheko, Abbosey Okai, Dansoman, Korle Bu and Lartebiokorshie. The high turnout rate in these facilities informed their selection for the research work.

3.3 Study Population

The study participants were pregnant adolescents between 15-19 years attending antenatal clinic at the ante-natal care units of the health facilities under investigation.

3.4 Sample Size Determination

The sample size calculator (StatCalc) in the Epi-Info version 7.2 software was used in calculating the sample size. Confidence interval was set at 95% (1.96). With an estimated population size of adolescent girls of 88,278 (GSS, 2015), expected frequency was set at 50%. The margin of error was 5%. The calculated sample size arrived at was 245. However, complete data was sourced from 83 participants.

3.5 Inclusion and Exclusion Criteria

Healthy pregnant adolescent girls' between 15-19 years attending their first antenatal visit for that particular pregnancy. Those who came to the hospital with other health related problems other than pregnancy were excluded from the study. Verbal or written consent was obtained before being recruited into the study.

3.6 Sampling Technique

Total enumeration method was employed in recruiting participants. All pregnant girls visiting the facilities within the period of four months were approached and details of the study explained to them. Those who agreed to participate and met the study selection criteria were recruited after providing consent.

3.7 Pre-testing Questionnaire

Questionnaire was pre-tested at the Madina Polyclinic to ensure that the questions were not incomprehensible or ambiguous and could be answered accurately. Corrections were made to the questionnaire after the pretesting to ensure accuracy.

3.8 Data Collection

3.8.1 Background Information

Socio-demographic data from participants including age, educational level, marital status and employment status were obtained with a semi-structured questionnaire.

Other relevant information such as the intake of dietary supplements and practice of pica were also obtained. Information on their current haemoglobin (Hb) levels were obtained from the maternal health records book at the selected healthcare facilities.

3.8.2 Dietary and Nutrient Intake Assessment

Dietary intakes were assessed using the 24-hour dietary recall and the food frequency questionnaire method. The first recall was obtained on the first day of recruitment. Subsequent recalls were obtained via phone calls.

3.8.2.1 Determination of Nutrient Intakes

A three day 24-hour dietary recall method was used to quantitatively estimate dietary intakes. Two of the recalls were obtained on weekdays and one on a weekend. With the aid of food models, the girls were asked to recall foods and beverages they had taken in the past 24 hours. The estimation was done using the Ghanaian handy measures such as cups, spoons, soup and stew ladles, match box, and other common household measures. The estimated foods were then converted into grams, and then entered into the Microdiet dietary analysis software (Downlee Systems, UK) to create data on the nutrient intakes. The mean nutrient intake was calculated for the individual participants and dietary data analysis carried out on the three day 24-hour dietary recall data taken. Mean nutrient intake data were compared with the estimated average requirements (EAR) or the recommended dietary allowance (RDA) reference values in pregnancy as published by the Institute of Medicine, Food and Nutrition Board (2005). Energy intakes were compared with the estimated energy requirement (EER) cut off points. The EAR is defined as nutrient intake value estimated to meet the requirement for a specific criterion of adequacy of half the healthy individuals in a particular age, sex and life stage group (IOM, 2005).

3.8.2.2 Determination of Dietary Patterns

Dietary pattern of consumption of foods were determine using a validated food frequency questionnaire adopted from a questionnaire used on a Ghanaian population to determine dietary patterns and intakes of micronutrients (Owusu, 2008). The questionnaire was made up of 13 main food and beverage groups. The intake category had options ranging from once a day, more than once a day, 1-2 times a week, 3-4 times a week, 5-6 times a week, 1-2 times a month, rarely and never. The girls were asked to recall and indicate the number of times they had consumed a particular food or beverage over specific periods of time.

3.9 Biochemical Data

Anaemia was categorized based on WHO classification of anaemia using the Hb levels: severe anaemia (<7.0 g/dl), moderate anaemia (7.0 – 9.9 g/dl), mild (10.0 – 10.9 g/dl) and normal Hb level (≥11.0 g/dl) (WHO, 2011).

3.10 Data Management Plan

Data obtained was kept in a password-protected laptop. Completed questionnaires were coded, filed and kept under lock in the Department of Dietetics, University of Ghana. The recruitment ensured voluntary participation of each participant. The data collected remained confidential by being stored in a password-protected database on a computer. The questionnaires used were kept in a locked-up cabinet throughout the study and were only accessible to the research team.

3.11 Data Analysis

3.11.1 Dietary Analysis

Dietary intakes collected from the 3-day 24 hour recall were converted to energy and nutrients and analysed using the Microdiet nutrition analysis software version 3.1 (Downlee, UK). Data from questionnaires and the food frequency checklist were coded and inputted into Statistical Package for the Social Sciences (SPSS) version 20 for analysis.

3.11.2 Statistical Analysis

Statistical Package for Social Sciences (SPSS) Version 20.0 was used to analyse data. Categorical data were summarized as frequencies and percentages. Continuous data were summarized as means, medians and standard deviations. A one sample t-test was used to compare mean nutrient intake to the EAR/RDA. Pearson Chi-square tests were used to determine the relationships between socio- demographic variables and dietary intakes of micronutrient, and socio-demographic variables and haemoglobin status. ANOVA was used to compare the mean intakes of the girls between trimesters. Statistical significance was set at $p<0.05$.

3.12 Ethical Approval

Ethical approval and permission was obtained from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences, University of Ghana. Permission for the study was also obtained from the Municipal Health Directorate and then from the various health facilities where data collection was done. Informed consent was also obtained from the participants. The recruitment ensured voluntary participation. Participant's right to withdraw from the study at any point was respected. There was no risk associated with their participation and the study adhered to the required ethical protocol for studies involving human subjects. Information about the study was made available to the girls and any questions they had during the period of the study were duly addressed. The data collected remained confidential. Results and report did not bear any participant`s name. No direct benefits went to the participants but they were advised to modify and diversify their diet to improve their micronutrient nutrient intake.

CHAPTER FOUR

4.0 RESULTS

A total number of 83 pregnant adolescent girls were recruited for the study. All 83 participants completed the questionnaires on socio-demographics, food frequency questionnaire and the 3- day 24-hour recall.

4.1 Socio-demographic Information

Table 4.1 summarizes the socio-demographic characteristics of the study participants. Their age range was between 15 -19 years. The mean age was 17.83±1.03 years. The religious backgrounds of the study participants were predominantly Christians (75.9%) whiles 24.1% were Muslims. A small percentage (3.6%) of the girls had senior high school as their highest form of education with about 30.1% having no formal education. Majority of the pregnant adolescent girls (41.0%) were unemployed with 20.5% and 38.6% being artisans and traders respectively. Majority (95.2%) of the girls were single whiles 4.8% were married. Very few (1.2%) of the girls practised pica and about (4.8%) of them used supplements before pregnancy. Only 13.3% of the girls had had previous pregnancies.

Table 4.1: Socio-demographic characteristics of pregnant adolescent girls (N=83)

Variable	Frequency (%)
Age (years), Mean (SD)	17.83 (1.03)
Range (years)	15-19
Education level	**N (%)**
No formal education	25 (30.1)
Primary	20 (24.1)
Junior High School	35 (42.2)
Senior High School	3 (3.6)
Marital status	
Married	4 (4.8)
Single	79 (95.2)
Religion	
Christian	63 (75.9)
Islam	20 (24.1)
Occupation	
Unemployed	34 (41.0)
Artisan	17 (20.5)
Trader	32 (38.6)
Who girl lives with	
Parents	34 (41.0)
Husband/Partner	26 (31.3)
Alone	5 (6.0)
Other Relative	18 (21.7)
Use of supplements	
Yes	4 (4.8)
No	79 (95.2)
Other pregnancies	
Yes	11 (13.3)
No	72 (86.7)
Practice of pica	
Yes	1 (1.2)
No	82 (98.2)

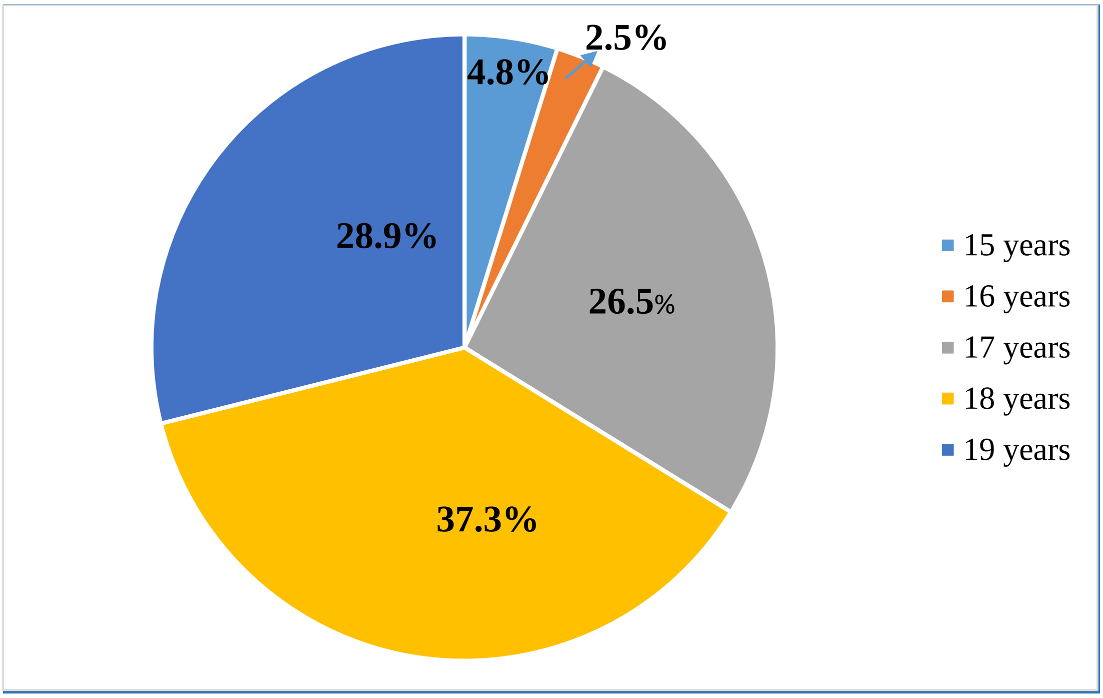

Fig 4.1: Percentage age (years) distribution of pregnant adolescent girls

4.2 Nutrient Intakes of Pregnant Adolescent Girls

Table 4.2 summarises the mean macronutrient and micronutrient intakes of the pregnant adolescent girls. The mean intakes of the macronutrients; energy (1638±579 Kcal) and protein (39.88±12.65 g) were lower than recommended levels of 2820 Kcal and 71 g respectively (DRI, 2004). The mean carbohydrate (284.20±123.69 g) intake of the pregnant adolescents was higher than recommended intakes (175 g) (DRI, 2002). The mean intakes of the selected micronutrients; iron, folate, vitamin B_{12}, calcium, phosphorus, zinc and vitamin C were 9.26±4.34 mg, 107.69±53.55 µg, 1.41±0.90 µg, 433±300 mg, 691.50±233.48 mg, 5.11±1.85 mg and 31.56±30.69 mg respectively.

Table 4.2: Nutrient intake of pregnant adolescent girls (N=83)

Nutrient	Mean	Median	Std. Deviation	Minimum	Maximum
Energy (Kcal)	1638	1609	579	481	3814
Carbohydrate (g)	284.28	263.13	123.69	58.12	825.03
Protein (g)	39.88	38.91	12.65	8.79	79.50
Fat (g)	45.15	41.59	20.71	2.24	109.71
Iron (mg)	9.26	8.52	4.34	1.02	26.35
Folate (µg)	107.69	93.67	53.55	17.55	339.54
Vitamin B_{12} (µg)	1.41	1.30	0.90	0.00	5.32
Calcium (mg)	433	325	300	89	1485
Phosphorus (mg)	691.50	661.93	233.48	210.29	1366.20
Zinc (mg)	5.11	4.79	1.85	0.39	10.57
Vitamin C (mg)	31.56	24.01	30.69	0.00	197.40

4.3 Estimating Micronutrient Intake Adequacy of the Pregnant Adolescent Girls

The micronutrient intake adequacy is presented in Table 4.3. A one sample T-test was done to show a comparison of the mean intake of the selected micronutrients to the Estimated Average Requirements (EAR) or Recommended Dietary Allowance (RDA). Intakes were compared to the estimated average requirements or recommended dietary allowance to determinate adequacy. Except for vitamin B_{12} and phosphorous, participants consumed less than 50% of EAR/RDA of all other nutrients.

Table 4.3: Comparison of mean micronutrient intakes to EAR/RDA (N=83)

Nutrient	Mean Intake	EAR/RDA	(%) of Intakes	*p*-Value
Iron (mg)	9.26	23	40.26	<0.001
Folate (µg)	107.69	520	20.71	<0.001
Vitamin B_{12} (µg)	1.41	2.20	64.09	<0.001
Calcium (mg)	432.47	1300	33.27	<0.001
Phosphorus(mg)	691.50	1055	65.55	<0.001
Zinc (mg)	5.11	10.5	48.67	<0.001
Vitamin C (mg)	31.56	80	39.45	<0.001

One Sample t-test significant at P<0.05. Mean intakes/EAR or RDA x 100

4.4 Determination of Dietary Pattern

A food frequency questionnaire was used to determine the pattern of consumption of the pregnant girls. Meat and meat products, fish and seafood, milk and milk products, fruits, vegetable and legumes were the main micronutrient source foods consumed. The summary of the findings are reported in graphs below. The frequency of consumption of the other food groups are reported in graphs in (Appendix IV).

4.4.1 Frequency of Consumption of Fruits

Consumption of fruits among respondents were generally low. The percentage of the girls who consumed pawpaw, pineapple, mango, citrus fruits, banana, pear, melon, apple, avocado pear and grapes on a daily basis ranged from 1.2% -7.3%. About 95.1%, 82.9%, 74.4% and 79.5% of the girls respectively never consumed plum, grapes, avocado pear and guava (Fig 4.2).

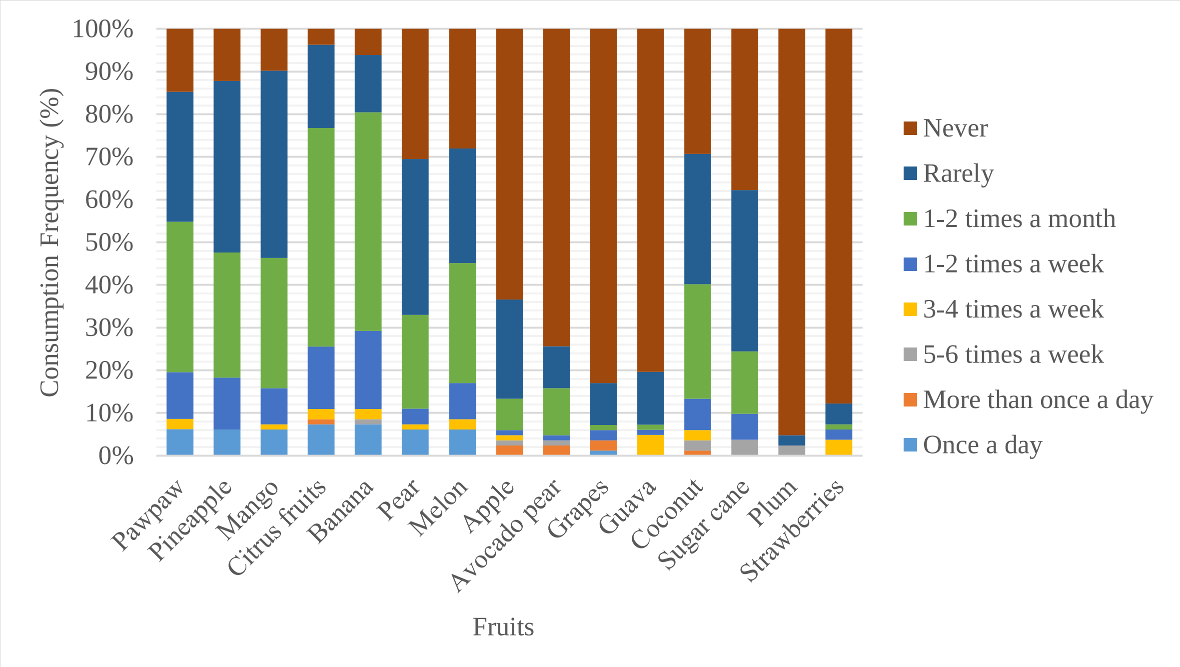

Fig 4.2: Frequency of consumption of fruits

4.4.2 Frequency of Consumption of Vegetables

Nearly all the girls did not consume vegetables on daily basis. About 30.1%, 28.9%, and 31.3% of the girls respectively consumed cabbage, kontomire (cocoyam leaves) and turkey berries at most 1-2 times/month. Okro was consumed by 22.9% of the girls at least 1-2 times in a week and sweet pepper was rarely consumed by 26.5% of the girls. About 75.9% of the respondents never consumed cauliflower. (Fig 4.3).

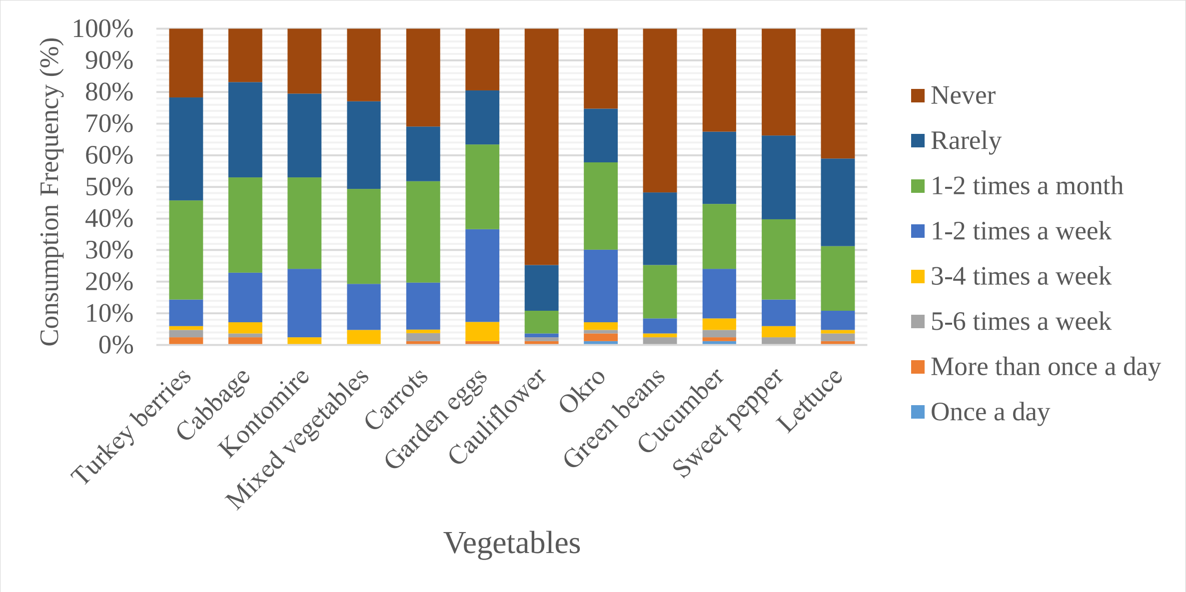

Fig 4.3: Frequency of consumption of vegetables

4.4.3 Frequency of Consumption of Milk and Milk Products

Despite the general low intakes observed, a range of 1.2%-3.6% of the girls consumed at least one type of the listed milk and milk products once a day. Ideal milk was the most frequently (38.6%) consumed milk at least 1-2 times/week. About 74.7%, 74.7%, 51.8%, 61.4% and 54.2% of the girls never consumed semi-skimmed milk, skimmed milk, carnation, yoghurt and soy milk respectively. Cheese was rarely consumed by 44.6% of the girls (Fig 4.4).

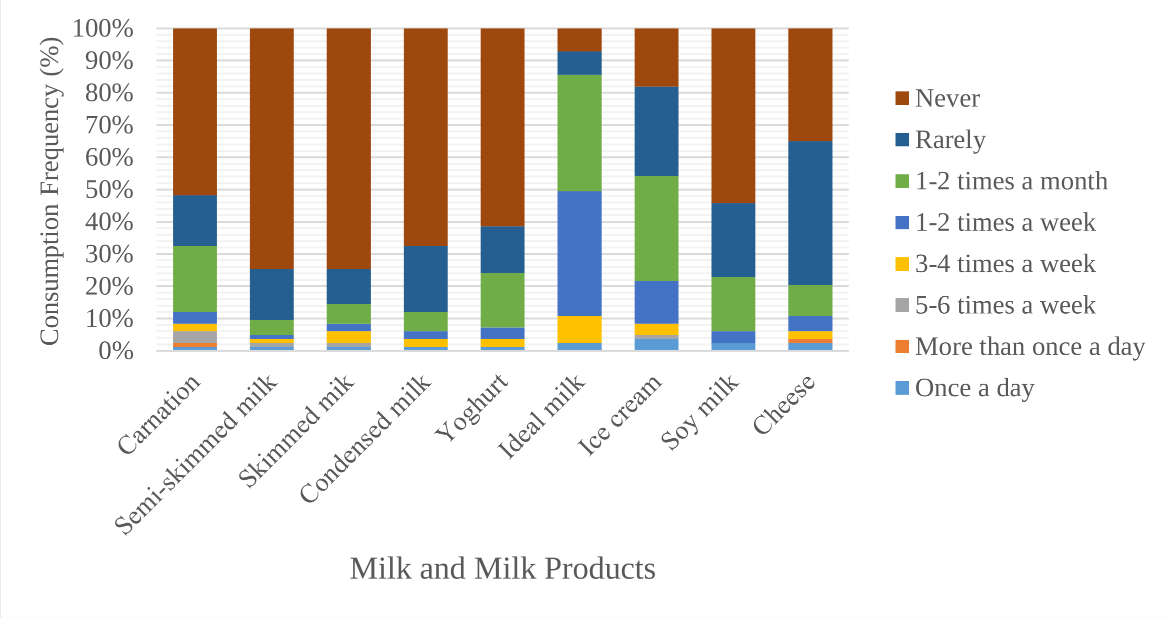

Fig 4.4: Frequency of consumption of milk and milk products

4.4.4 Frequency of Consumption of Meat and Meat Products

Among the meat and meat products, eggs were the most frequently (55.4%) consumed by the girls at least 1-2 times/week. Chicken, beef, goat meat, sausage and cow skin were consumed by 47.0%, 34.9%, 42.2%, 41.5%, and 41.0% of the girls respectively at most 1-2 times a month. More than half, 54.2%, 55.4%, 69.5%, 64.6% and 53.0% of the girls never consumed turkey, pork, snails, offal and game respectively (Fig 4.5).

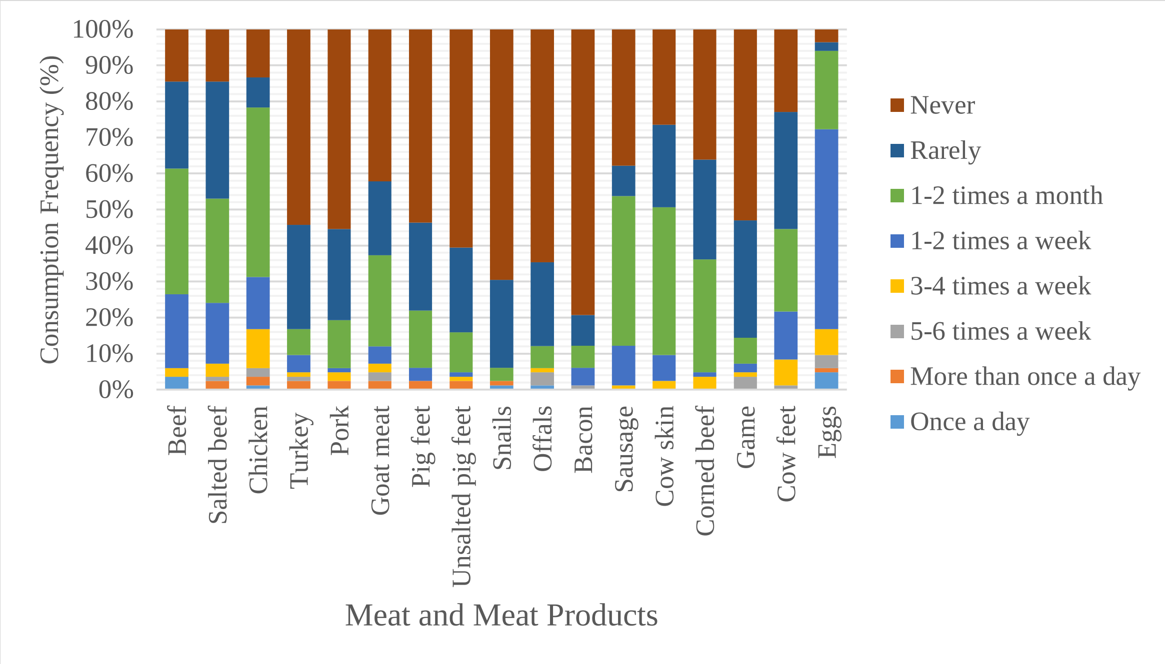

Fig 4.5: Frequency of consumption of meat and meat products

4.4.5 Frequency of Consumption of Fish and Sea Foods

Fish was consumed at least 1-2 times a week by 39.8% of the girls. About (53.0%, 36.1% and 74.7%) of the girls never consumed shrimps, canned fish and lobsters respectively. At most, 21.7% of the girls consume crabs 1-2 times in a month (Fig 4.6).

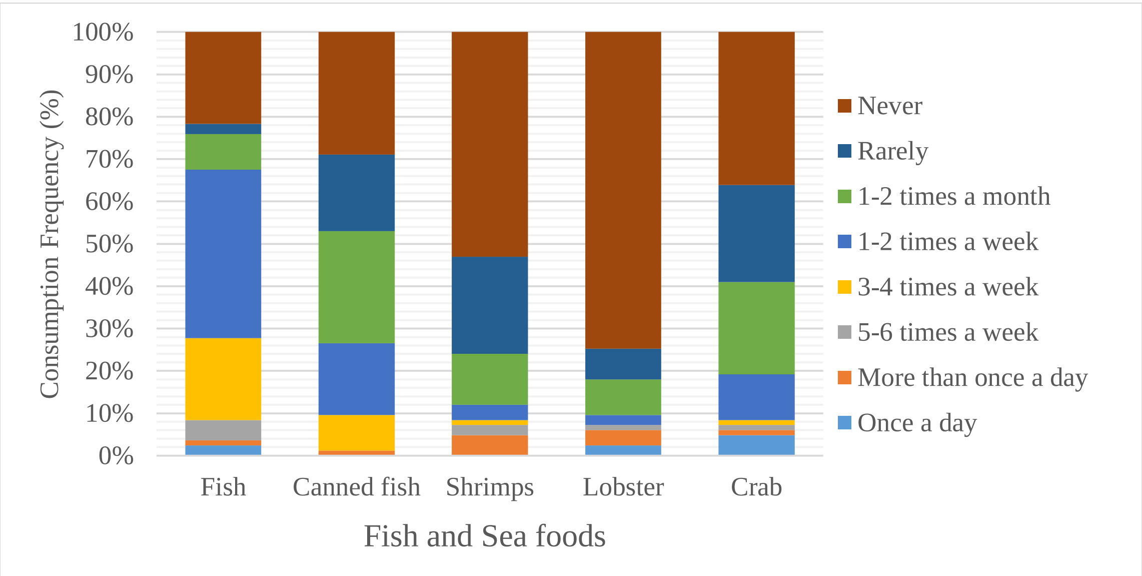

Fig 4.6: Frequency of consumption of fish and seafood

4.4.6 Frequency of Consumption of Legumes

None of the legume source foods were consumed on daily basis. Intakes of Soy flour, baked beans and Bambara beans were low. These foods were never consumed by 77.1%, 57.8% and 49.4% of the girls respectively. Black/red eyed beans was consumed by 28.9% of the pregnant girls 1-2 times/month (Fig 4.7).

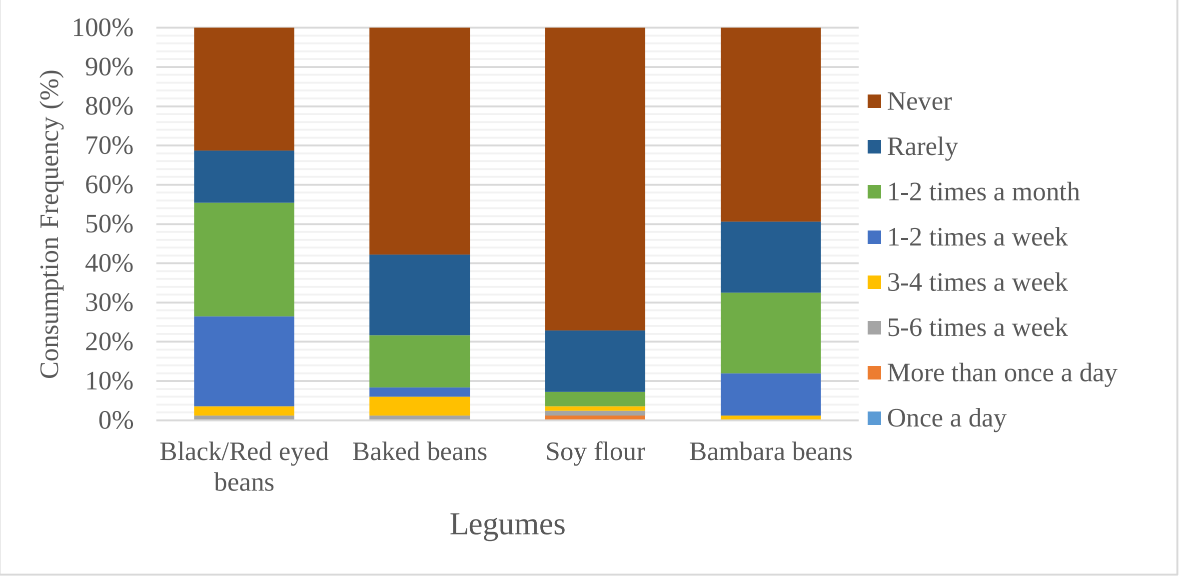

Fig 4.7: Frequency of consumption of legumes

4.5 Nutrient intakes according to trimester of pregnancy

Table 4.4 shows a comparison of the mean nutrient intakes between trimesters of pregnancy using the ANOVA test. Mean dietary intakes of macronutrients and micronutrients among the girls showed a general trend of increased nutrient intakes across the three trimesters of pregnancy. However, the increases were not statistically significant.

Table 4.4: Comparison of the mean nutrient intakes of the pregnant adolescent girls between trimesters (N=83)

Nutrient	First Trimester	Second Trimester	Third Trimester	Total	*p*-Value
Energy (Kcal)	1570	1600	1986	1620	0.131
Carbohydrate (g)	272.77	277.14	356.87	281.79	0.148
Protein (g)	37.22	40.66	39.38	39.62	0.473
Fat (g)	43.33	43.56	54.46	44.31	0.301
Iron (mg)	8.51	9.21	10.22	9.09	0.540
Folate (µg)	121.33	100.98	124.11	108.34	0.149
Vitamin B_{12} (µg)	1.45	1.43	1.71	1.46	0.698
Calcium (mg)	328	425	558	408	0.089
Phosphorus (mg)	671.66	682.74	716.09	682.14	0.885
Zinc (mg)	4.99	4.99	4.97	4.99	0.999
Vitamin C (mg)	121.33	100.98	124.99	108.34	0.149

ANOVA Test Significant differences in mean intakes between trimesters set at $p < 0.05$.

4.6 Relationship between socio-demographic variables and dietary micronutrient intakes

Relationship between socio-demographic variables and mean dietary intakes of selected micronutrients (iron, vitamin B_{12}, calcium, phosphorus, zinc and vitamin C) is presented in Tables 4.5a-f. A Pearson Chi-square test was done to show the association between socio-demographic characteristics and dietary micronutrients intake. There was no significant association between the socio-demographic variables and dietary intakes with the exception of occupation which was significantly associated with dietary phosphorus (*p*=0.017). Chi-square test was not done for dietary folate because none of the girls had adequate intake of folate.

Table 4.5a: Association between dietary iron intake and socio-demographic variables

Socio-demographic variables	Iron (mg)		$\chi 2$	*p*-Value
	Inadequate n (%)	Adequate n (%)		
Education level			1.778	0.620
No formal education	24 (29.6)	1 (50.0)		
Primary	19 (23.5)	1 (50.0)		
JHS	35 (43.2)	0 (0.0)		
SHS	3 (3.7)	0 (0.0)		
Marital status			0.104	0.747
Married	4 (4.9)	0 (0.0)		
Single	77 (95.1)	2 (100)		
Religion			0.651	0.420
Christian	61 (75.3)	2 (100)		
Moslem	20 (24.7)	0 (0.0)		
Occupation			3.266	0.195
Unemployed	34 (42.0)	0 (0.0)		
Artisan	17 (21.0)	0 (0.0)		
Trader	30 (37.0)	2 (100)		
Who girl lives with			7.401	0.060
Parents	34 (42.0)	0 (0.0)		
Husband/Partner	26 (32.1)	0 (0.0)		
Alone	5 (6.2)	0 (0.0)		
Other Relative	16 (19.8)	2 (100)		
Use of supplements			0.104	0.747
Yes	4 (4.9)	0 (0.0)		
No	77 (95.1)	2 (100)		
Other pregnancies			2.407	0.121
Yes	10 (12.3)	1 (50.0)		
No	71 (87.7)	1 (50.0)		
Practice of pica			0.025	0.874
Yes	1 (1.2)	0 (0.0)		
No	80 (98.8)	2 (100)		

Chi-square test significant at $p<0.05$

Table 4.5b: Association between dietary vitamin B_{12} intake and socio-demographic variables

Socio-demographic variables	Vitamin B_{12} (μg)		$\chi 2$	*p*-Value
	Inadequate n (%)	Adequate n (%)		
Education level			6.446	0.092
No formal education	21 (30.0)	4 (30.8)		
Primary	14 (20.0)	6 (46.2)		
JHS	33 (47.1)	2 (15.4)		
SHS	2 (2.9)	1 (7.7)		
Marital status			3.751	0.053
Married	2 (2.9)	2 (15.4)		
Single	68 (97.1)	11 (84.6)		
Religion			0.375	0.540
Christian	54 (77.1)	9 (69.2)		
Moslem	16 (22.9)	4 (30.8)		
Occupation			2.231	0.328
Unemployed	31 (44.3)	3 (23.1)		
Artisan	13 (18.6)	4 (30.8)		
Trader	26 (37.1)	6 (46.2)		
Who girl lives with			3.390	0.335
Parents	27 (38.6)	7 (53.8)		
Husband/Partner	24 (34.3)	2 (15.4)		
Alone	5 (7.1)	0 (0.0)		
Other Relative	14 (20.0)	4 (30.8)		
Use of supplements			0.780	0.377
Yes	4 (5.7)	0 (0.0)		
No	66 (94.3)	13 (100)		
Other pregnancies			1.294	0.255
Yes	8 (11.4)	3 (23.1)		
No	62 (88.6)	10 (76.9)		
Practice of pica			0.188	0.665
Yes	1 (1.4)	0 (0.0)		
No	69 (98.6)	13 (100)		

Chi-square test significant at $p<0.05$

Table 4.5c: Association between dietary calcium intake and socio-demographic variables

Socio-demographic variables	Calcium (mg)		$\chi 2$	*p*-Value
	Inadequate n (%)	Adequate n (%)		
Education level			0.347	0.951
No formal education	23 (30.3)	2 (28.6)		
Primary	18 (23.7)	2 (28.6)		
JHS	32 (42.1)	3 (42.9)		
SHS	3 (3.9)	0 (0.0)		
Marital status			0.387	0.534
Married	4 (5.3)	0 (0.0)		
Single	72 (94.7)	7 (100)		
Religion			0.084	0.772
Christian	58 (76.3)	5 (71.4)		
Moslem	18 (23.7)	2 (28.6)		
Occupation			0.449	0.799
Unemployed	31 (40.8)	3 (42.9)		
Artisan	15 (19.7)	2 (28.6)		
Trader	30 (39.5)	2 (28.6)		
Who girl lives with			2.931	0.402
Parents	30 (39.5)	4 (57.1)		
Husband/Partner	23 (30.3)	3 (42.9)		
Alone	5 (6.6)	0 (0.0)		
Other Relative	18 (23.7)	0 (0.0)		
Use of supplements			1.560	0.212
Yes	9 (11.8)	2 (28.6)		
No	67 (88.2)	5 (71.4)		
Other pregnancies			1.560	0.212
Yes	9 (11.8)	2 (28.6)		
No	67 (88.2)	5 (71.4)		
Practice of pica			0.093	0.760
Yes	1 (1.3)	0 (0.0)		
No	75 (98.7)	7 (100)		

Chi-square test significant at $p<0.05$

Table 4.5d: Association between dietary phosphorus intake and socio-demographic variables

Socio-demographic variables	Phosphorus (mg)		$\chi2$	*p*-Value
	Inadequate n (%)	Adequate n (%)		
Education level				
No formal education	22 (28.9)	3 (42.9)	3.214	0.360
Primary	17 (22.4)	3 (42.9)		
JHS	34 (44.7)	1 (14.3)		
SHS	3 (3.9)	0 (0.0)		
Marital status			0.387	0.534
Married	4 (5.3)	0 (0.0)		
Single	72 (94.7)	7 (100)		
Religion			0.084	0.772
Christian	58 (76.3)	5 (71.4)		
Moslem	18 (23.7)	2 (28.6)		
Occupation			8.185	**0.017**
Unemployed	34 (44.7)	0 (0.0)		
Artisan	13 (17.1)	4 (57.1)		
Trader	29 (38.2)	3 (42.9)		
Who girl lives with			3.693	0.297
Parents	33 (43.4)	1 (14.3)		
Husband/Partner	23 (30.3)	3 (42.9)		
Alone	5 (6.6)	0 (0.0)		
Other Relative	15 (19.7)	3 (42.9)		
Use of supplements			0.387	0.534
Yes	4 (5.3)	0 (0.0)		
No	72 (94.7)	7 (100)		
Other pregnancies			1.560	0.212
Yes	9 (11.8)	2 (28.6)		
No	67 (88.2)	5 (71.4)		
Practice of pica			0.093	0.760
Yes	1 (1.3)	0 (0.0)		
No	75 (98.7)	7 (100)		

Chi-square test significant at $p<0.05$

Table 4.5e: Association between dietary zinc intake and socio-demographic variables

Socio-demographic variables	Zinc (mg)		$\chi 2$	*p*-Value
	Inadequate n (%)	Adequate n (%)		
Education level			3.188	0.363
No formal education	25 (30.5)	0 (0.0)		
Primary	19 (23.2)	1 (100)		
JHS	35 (42.7)	0 (0.0)		
SHS	3 (3.7)	0 (0.0)		
Marital status			0.051	0.821
Married	4 (4.9)	0 (0.0)		
Single	78 (95.1)	1 (100)		
Religion			3.188	0.074
Christian	63 (76.8)	0 (0.0)		
Moslem	19 (23.2)	1 (100)		
Occupation			3.930	0.140
Unemployed	34 (41.5)	0 (0.0)		
Artisan	16 (19.5)	1 (100)		
Trader	32 (39.0)	0 (0.0)		
Who girl lives with			2.219	0.528
Parents	34 (41.5)	0 (0.0)		
Husband/Partner	25 (30.5)	1 (100)		
Alone	5 (6.1)	0 (0.0)		
Other Relative	18 (22.0)	0 (0.0)		
Use of supplements			0.051	0.821
Yes	4 (4.9)	0 (0.0)		
No	78 (95.1)	1 (100)		
Other pregnancies			0.155	0.694
Yes	11 (13.4)	0 (0.0)		
No	71 (86.6)	1 (100)		
Practice of pica			0.012	0.912
Yes	1 (1.2)	0 (0.0)		
No	81 (98.8)	1 (100)		

Chi-square test significant at $p<0.05$

Table 4.5f: Association between dietary vitamin C intake and socio-demographic variables

Socio-demographic variables	Vitamin C (mg)		$\chi 2$	*p*-Value
	Inadequate n (%)	Adequate n (%)		
Education level			0.811	0.847
No formal education	24 (30.8)	1 (20.0)		
Primary	19 (24.4)	1 (20.0)		
JHS	32 (41.0)	3 (60.0)		
SHS	3 (3.8)	0 (0)		
Marital status			0.269	0.604
Married	4 (5.1)	0 (0.0)		
Single	74 (94.9)	5 (100)		
Religion			0.736	0.391
Christian	60 (76.9)	3 (60.0)		
Moslem	18 (23.1)	2 (40.0)		
Occupation			1.206	0.547
Unemployed	33 (42.3)	1 (20.0)		
Artisan	16 (20.5)	1 (20.0)		
Trader	29 (37.2)	3 (60.0)		
Who girl lives with			4.719	0.194
Parents	34 (43.6)	0 (0.0)		
Husband/Partner	23 (29.5)	3 (60.0)		
Alone	5 (6.4)	0 (0.0)		
Other Relative	16 (20.5)	2 (40.0)		
Use of supplements			0.211	0.646
Yes	10 (12.8)	1 (20.0)		
No	68 (87.2)	4 (80.0)		
Other pregnancies			0.269	0.604
Yes	4 (5.1)	0 (0.0)		
No	74 (94.9)	5 (100)		
Practice of pica			0.065	0.799
Yes	1 (1.3)	0 (0.0)		
No	77 (98.7)	5 (100)		

Chi-square test significant at $p<0.05$

4.7 Anaemia prevalence among pregnant adolescent girls

Information on the haemoglobin status of the pregnant adolescent girls is presented in Table 4.6. The mean haemoglobin level concentration was 10.07±1.24 g/dl. Specifically, the percentages of severe, moderate, mild anaemia and those with normal haemoglobin levels were found in 1.2%, 36.1%, 47.0% and 15.7% of the pregnant adolescent girls respectively. Anaemia in pregnancy was defined as haemoglobin levels <11g/dl. An overall prevalence of anaemia among the pregnant adolescent girls was 62.7%.

Table 4.6: Haemoglobin status of pregnant adolescent girls (N=83)

Haemoglobin (Hb) status	N (%)
Mean Hb (SD) (g/dl)	10.07 (1.24)
Severe anaemia (<7.0 g/dl)	1 (1.2)
Moderate anaemia (7.0-9.9 g/dl)	30 (36.1)
Mild anaemia (10.0-10.9)	39 (47.0)
Normal (≥11.0 g/dl)	13 (15.7)

4.8 Relationship between haemoglobin status and socio-demographic characteristics

The association between haemoglobin status and socio-demographic characteristics is presented in Table 4.7. A Pearson Chi-square showed no significant association between any of the socio-demographic characteristics and haemoglobin status of the pregnant adolescent girls.

Table 4.7: Association between haemoglobin status and socio-demographic variables

Socio-demographic variables	Normal n (%)	Anaemic n (%)	χ2	*p*-Value
Education level			1.547	0.671
No formal education	5 (38.5)	20 (28.6)		
Primary	3 (23.1)	17 (24.3)		
JHS	4 (30.8)	31 (44.3)		
SHS	1 (7.7)	2 (2.9)		
Marital status			0.780	0.377
Married	0 (0)	4 (5.7)		
Single	13 (100)	66 (94.3)		
Religion			0.375	0.540
Christian	9 (69.2)	54 (77.1)		
Moslem	4 (30.8)	16 (22.9)		
Occupation			0.297	0.862
Unemployed	6 (46.2)	28 (40.0)		
Artisan	2 (15.4)	15 (21.4)		
Trader	5 (38.5)	27 (38.6)		
Who girl lives with			1.837	0.607
Parents	7 (53.8)	27 (38.6)		
Husband/Partner	4 (30.8)	22 (31.4)		
Alone	0 (0)	5 (7.1)		
Other Relative	16 (22.9)	16 (22.9)		
Use of supplements			0.277	0.598
Yes	1 (7.7)	3 (4.3)		
No	12 (92.3)	67 (95.7)		
Other pregnancies			0.415	0.520
Yes	1 (7.7)	10 (14.3)		
No	12 (92.3)	60 (85.7)		
Practice of pica			0.188	0.665
Yes	0 (0.0)	1 (1.4)		
No	13 (100)	69 (98.6)		

Chi-square test significant at $p<0.05$

CHAPTER FIVE

5.0 DISCUSSION

5.1 Discussion

Poor maternal micronutrient status in pregnancy is as a result of poor quality diet, inadequate dietary intakes, unequal intra-household food allocation and harmful dietary practices (Darnton-Hill & Mkparu, 2015; Torheim et al., 2010). The aim of this study was to identify the determinants of micronutrient deficiencies in pregnant adolescent girls in Accra, Ghana.

5.2 Nutrient adequacy of pregnant adolescents

Nutritional needs in pregnancy increases to meet the high nutrient demands of both the growing foetus as well as the pregnant woman who also goes through a period of growth to carry the child and prepare for lactation. However, this was not the case for this study with regards to intakes of macronutrients and micronutrients observed among the pregnant adolescent girls. Findings of this study showed intakes of a number of the micronutrients; iron, folate, calcium, zinc and vitamin C to be lower than 50% of EAR/RDA, hence intakes were inadequate. Vitamin B_{12} and phosphorus intakes were above 50% of EAR, hence adequate. Similar studies have reported inadequate intake of micronutrients among pregnant adolescents (Singh et al., 2017; Lee et al., 2014). Concerning, iron intake, reports from other studies in India and Ethiopia indicated that adolescents had low iron intake due to the high consumption of non-haeme rich foods which inhibited iron absorption (Teferi et al., 2018; Deka et al., 2015). The finding of this study showed that mean energy (1638 Kcal) intake among the pregnant adolescent girls was below recommended levels (2820 Kcal) in pregnancy (DRI, 2004). This is consistent with findings of other studies which reported low energy intake among adolescents (Maziya, 2014; Bwalya, 2015; Parimalavalli et al., 2011). This low energy intake observed among the pregnant adolescent girls in this study could be attributed to inadequate food intake which could be the result of meal skipping which is a common trait among adolescents (Moreno et al., 2010; Li et al., 2010; Burgess-Champoux et al., 2009; Briefel et al., 2009).

The mean protein (39.88 g) intake was lower than recommendations of the Institute of Medicine (71 g) for pregnant women (DRI, 2002). Studies by Nguyen et al., (2018) and Hogrey, (2018) in Bangladesh and Ghana among pregnant adolescent girls reported similar findings of mean intakes of protein (68.6 g and 40.25 g respectively) to be lower than recommended levels. The inadequate dietary intakes of the macronutrients and micronutrients observed in this study could partly be explained by the poor income status at that stage of life. Majority of the girls in this study were unemployed and those who had some form of employment engaged in petty trading which is normally associated with low income therefore could not afford to purchase and eat nutritious foods. Also, a good proportion of the girls had no education and may lack the knowledge on how to combine different foods to achieve optimum nutrition. These reasons might have contributed to their suboptimal intakes. To support this assertion, studies from Darmon et al., (2008) and Choudhury et al., (2008) reported that nutrient poor diets are more consumed by those with limited economic means and lower education level. Also, in this study, most of these teenagers were having their first pregnancies, and are less likely to adapt to pregnancy symptoms (nausea, vomiting, and hyperemesis gravidarum) which can reduce their appetite for food and consequently lead to inadequate nutrient intakes. This is acknowledged by Crozier et al., (2017) in a study among pregnant women where those who experienced severe nausea in the early stages of their pregnancy had significant low diet scores.

On the other hand, mean intake of carbohydrate (284.28 g) was higher than recommended levels of 175 g (DRI, 2002). Abdul Majid et al., (2016) and Nicholaus et al., (2020) reported similar findings among adolescents where carbohydrate intakes exceeded recommended levels and supplied most of the daily energy intake. The finding of this study could be due to the fact that carbohydrate source foods are cheaper and the Ghanaian diet rely on carbohydrates where most of the traditional foods are staples from starchy roots (yam, cassava) and plantain as well as cereals (rice, maize). Hence these carbohydrate rich source foods are frequently consumed (FAO, 2015).

5.3 Consumption pattern of micronutrient source foods

In this study, food consumption pattern was investigated by assessing the frequencies of food intake. Meat and meat products, fish and seafood, milk and milk products, fruits, vegetable and legumes were the main micronutrient food sources consumed by the pregnant adolescents. A general low intake of micronutrient source foods were reported in this study. This could also have accounted for the inadequate dietary intakes of the selected micronutrients observed in this study.

Frequent consumption from fruits and vegetables source foods were low among pregnant adolescent girls. Almost all the girls did not consume vegetables daily and about 7.3% of the girls consumed banana and citrus fruits once a day. Similar findings of infrequent fruits and vegetables intake among adolescents have been reported in Ghana and other countries like United States and Britain (Huang et al., 2019; Doku et al., 2011; Xie et al., 2015) where adolescents' consumption of fruits and vegetables were below recommended levels of at least a daily consumption of vegetables 5-6 times and fruits 4-5 times (400 g daily) (WHO, 2003). The study findings could be explained by the reason that most fruits and vegetables (mango, apple, pear, banana, citrus fruits, kontomire, and okro) are seasonal and consumption is high when in season and vice versa. This is agreed by two studies conducted by Krølner et al., (2011) and Nsiah-Amoah et al., (2018) where seasonal variation, availability and accessibility of fruits and vegetables were found to influence consumption of participants. Also some fruits and vegetables (plums, strawberries, grapes and cauliflower) are imported and very expensive. Adolescents of low socioeconomic status cannot afford to purchase and consume them frequently. This assertion is agreed by several studies which found that individuals in low-income groups were more likely to consume less fruits and vegetables than those with higher socioeconomic status due to cost (Okop et al., 2019; Nsiah-Amoah et al., 2018; Perera & Madhujith, 2012).

The study reported suboptimal intake of animal products; milk and milk products, meat and meat products, fish and seafood were observed in this study. This is similar to findings of other cross-sectional studies in pregnant adolescents where animal source foods were occasionally consumed and intakes were also inadequate (Nguyen et al., 2017; Soltani et al., 2017; Nicholaus et al., 2020). The observed results in this study could be due to the low socio-economic status of the pregnant adolescent girls making it difficult to afford these foods. Similar finding was reported by a study among adolescent boarding schoolers in Tanzania where animal source foods were considered expensive in terms of cost and hence were less frequently consumed or omitted completely from the diet (Nicholaus et al., 2020). Some of the foods (cheese, yoghurt, skimmed milk, and semi-skimmed milk) are imported and not a traditional meal hence observed to be rarely or never consumed by the girls. Others like snails are avoided in pregnancy among some tribes due to the fear and belief that intake of such foods could harm unborn children. A study conducted by Arzoaquoi., (2014) in the Yilo Krobo district of Ghana found that snail intake was avoided during pregnancy due to the fear of giving birth to a baby with dripping or watery mouth. Hence it is no surprise that snails were never consumed by 69.5% of the girls.

Legumes were not frequently consumed by the girls. Black/red eyed beans were consumed by only 1.2% of the girls 5-6 times/week. A study by Nicholaus et al., (2020) in Tanzania reported that 96.3% of the adolescents in their study frequently consumed kidney beans 7 times a week. In their study, it was reported that legumes were one of the major sources of energy and proteins among the population and are readily accessed in nearby regions in case of deficit. This is contrary to the finding of this study. The less frequent intake of legume source foods in this study could be due to the perception that such foods cause stomach distress including excessive flatulence (gas) (Winham & Hutchins, 2011). Since animal sources of protein are expensive in Ghana, there is the need to encourage increased consumption of legumes (which are relatively cheaper) among the adolescents to increase the intake of protein given the important role it plays in growth and development.

5.4 Socioeconomic status and dietary micronutrient intakes of study participants

Socio-demographic factors such as education level, marital status and occupation have been shown to influence the amount of nutrient intake. In this study occupation showed significant association with mean dietary phosphorus intake (p=0.017). However, there was a significant lack of published data to support this observation. There was no association between socio-demographic characteristics and mean nutrient intakes of iron, vitamin B_{12}, calcium, zinc and vitamin C). Similar finding was reported by Koryo-Dabrah et al., (2012) among pregnant women in Ghana where there was no significant association between education level and marital status with dietary intakes of vitamin B_{12}, folate, iron and zinc). The mean intake of folate was very low. All the girls had inadequate folate intake. This finding is consistent with studies conducted in Sweden and Ghana by Andersen et al., (2008) and Koryo-Dabrah et al., (2012) where folate intakes among the study participants were alarmingly low. The very low folate intake observed in this study could probably be due to the low intake of vegetables among the girls. Since the recommended intake of folate is increased during pregnancy, increased consumption of dark green leafy vegetables and a general increased intake of fruits and vegetables should be encouraged especially during pregnancy to meet nutritional needs. Folate is particularly of importance to women of reproductive age. Inadequate intakes can lead to deficiencies. A folate deficiency in pregnancy can lead to anaemia (Lee et al., 2012; Zerfu et al., 2016). Daily folic acid supplementation in women of child-bearing age reduced the risk of neural tube defects in the offspring (Bibbins et al., 2017; Imbard et al., 2013).

5.5 Anaemia and socio-demographic characteristics

Anaemia has shown to have adverse health implications such as fatigue, increased risk of infection, pre-term delivery, low birth weight and mortality. (GSS, 2015). Pregnant women, nursing mothers, women of reproductive age and children are the most at risk. Anaemia was reported as Hb<11g/dl and this was based on WHO classifications (WHO, 2011). This study found anaemia prevalence among the pregnant adolescent girls to be 62.7% which is higher than that from the 2014 Ghana Demographic and

Health Survey (GDHS) in which the overall national prevalence of anaemia in pregnancy was 44.6% (GSS, 2014). The high prevalence of anaemia reported among the pregnant adolescent girls in this study is similar to reports by other studies in Kenya (57%), Cote d'Ivoire (77.7%) and South Africa (57%) (Asiko, 2015; Bleyere et al., 2013; Bopape et al., 2008). In Ghana, other studies have also reported the prevalence of anaemia in pregnant adolescents: 73.2% in West Gonja District, 56.5% in Ashanti Region, and 43.9% in Secondi Takoradi (Tibambuya et al., 2019; Ayensu et al., 2020; Orish et al., 2010). The high prevalence of anaemia observed in this study could also be explained by the low consumption of animal source foods among the pregnant adolescents. An observational study among young women found a positive correlation between meat consumption and iron stores (Leonard et al., 2014).

Socio-demographic factors such as education level, marital status, religion, pica practice, occupation, parity and who the girl lived with had no significant association with anaemia. These findings are agreed by a study conducted by Ndukwu & Dienye (2012) where there was no significant association between anaemia and education level as well as marital status. Other studies including Glover-Amengor et al., (2005) and Stephen et al., (2018) did not find a significant association between occupation and anaemia. Again, Stephen et al., (2018) did not find any significant association with pica practice and anaemia. Contrary to the findings of this study, some studies found factors such as education, pica and occupation to be significantly associated with anaemia in pregnancy (Sumaila, 2019; Adanikin & Awoleke, 2016; Sharma et al., 2013; Orish et al., 2010). These differences observed could be other causes of anaemia such as suboptimal dietary intakes influencing the outcomes. This is consistent with the findings that the primary cause of nutritional anaemia in pregnancy is the result of suboptimal or inadequate dietary intake (Lee et al., 2012; Zerfu et al., 2016). Also the prenatal Hb of the pregnant adolescent girls may also play a key role in these studies outcomes.

5.7 Limitations of this study

Under- and over-reporting are sources of bias in the recall of dietary intake because individuals are more likely to under-report foods that may be viewed as unhealthy whereas over-reporting of foods perceived to be healthy.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Dietary intakes of iron, folate, calcium, zinc and vitamin C were lower than 50% of EAR, except for vitamin B_{12} and phosphorus. Consumption of foods rich in micronutrients were generally low which reflected a poor consumption pattern among the pregnant adolescent girls. Anaemia prevalence was found to be 62.7% among the pregnant adolescents. The study found no significant association between socio-demographic characteristics and anaemia status. There was no significant association of socio-demographic characteristics with iron, vitamin B_{12}, calcium, zinc and vitamin C with the exception of occupation which was significantly associated with phosphorus (p=0.017). There was no statistical significant difference between nutrient intakes across trimesters of pregnancy. Findings suggest that there is a significant need for establishing healthy eating patterns and improving dietary intakes among adolescent girls.

6.2 Recommendations

I recommend that more attention should be focused on dietary approaches, including fortification of foods with micronutrients, which may prove to be more beneficial and sustainable than provision of supplements during pregnancy.

Nutrition education programs and interventions should be designed to improve knowledge of food and nutrition as well as to enhance dietary diversification to encourage appropriate food choices.

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APPENDIX I

PARTICIPANT'S CONSENT FORM

DEPARTMENT OF NUTRITION AND DIETITICS, SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES, COLLEGE OF HEALTH SCIENCES, UNIVERSITY OF GHANA

<u>DETERMINANTS OF MICRONUTRIENT DEFICIENCIES IN PREGNANT ADOLESCENTS IN ACCRA.</u>

<u>INFORMATION SHEET</u>

My name is Eunice Donkor-Adjei, a final year MSc Dietetics Student of the School Of Biomedical And Allied Health Sciences, University of Ghana.

I am carrying out a research on "DETERMINANTS OF MICRONUTRIENT DEFICIENCIES IN PREGNANT ADOLESCENTS IN ACCRA" as a partial fulfilment of my MSc. degree in Dietetics.

The purpose of this study is to identify the determinants of micronutrient deficiencies in pregnant adolescents. You are being invited to partake in this study. Please note that participation is entirely voluntary: you may refuse to take part or withdraw without any objections. If you agree to participate, you will please need to complete the attached questionnaire to provide a little information about yourself and your diet. There are no direct risks in partaking in this research. There may however be inconveniences like taking part of a participant's time and asking personal information that a participant may not be very comfortable in divulging, like her age or pica practice.

There will not be a direct benefit to you if you decide to participate in this study. However, information generated will help policy makers better understand the factors that causes pregnant adolescent girls to be micronutrient deficient, its complications and put in place appropriate measures of intervention.

Please note that ethical clearance has been obtained the Ethics and Protocol Review Committee of the School Of Biomedical and Allied Health Sciences (SBAHS), College of Health Sciences (CHS), University of Ghana. Permission was also obtained from the Municipal Health Directorate and then from the various health facilities where data collection was done. All information will be kept with strict confidentiality and will be used for the research only.

If you have any questions, please you call any of the contacts below:

Researcher's Contact

Eunice Donkor-Adjei

Department of Dietetics

University of Ghana

0242579917

Supervisors' Contacts

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Department Dietetics

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Department of Obstetrics and Gynaecology

Korle Bu Teaching Hospital

0244295763

INFORMED CONSENT FORM

I………………………………………………………………………………………………

….have read (or has been read to me in a language that I understand) the proposed study and I have understood what is going to be done. Also, any concern that I have, have been fully addressed. My signature/ thumbprint below shows that I agree to take part in the study.

Signature/ Thumbprint……………………………….

Date………/…………/………….

Statement by the Researcher

I certify that the participant has read the information provided in the consent form (or had it read to her) and all the concerns she has have been addressed.

Signature …………………………

Date.........../.............../................

APPENDIX II

QUESTIONNAIRE

ID NO.......................

UNIVERSITY OF GHANA

College of Health Sciences, School of Biomedical and Allied Health Sciences

DETERMINANTS OF MICRONUTRIENT DEFICIENCIES IN PREGNANT ADOLESCENTS

Introduction

You are invited to take part in the research on nutritional anaemia in pregnant adolescent girls. This questionnaire seeks to obtain information on nutritional anaemia in pregnant adolescent girls. You are assured that any information given is solely for academic purposes and will be kept confidential. You are requested to answer all the questions as accurately and honestly as possible. Thank you

DEMOGRAPHIC INFORMATION **CODE**		
1. Name		
2. Age		AGE
3. Telephone No.		
4. Religion	(1)Christian (2)Moslem (3) Traditionalist (4) Other..................	RELIGION
5. Community	(1)James town (2) La (3) Mamprobi	COMMUNITY
6. What is your level of education?	(1) No formal education (2)Primary (3) JHS (4) SHS (5) Tertiary	EDUCATION LEVEL
7. What is your occupation?	(1) Unemployed (2) Artisan (3) Trader (4) Other..........................	OCCUPATION
8. What is your marital status?	(1) Married (2) Single (3) Co habitation (4) Divorced	MARITAL STATUS
9. Who do you live with?	(1)Parents (2) Husband/Partner (3) Alone (4) Other relative (5) Other......................	WHO GIRL LIVE WITH

INFORMATION ON PREGNANCY		
10. How many months pregnant are you?	(1) (2) (3) (4) (5) (6) (7) (8) (9)	MONTHS PREGNANT
11. Have you had any previous pregnancy	(1) Yes (2) No	OTHER PREGNANCY
12. Where you on any nutritional supplements before getting pregnant?	(1) Yes (2) No	USE OF SUPPLEMENTS
13. Do you take any of these substances?	(1) White clay (2) Chalk (3) Mud (4) Starch (5) Wood/paper (6) Other.........................	PRACTICE OF PICA

DIETARY ASSESSMENT

24-hour recall dietary assessment **DAY 1**

	Handy measures estimation	**Grams**
Breakfast		
Mid-Morning snack		
Lunch		
Afternoon snack		
Supper		
Bedtime snack		

DAY 2

	Handy measures estimation	Grams
Breakfast		
Mid-Morning snack		
Lunch		
Afternoon snack		
Supper		
Bedtime snack		

DAY 3

	Handy measures estimation	Grams
Breakfast		
Mid-Morning snack		
Lunch		
Afternoon snack		
Supper		
Bedtime snack		

APPENDIX III

FOOD FREQUENCY QUESTIONNAIRE

Can you please answer the following questions?

How often do you usually eat the following foods? (Please tick one)

Food/dish	**Once a day**	**More than once a day**	**5-6x a Wk**	**3-4x a week**	**1-2x a Wk**	**1-2x a month**	**Rarely**	**Never**
Beverages								
Tea Leaf								
Chocolate drink Bournvita /Milo/ Cocoa powder etc.								
Horlicks								
Coffee								
Porridges								
Corn porridge (koko)								
Millet porridge(hausa)								
Rice porridge								
Oats porridge								
Wheat porridge								
Weanimix								
Breakfast cereal e.g. corn flakes, weetabix								
Milk and milk products								
Carnation								
Semi-skimmed milk								

Skimmed milk								
Condensed milk								
Yoghurt								
Ideal milk								
Food/dish	**Once a day**	**More than once a day**	**5-6x a Wk**	**3-4x a week**	**1-2x a Wk**	**1-2x a month**	**Rarely**	**Never**
Ice cream								
Soymilk								
Cheese								
Spreads								
Butter								
Margarine								
Polyunsaturated margarine								
Peanut butter								
Marmalade/Jam								
Bread								
Wholemeal (brown b								
White bread								
Sugar bread								
Butter bread								
Deep fried foods								
Fried yams								
Fried plantain								
French fries								
Potato chips								
Oils								
Palm oil								
White oil e.g. sunflower, frytol/								

soybean								
Coconut oil								
Food/dish	**Once a day**	**More than once a day**	**5-6x a Wk**	**3-4x a week**	**1-2x a Wk**	**1-2x a month**	**Rarely**	**Never**
Palm kernel oil								
Groundnut oil								
Vegetables								
Turkey berries/Pebble garden egg (abeduru)								
Cabbage								
Kontomire								
Mixed vegetables (e.g. Coleslaw								
Carrots								
Garden eggs								
Cauliflower								
Okro								
Green beans (runner beans etc)								
Cucumber								
Sweet peppers								
Lettuce								
Fish and seafood								
Fish								
Canned fish								
Shrimps								

Lobster								
Crabs								
Food/dish	**Once a day**	**More than once a day**	**5-6x a Wk**	**3-4x a week**	**1-2x a Wk**	**1-2x a month**	**Rarely**	**Never**
Meat and meat products								
Beef								
Salted beef								
Chicken								
Turkey								
Pork								
Goat meat								
Pig feet								
Pig feet (unsalted)								
Snails								
Offals (gizzard, Liver, tripe, etc)								
Bacon								
Sausages								
Cow's skin								
Canned meat (corned beef)								
Game (Bush meat)								
Cow foot								
Eggs								
Starches								

Banku								
Kenkey								
Fufu flour								

Food/dish	**Once a day**	**More than once a day**	**5-6x a Wk**	**3-4x a week**	**1-2x a Wk**	**1-2x a month**	**Rarel y**	**Never**
Fufu (pounded)								
Plantain								
Yam								
Gari								
Cocoyam								
Rice								
Pasta, macaroni, spaghetti								
Soups								
Palm soup								
Ground-nut soup								
Light soup								
Okro soup								
Stews								
Kontomire stew (no agushie)								
Kontomire stew (plus agushie)								
Aubergine or garden egg stew								
Agushie stew								
Tomato stew								

Fruits								
Pawpaw								
Pineapple								
Mango								
Citrus fruits								
Food/dish	**Once a day**	**More than once a day**	**5-6x a Wk**	**3-4x a week**	**1-2x a Wk**	**1-2x a month**	**Rarel y**	**Never**
Banana								
Pear								
Melon								
Apples								
Food/dish	**Once a day**	**More than once a day**	**5-6x a Wk**	**3-4x a week**	**1-2x a Wk**	**1-2x a month**	**Rarel y**	**Never**
Avocado pear								
Grapes								
Guava								
Coconut								
Sugarcane								
Fruit juices(eg**.** apple								
Soft drinks								
Fanta, coke etc.								
Supermalt								
Malta guinness								
Diet drinks								
Alcoholic beverages								

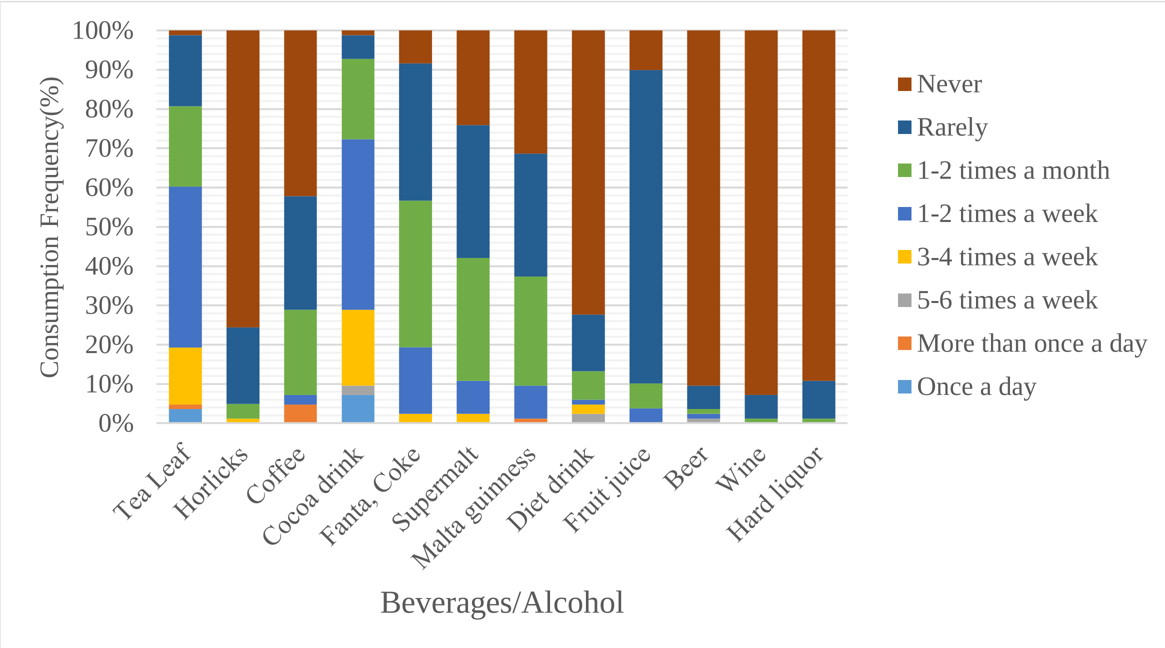
Beers								
Wine								
Hard liquor								
Snacks								
Food/dish	Once a day	More than once a day	5-6x a Wk	3-4x a week	1-2x a Wk	1-2x a month	Rarely	Never
Crisps and savoury snacks								
Pastries								
Plantain chips								
Biscuits								
Roasted groundnuts								
Fast Foods								
Hamburgers, pizza, takeaway etc.								
Sweets								
Toffees, chocolates etc.								
Legumes								
Black/red-eyed beans								
Baked beans								
Soy flour								
Bambara beans								

APPENDIX IV

FREQUENCY OF CONSUMPTION OF FOODS

Frequency of Consumption of Hot and Cold Beverages

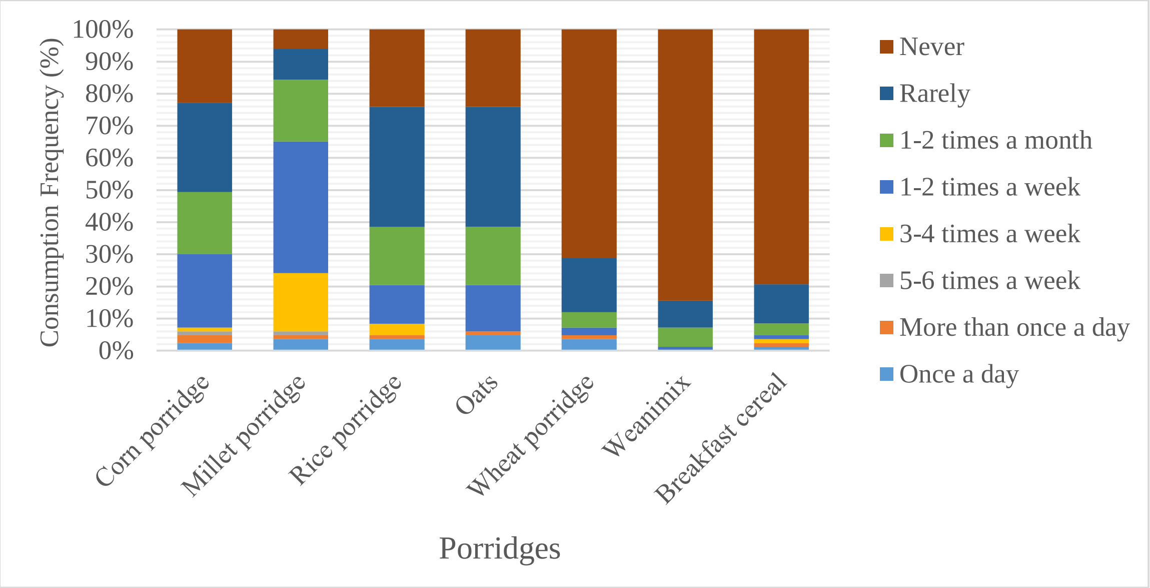
Among the hot beverages, tea leaf and cocoa (chocolate) were consumed 1-2 times a week by 41% and 43.4% of the participants respectively. The carbonated drinks (Fanta, Coke, Supermalt, and Malta Guinness) were consumed 1-2 times per month by 37.3%, 31.3% and 27.7% of the participants respectively. About 72.3%, 90.4%, 92.8% and 89.2% of the pregnant girls never consumed diet drinks, beer, wine or hard liquor respectively.



Frequency of consumption of beverages/alcohol

Frequency of Consumption of Porridges

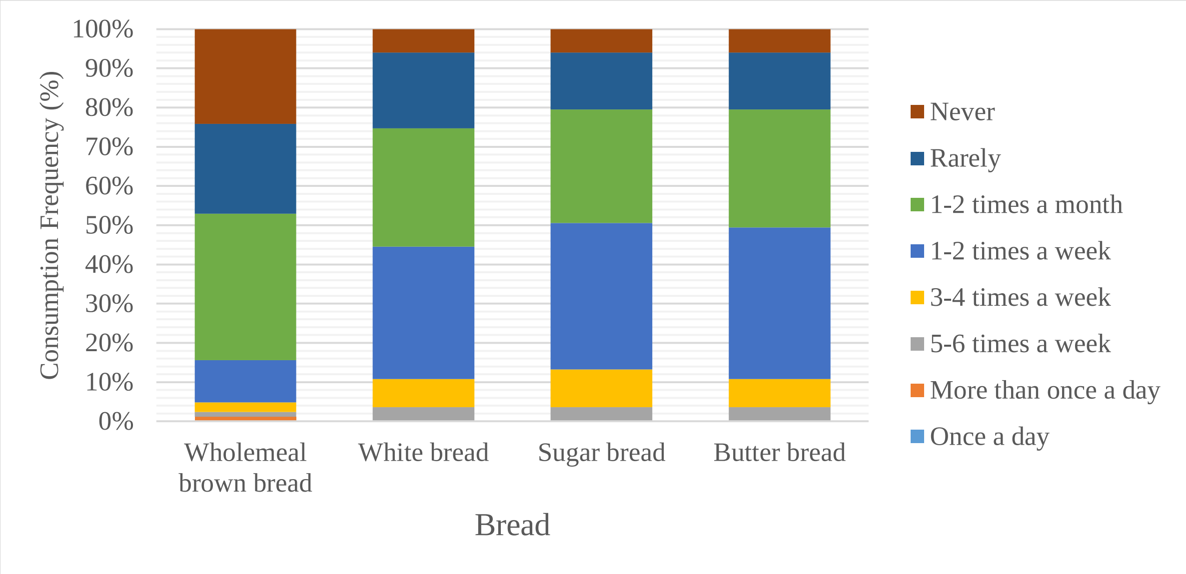
Corn porridge, rice porridge and oats were rarely consumed by 27.7%, 37.3% and 37.3% of the girls respectively. About 41.0% of the girls consumed millet porridge frequently for at least 1-2 times per week. Wheat porridge, weanimix and fortified breakfast cereals were never consumed frequently by 71.1%, 84.3% and 79.3% of the girls respectively.



Frequency of consumption of porridges

Frequency of Consumption of Breads

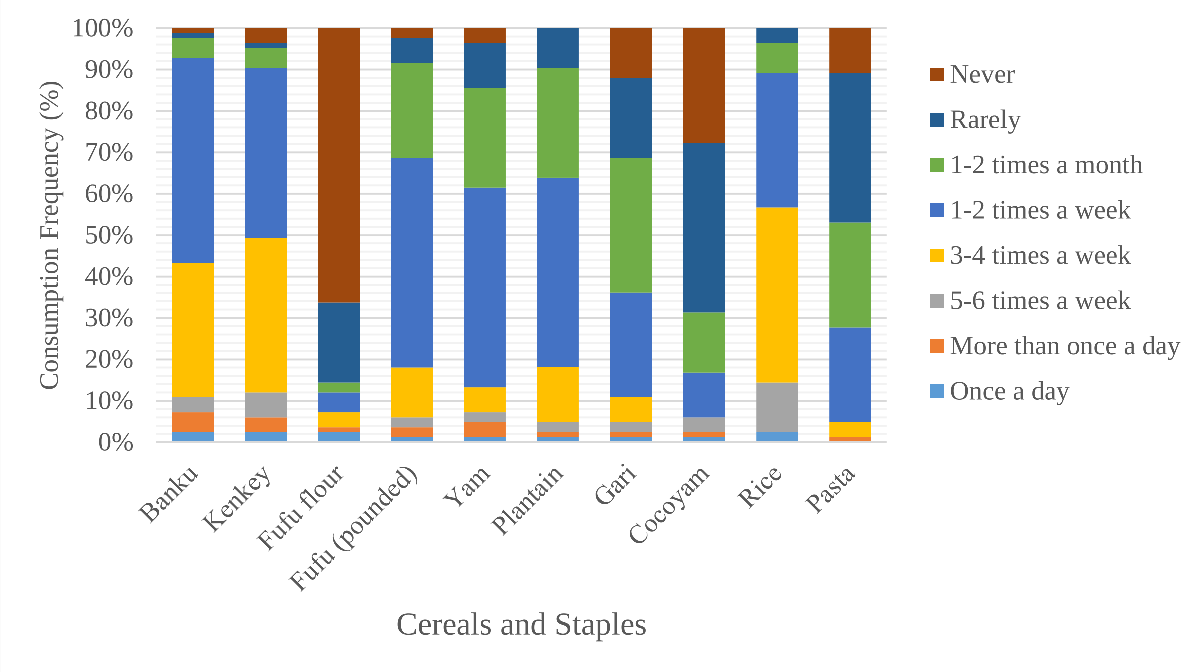
The girls consumed brown bread, white bread, sugar bread and butter bread 37.3%, 30.1%, 28.9% and 30.1% respectively within 1-2 time a month with butter bread being the most frequently consumed (38.6%) at least 1-2 times a week.



Frequency of consumption of breads

Frequency of Consumption of Cereals and Staples

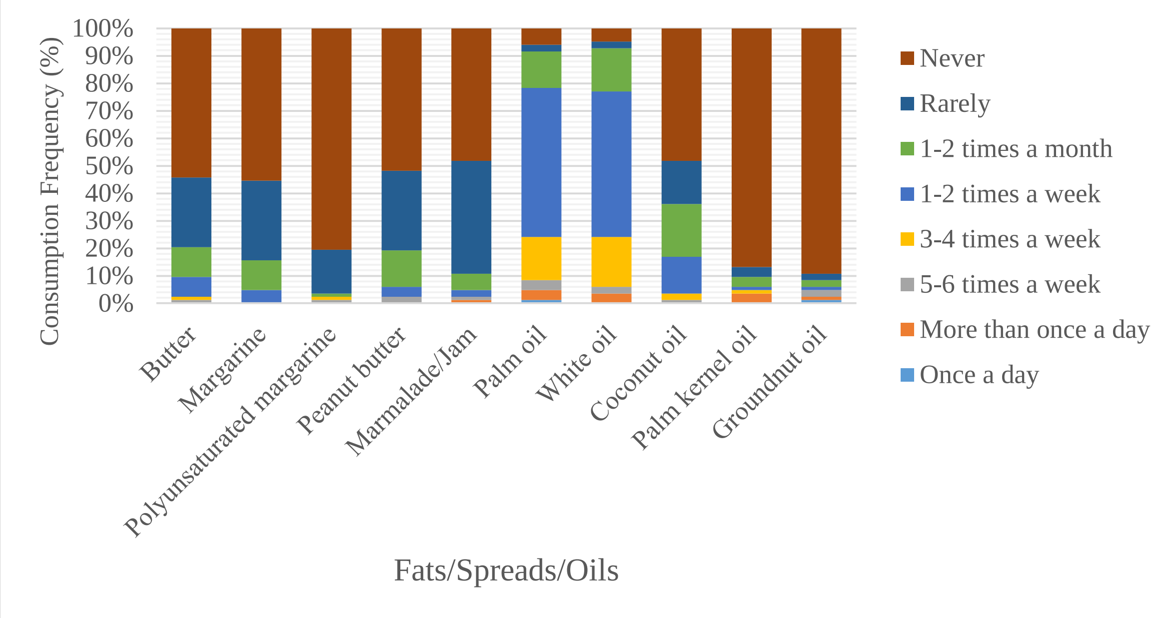
Banku (prepared from fermented maize) and kenkey (prepared from fermented maize) were consumed at least 1-2 times per week by 49.4% and 41.0% of the girls respectively. Pasta (Macaroni, Spaghetti) was rarely consumed by 36.1% of the girls. About 66.3% of the girls never consumed fufu (prepared from cassava) flour. However, 50.6% of the girls frequently consumed pounded fufu 1-2 times/week. Cereal like rice was frequently consumed by 42.2% of the girls in 3-4 times a week. Staples such as yam and plantain were mostly consumed 1-2 times a week by 48.2% and 45.8% of the girls respectively whiles 41.0% of the girls rarely consumed cocoyam.



Frequency of consumption of cereals and staples

Frequency of Consumption of Fats, Spreads and Oils

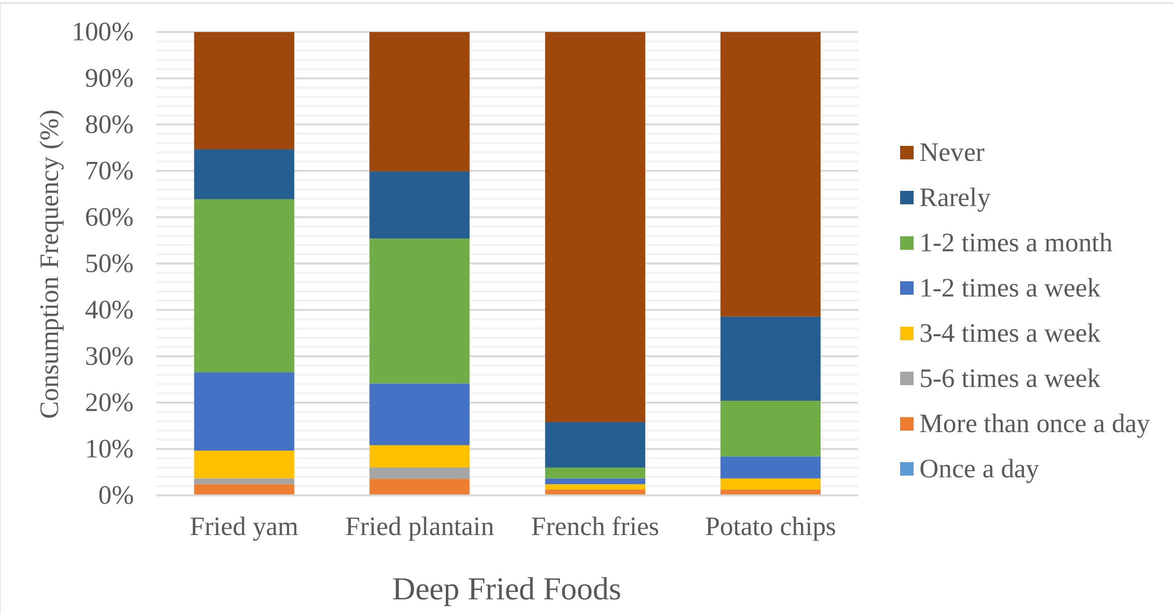
Consumption of the spreads (butter, margarine, polyunsaturated margarine, peanut butter and Marmalade/Jam) among the girls were generally low. A percentage range of 6.0%-13.3% of the girls consumed these foods at least 1-2 times a month. About 54.2% and 53.0% of the girls used palm oil and white oil (sunflower oil, frytol) respectively at least 1-2 times a week which were mostly for preparation of stew or other savouries. Consumption of coconut oil, palm kernel oil and groundnut oil were uncommon among the girls with 48.2%, 86.7% and 89.2% of the girls respectively never consuming any of these products.



Frequency of consumption of fats, spreads and oils

Frequency of Consumption of Deep Fried Foods

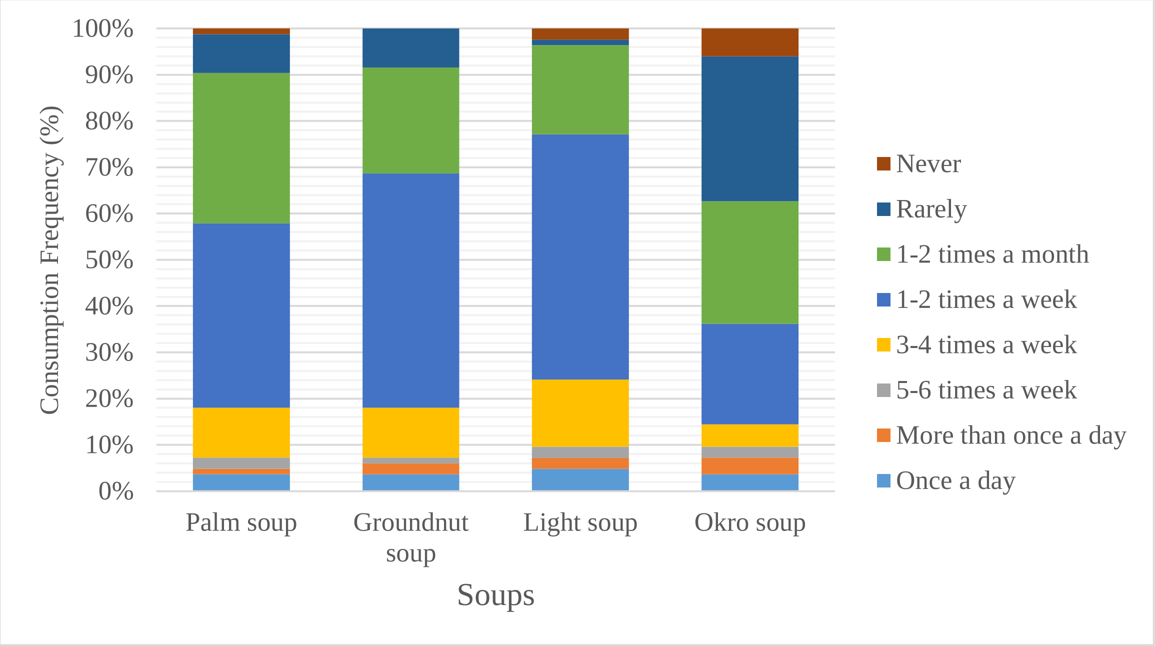
About 84.1% and 61.4% of the girls never consumed French fries and potato chips respectively. Fried yam and fried plantain were consumed by 37.3% and 31.3% participants respectively, within 1-2 times a month.



Frequency of consumption of deep fried foods

Frequency of Consumption of Soups

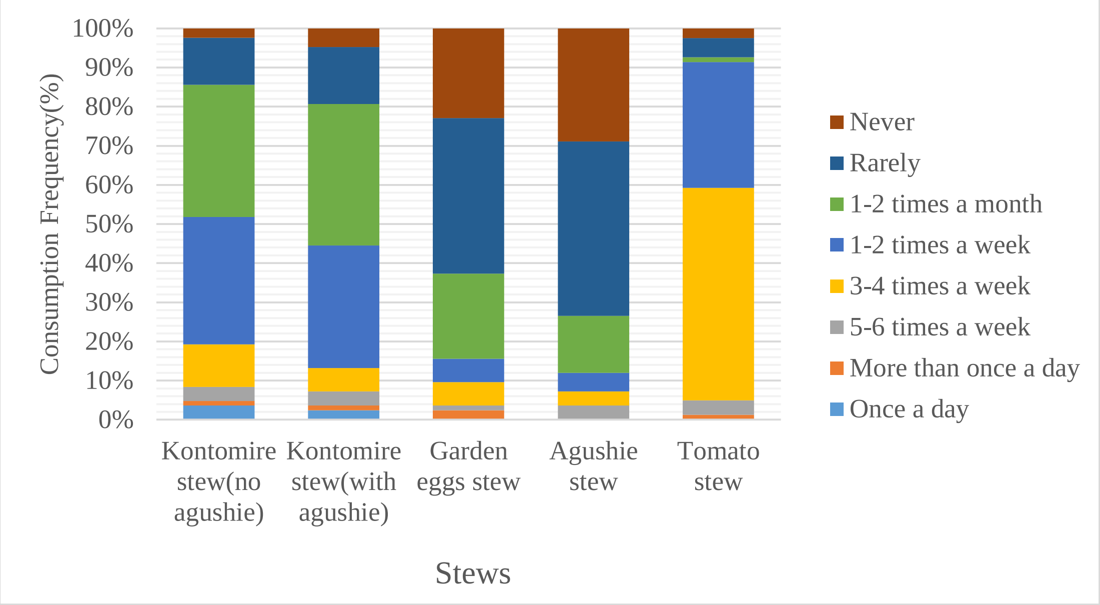
Palm soup, groundnut soup and light soup were consumed 1-2 times a week by 39.8%, 50.6%nand 53.0% of the girls respectively. Okro soup was rarely consumed by 31.3% of the girls.



Frequency of consumption of soups

Frequency of Consumption of Stews

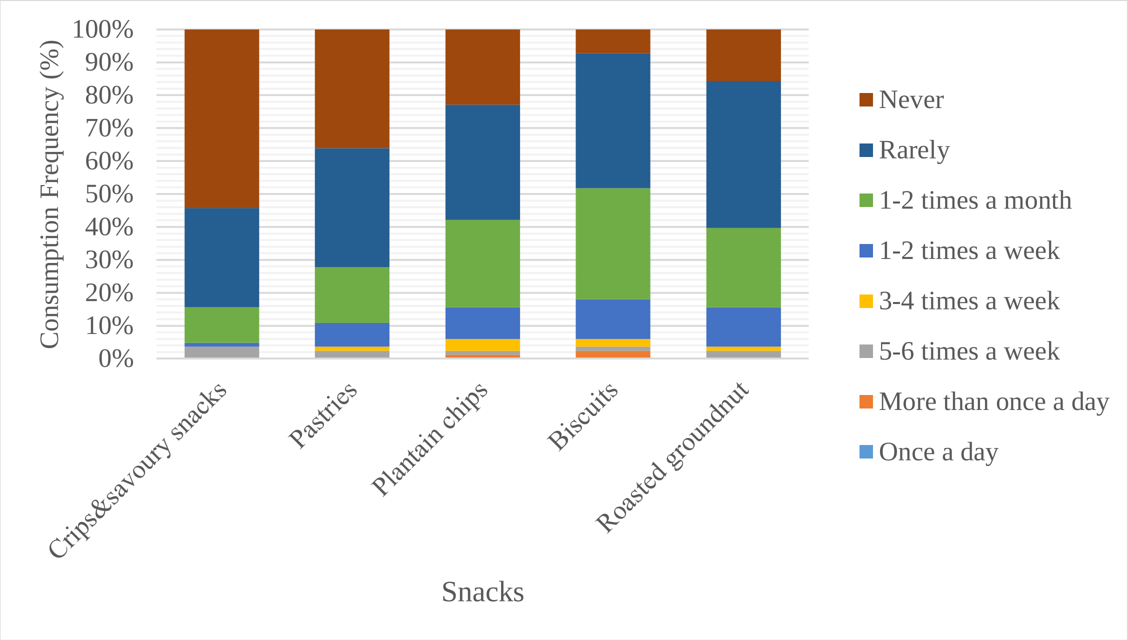
Kontomire (cocoyam leaves) stews with or without agushie (melon seeds) were consumed 1-2 times/month by 36.1% and 33.7% of the girls respectively. The consumption of agushie and garden eggs stews were rare. Tomato stew was consumed at most 3-4 times/week by 53.0% of the girls.



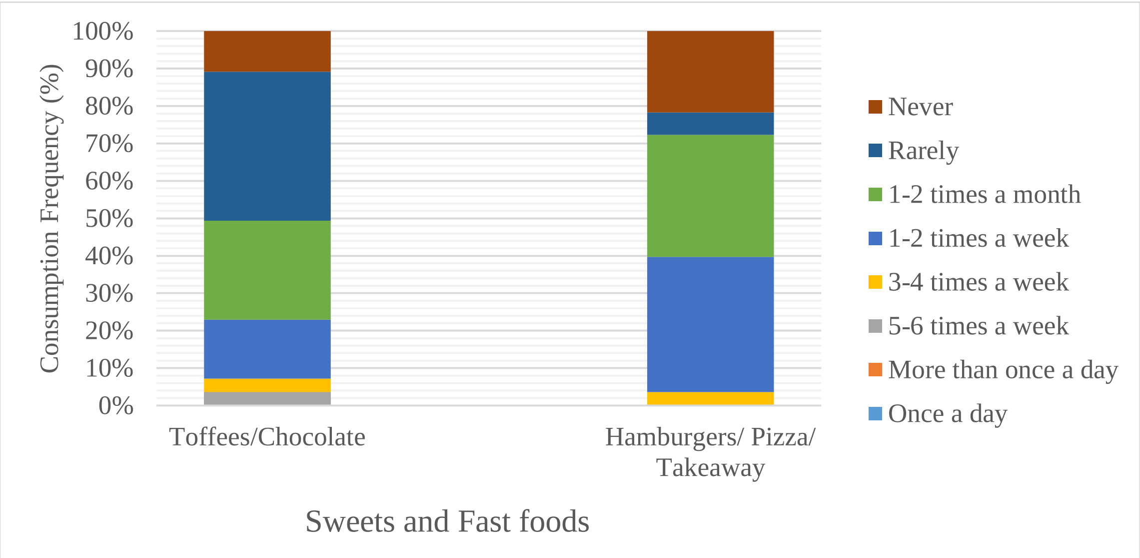
Frequency of consumption of stews

Frequency of Consumption of Snacks, Sweets and Fast Food

No daily consumption of the listed snack foods were observed. Plantain chips and biscuits were the most frequently consumed snacks by 26.5% and 33.7% of the girls respectively (1-2 times/month). Crisps and savoury snacks as well as sweets such as toffee/chocolate were never or rarely consumed by majority of the girls. Fast food including hamburgers, pizza or takeaway were consumed at most 1-2 times weekly by 36.1% of the pregnant adolescent girls.



Frequency of consumption of snacks



Frequency of consumption of sweets and fast foods