UNIVERSITY FOR DEVELOPMENT STUDIES

MATERNAL CHARACTERISTICS INFLUENCING BIRTH WEIGHT AND EARLY CHILDHOOD GROWTH IN THE TAMALE METROPOLIS

ELIASU YAKUBU

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MATERNAL CHARACTERISTICS INFLUENCING BIRTH WEIGHT AND EARLY CHILDHOOD GROWTH IN THE TAMALE METROPOLIS

BY

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(UDS/CHD/0077/12)

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF PUBLIC HEALTH, SCHOOL OF ALLIED HEALTH SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN COMMUNITY HEALTH AND DEVELOPMENT

JULY, 2018

DECLARATION

I hereby declare that, this thesis is as a result of my own efforts and that it has never been submitted anywhere either in part or whole for the award of any degree.

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ELIASU YAKUBU **DATE**

(STUDENT/AUTHOR)

I hereby declare that the preparation and presentation of the dissertation was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

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(H.O.D)

ABSTRACT

Birth weight is used as a measure of maternal health and nutritional status as well as infant growth and survival. Low birth weight and early childhood malnutrition have both been associated with increased mortality and morbidity in children. Despite interventions like the ANC and growth monitoring and promotion by the Ghana Health Service to ensure adequate birth weight and early childhood growth, the prevalence of low birth weight and poor early childhood growth in the Northern Region of Ghana are still very high and unacceptable. The main aim of this study therefore was to identify maternal factors that influence birth weight and early childhood growth in the Tamale metropolis. A retrospective cohort study design was used in the study in which the exposed group was mothers with height <160 cm while the non-exposed group consisted of mothers with height ≥ 160 cm. A systematic random sampling technique was used to select mother-child pairs attending CWC at the Tamale Central and Tamale Teaching hospitals. The study population included mothers with children 12-23 months who were singleton and born to term. In all, four hundred and fourteen (414) mother-child pairs were sampled and included in the study. Hierarchical multiple regression analyses were used to determine the independent predictors of child birth weight, height-for-age Z-scores and growth rate after controlling for confounders. The prevalence of low birth weight and macrosomia among children in the Tamale metropolis were relatively high at 21% and 7.7% respectively while the prevalence of stunting, wasting and underweight were 16.7%, 15.7% and 17.9% respectively. The results also showed significant positive correlations between maternal weight and birth weight ($r = 0.37$, $p < 0.001$), maternal height and birth weight ($r = 0.27$, $p < 0.001$), maternal body mass index and birth

weight (r = 0.32, p < 0.001). After controlling for potential confounding factors, maternal height and gestational weight gain accounted for 13.8 % of the variance in birth weight. Maternal height had a significant positive association with mean height-for-age Z-score (HAZ) **b**ut no effect on growth rate/month. Children of taller (≥160 cm) had 0.18 higher HAZ than those of shorter mothers (<160 cm) (p <0.0001). Children who initiated breastfeeding within 1 hour of birth had mean HAZ which was 0.15 standard units significantly higher than their counterparts who did not [beta = 0.15 (95% CI: 0.17, 0.57)]. The strongest predictor of HAZ was minimum DDS (> 4) with a standardized beta (β) weight of 0.43, p < 0.001. The set of variables accounted for 44.8 % of the variance in mean HAZ (Adjusted R Square = 0.448). Birth order, minimum DDS, age of mother, number of pregnancies, number of under-five children were the most consistent predictors of growth rate of children aged 12-24 months with meeting the minimum dietary diversity of 4 being the highest contributor, F (9, 351) = 32.95, p < 0.001. A number of maternal factors were found to influence the birth weight and growth in the second year of life of children in the Tamale metropolis. Policy makers must therefore take into consideration the influence of these factors in designing and/or modifying health interventions aimed at reducing LBW and poor early childhood growth for maximum impact.

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To my enthusiastic team of data collectors particularly Issah Sumaila Seini, staff of the child welfare clinics of the Tamale Teaching and Tamale Central Hospitals, managements of the two hospitals and the gallant mothers and their children (who served as my study participants) I say to you all thank you for your various forms of support and cooperation which has contributed to the successful conduct of this study. I am grateful.

Finally, I wish to thank the staff of the Graduate school of the University for Development Studies particularly those of the Department of Public Health most especially Mr. Akwasi Boakye Yiadom for their support, guidance and encouragement throughout my study period.

DEDICATION

I wish to dedicate this work to my immediate family which include my wife, Abizari Nasira, my son, Zaidan Danjumah Eliasu and my daughter, Lina Tasallah Eliasu.

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LIST OF ABBREVIATIONS

ACC/SCN	Administrative Committee on Coordination and Sub-Committee on Nutrition of the United Nations
ACOG	American College of Obstetricians and Gynaecologists
ANC	Antenatal Care
BMI	Body Mass Index
CI	Confidence Interval
cm	Centimetres
CWC	Child Welfare Clinic
DDS	Dietary Diversity Score
DHS	Demographic and Health Survey
ENA	Emergency Nutrition Assessment
FAO	Food and Agriculture Organization
g	Grams
g/dL	Grams per Deciliter
GDHS	Ghana Demographic and Health Survey
GHS	Ghana Health Service
HAZ	Height-for-Age Z-Score
Hb	Haemoglobin
HoD	Head of Department
IYCF	Infant and Young Child Feeding
JHS	Junior High School
kg	Kilogram
kg/m^2	Kilogram per Metre Square

LAZ	Length-for-Age Z-Score
LBW	Low Birth Weight
MDD	Minimum Dietary Diversity
MICS	Multiple Indicator Cluster Survey
NGOs	Non-Governmental Organizations
PHC	Population and Housing Census
SD	Standard Deviation
SGA	Small for Gestational Age
SHS	Senior High School
SPSS	Statistical Software for the Social Sciences
STDs	Sexually Transmitted Diseases
STIs	Sexually Transmitted Infections
TIBF	Timely Initiation of Breastfeeding Rate
TMA	Tamale Metropolitan Assembly
UNICEF	United Nations International Children's Emergency Fund
WAZ	Weight-for-Age Z-Score
WHO	World Health Organization
WHZ	Weight-for-Height Z-Score
WLZ	Weight-for-Length Z-Score

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Birth weight according to Jackson and Robinson (2001), is the most measurable outcome of pregnancy. Weight at birth is a powerful predictor of maternal health and nutritional status as well as infant growth and survival (ACC/SCN, 2000; MICS, 2011). Both low and high birth weights have been associated with increased infant mortality and long-term morbidity (Zhang et al., 2008; Mcintire et al., 1999). In addition, both groups of infants are more likely to be delivered through caesarean section. Thus, reducing the delivery of excessively low and high birth weight infants translates into fewer surgical risks for women (Caulfield, Stoltzfus & Witter, 1998). The World Health Organization has defined low birth weight as a weight at birth of less than 2,500g (or 2.5 kg) while Ota et al., (2010) defined macrosomia (high birth weight) as a birth weight of greater than 4000g (4.0 kg). In developing countries and for that matter Africa, the major problem related to birth weight is low birth weight.

Each year, approximately 22 million infants are born with low birth weight in developing countries (UNICEF and WHO, 2004). In sub-Saharan Africa, the levels of low birth weight are around 15% which is more than double the levels in developed countries which are around 7% (Ceesay at al., 1997; ASS/SCN, 2000). The fact that more than half of infants in developing countries are delivered outside the health facilities and so are not weighed suggest that the rates of low birth weight could be under estimated in developing countries (UNICEF and WHO, 2004).

The proportions of low birth weight (LBW) children in the Tamale Metropolis and the Northern Region as a whole have been consistently high. In the MICS (2011) survey, Northern Region recorded the highest proportion of low birth weight children of

11.9% while data from the Northern Regional Health Directorate shows an increasing trend in the proportion of LBW children from 9.2% in 2012 to 9.4% in 2013 to 10.2% in 2014. Data from the Tamale Metropolitan Health Directorate also shows a similar increasing trend in the proportion of children with low birth weight in the Tamale Metropolis from 10.1% in 20 13 to 12.6% in 2014. A study conducted in 2012 also puts the proportion of children with low birth weight in the Tamale metropolis at 17% (Saaka, 2012).

Early childhood malnutrition and poor growth are also said to have both short term and long term consequences and implications for health with long term implications for educational achievement, life-time earnings and the development of human capital (Black et al., 2008). Despite these negative effects of early childhood poor growth, the prevalence of indicators of poor child growth in northern region are still very high and unacceptable even though all the three indicators have recorded marginal decreases comparing the 2008 GDHS and 2014 GDHS figures. Northern Region has the highest prevalence of stunting and underweight in Ghana with figures as high as 33.1% and 20.0% for stunting and underweight respectively which are each almost double the national average figures of 23.7% and 12.7% respectively (GDHS, 2014).

Early childhood growth is very crucial as growth deficit before age two is associated with increased risk of chronic diseases in adulthood. However, the period of a child's most rapid growth and development also happens to be the period of their greatest vulnerability to growth faltering (UNICEF, 2009). It is also now better understood that the period of growth up to around two to three years of age provides a window of opportunity for ensuring adequate growth, development and nutritional status (ACC/SCN, 1993; Grantham-McGregor et al., 1991). Low birth weight children are particularly more vulnerable to faltering growth as they are disadvantaged even before they are born and evidence suggests that such children rarely catch-up in growth (World Bank, 2006; UNICEF, 2009).

This study seeks to determine the relationship between maternal characteristics, birth weight and early childhood growth in the Tamale Metropolis.

1.2 Problem Statement

A reduction in LBW and poor growth in early childhood requires appropriate interventions which are based on proper understanding of factors that influence birth weight and early childhood growth. Despite this, not much work has been done to establish the relationship between maternal characteristics and birth weight as well as early childhood growth in the first two years of life.

Limited evidence has shown that maternal characteristics such as postnatal depression and maternal eating habits influence infant weight gain and may predispose infants to stunted growth. Maternal nutrition is the major fuel for fetal growth (Cetin, 2009). The association between maternal characteristics and child nutritional status has not yet been explored in Northern Ghana, where the prevalence of stunting is high and overall dietary quality is likely to be poor.

This study therefore seeks to assess maternal characteristics that influence birth weight and early childhood growth in the first two years of life in the Tamale Metropolis so as to contribute to a better understanding of the relationship between maternal characteristics and birth weight and child nutritional status.

1.3 Hypotheses

Alternative hypothesis: There is a relationship between maternal characteristics and birth weight and childhood growth in the second year of life

Null hypothesis: There is no relationship between maternal characteristics and birth weight and childhood growth in the second year of life

1.4 Aim and Objectives of the Study

The main aim is to assess the relationship between maternal characteristics and the weight of baby at birth and growth in the second year of life in the Tamale Metropolis.

The specific objectives of the study were;

i. To determine the prevalence of low birth weight and macrosomia in the Tamale Metropolis.
ii. Compare the distributions of two nutritional indexes of children, height-for-age (HAZ) and growth rate, by categories of maternal height.
iii. To assess the infant and young child feeding practices of mothers and their relationship with child growth.
iv. To assess the growth of children less than two years in the study population
v. To identify the determinants of birth weight and early childhood growth.

1.5 Conceptual Framework

Maternal under-nutrition is said to be a major determiner of birth weight while child under-nutrition is said to be a main cause of growth faltering in early childhood (ACC/SCN, 2000; UNICEF, 2009). Both low birth weight and poor child growth can therefore be said to be outcomes of malnutrition which in itself is an outcome of multiple and interrelated factors. Multifaceted and multi-sectorial approaches are needed to deal with the problem of low birth weight and poor child growth as outcomes of malnutrition (UNICEF, 1998).

The conceptual framework used for this study was developed based on the understanding that, both low birth weight and poor child growth are outcomes of under-nutrition. In this model, low birth weight and poor child growth are respectively considered to be caused by maternal under-nutrition through inadequate gestational weight gain and short maternal stature; and child under-nutrition through inadequate weight gain during infancy. Maternal under-nutrition is also considered to be caused by malaria infection during pregnancy, micronutrient deficiency during pregnancy, poor maternal diet quality and physical hard work during pregnancy while child under-nutrition is seen to be caused by maternal under-nutrition and poor maternal infant and young child feeding practices.

Malaria infection during pregnancy, micronutrient deficiency during pregnancy and poor maternal diet quality are in turn seen to be caused by unviable SP dosage during pregnancy, lack/inadequate micronutrient supplementation during pregnancy and low maternal nutrition knowledge respectively while poor maternal diet quality, physical hard work during pregnancy and poor maternal infant and young child feeding practices are also linked to poor maternal economic status. Unviable SP dosage during pregnancy, lack/inadequate micronutrient supplementation during pregnancy and low maternal nutrition knowledge are all considered to be the result of zero/limited ANC/CWC attendance which in turn could be linked to poor maternal economic status.

The figure below represents the conceptual framework of the study showing the various maternal factors and how they each contribute to low birth weight and poor child growth in the first two years of life.

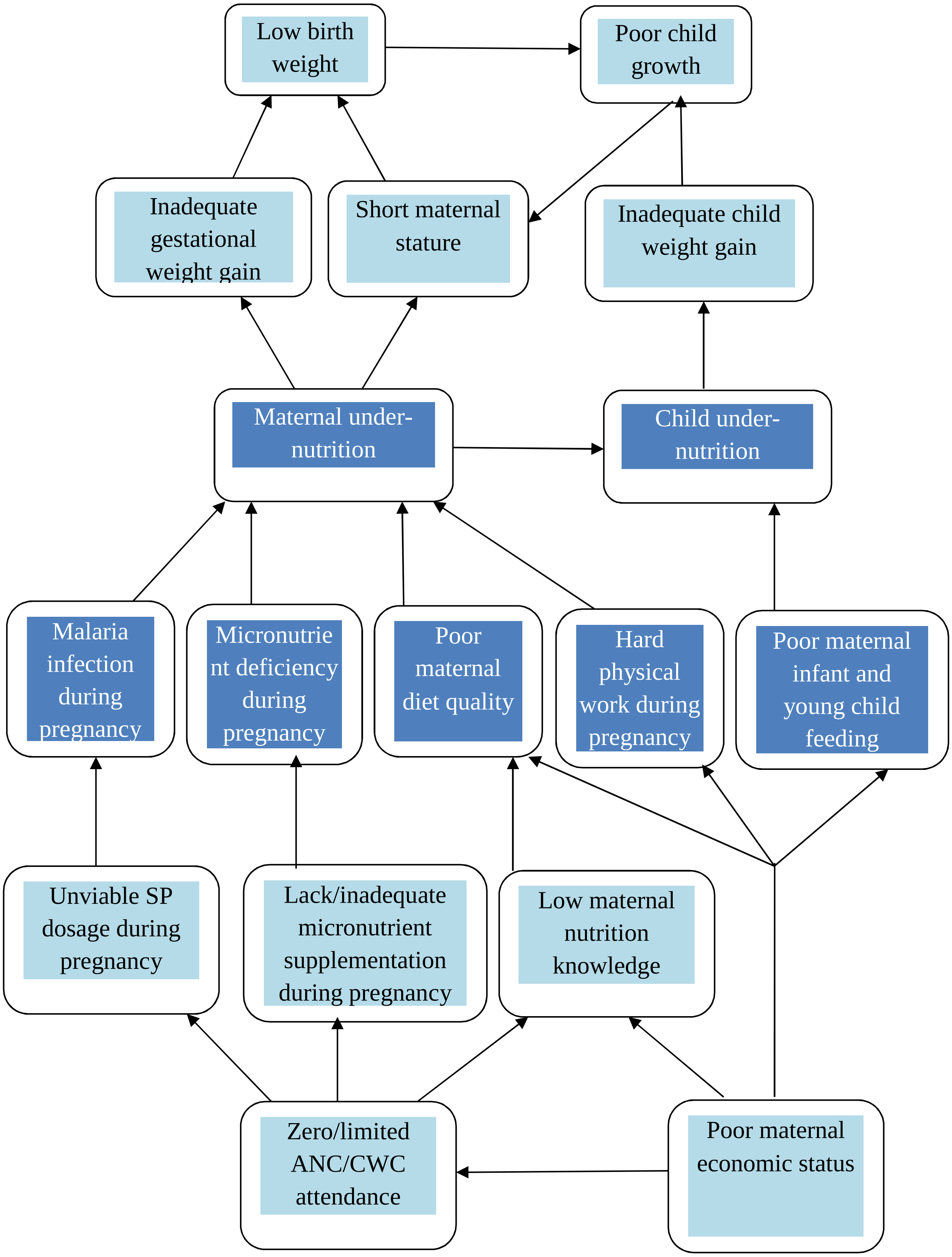


Figure 1.1: Conceptual framework of the study

Source: Author's construct, 2016

1.6 Significance of the Study

The study seeks to provide information on the maternal characteristics that influence birth weight and early childhood growth as there is limited work done on the subject matter in Northern Ghana. The information may inform policy, planning and interventions in the health sector to help deal with the problem of low birth weight and poor childhood growth in Northern Ghana in particular and the country as a whole.

CHAPTER TWO

LITERARURE REVIEW

2.1 Introduction

This chapter reviews literature on facts and findings on various aspects related to the topic of the study as established by other researchers. Some of the headings around which literature was reviewed includes low birth weight and its prevalence; maternal socio-demographic characteristics and birth weight; maternal socio-economic status and birth weight; antenatal attendance and birth weight; child nutritional status and its prevalence; maternal infant and young child feeding practices and child nutritional status; determinants of early childhood growth and the relationship between child birth weight and nutritional status among others.

2.2 Low birth weight and its prevalence

UNICEF AND WHO (2004), defined birth weight as the first weight of the newborn measured after birth within the first hour of birth, before significant postnatal weight loss occurs. According to Jackson and Robinson (2001), the most measurable outcome of pregnancy is birth weight. Weight at birth is also said to be a strong indicator of maternal health and nutritional status as well as infant growth and survival (ACC/SCN, 2000; MICS, 2011; GDHS, 2014). The World Health Organization has defined low birth weight as a weight at birth of less than 2,500g (or 2.5 kg) while Ota et al., (2010) defined macrosomia (high birth weight) as a birth weight of greater than 4000g (4.0 kg). Both low and high birth weights are said to lead to increased infant mortality and long-term morbidity. In Africa and other developing countries, the main problem associated with birth weight is low birth weight (Zhang et al., 2008; Mcintire et al., 1999).

Every year, about 22 million infants are born with low birth weight in developing countries (UNICEF and WHO, 2004). In sub-Saharan Africa, the rates of low birth weight are around 15% which is more than double the rates in developed countries which are around 7% (Ceesay at al., 1997; ASS/SCN, 2000). The fact that majority of infants in developing countries are delivered outside the health facilities where they are not weighed, suggest that the rates of low birth weight could be under estimated in developing countries (UNICEF and WHO, 2004). In Ghana, the prevalence of low birth weight among children under-five was found to be 9.5% (GDHS, 2014).

The proportions of low birth weight (LBW) children in both the Tamale Metropolis and Northern region as a whole have been consistently high. Available data shows that the proportion of low birth weight in Northern region increased from 11.9% in the 2011 MICS survey to 12.9% in the 2014 GDHS survey while data from the Northern Regional Health Directorate also shows a similar increasing trend in the proportion of LBW children from 9.2% in 2012 to 9.4% in 2013 to 10.2% in 2014. Data from the Tamale Metropolitan Health Directorate also shows a similar increasing trend in the proportion of children with low birth weight in the Tamale metropolis from 10.1% in 20 13 to 12.6% in 2014. A study conducted in 2012 also puts the proportion of children with low birth weight in the Tamale metropolis at 17% (Saaka, 2012).

2.2.1 Causes of low birth weight

A number of maternal factors have been identified to influence the birth weight of newborns. According to UNICEF and WHO (2004), there are two main causes of low birth weight in newborns which are preterm birth (birth before 37 weeks of gestation) and intrauterine growth retardation (restricted foetal growth). This study focuses on the intrauterine growth retardation which is said to be relatively common in developing countries by Villar and Belizan, (1982). Many factors related to the mother have been found to greatly affect foetal growth and thus, the birth weight of newborns. Maternal foetal growth and nutrition during pregnancy measured by her body composition at conception and gestational weight gain respectively, have influence on the birth weight of the newborn. Mothers living in deprived socioeconomic conditions have also been observed to frequently have low birth weight infants. High occurrence of specific and non-specific infections during pregnancy, complications and involvement in work that is physically demanding during pregnancy which are all influenced by poverty also contribute to low birth weight of newborns (UNICEF and WHO, 2004).

In a cohort study, Deshmukh, Motghare, Zodpey and Wadhva, (1996) also identified low socioeconomic status, tobacco exposure, short maternal stature, low body mass index, low gestational weight gained, parity, primiparity, low maternal age and anaemia as significant risk factors associated with low birth weight. Closely spaced pregnancies have further been identified to significantly increase the risk of having low birth weight infants (Khoshnood et al., 1998; Shults et al., 1999; Zhu et al., 1999 & Zhu et al., 2001). Maternal educational level and antenatal care have also been found to have significant association with birth weight (Fosu et al., 2013) while adolescent mothers are reported to have as twice the risk of having LBW babies compared with their adult counterparts (Lenders, McElrath & Scholl, 2000). Mother's nutrition, malaria, first birth, and infections such as STDs have also been noted as risk factors for low birth weight (Verhoeff et al., 2001 & Henriksen, 1999).

The Administrative Committee on Coordination and Sub-Committee on Nutrition of the United Nations (2000), further reports that poor maternal nutritional status at conception, low pregnancy weight gain due to low dietary intake during pregnancy and short maternal height as a result of mother's own childhood undernutrition and infections (acute and chronic like STDs and urinary tract infections) as main determinants for low birth weight in developing countries. The GDHS (2014), also reports that the highest proportion of low birth weight children were recorded among teenage mothers (12%), first order births (12%) and mothers with lowest wealth index (11%).

2.2.2 Effects of low birth weight

There are a number of effects, both short-term and long-term including health risk for individuals born small-for-gestational age (SGA) which have been documented (Wilcox & Rusell, 1993). Low birth weight for decades has been used as a measure of poor health among newborns (Currie & Moretti, 2005). It is also well known that infants born small-for-gestational age have higher risk of perinatal morbidity, mortality, and serious developmental outcomes (Bernstein at al., 2000). Infants born with low birth weight start life already disadvantaged and are faced with very poor growth and survival rates (ACC/SCN, 2000). Many low birth weight infants who survive develop neurological and cognitive impairment with a higher risk of morbidity and premature death from cardiovascular disease, hypertension, insulin resistance, impaired glucose tolerance, and type II diabetes mellitus (ACC/SCN, 2000; Hales et al., 1991; Jaquet et al., 2000).

A number of studies have also demonstrated that low birth weight infants have lower scores in different types of test of intellectual and social development (Breslau et al., 1994; Brooks-Gunn, Klebanov & Duncan, 1996). Currie and Hyson (1996), using data from the British 1958 Birth Cohort study concluded that low birth weight was a predictor of lower school attainments, future earnings, and employment opportunities as of age 33, irrespective of the socioeconomic status of the parents. Conley and

Bennett (2000), also indicated that low birth weight decreases the possibility of high school graduation in models with mother fixed effects. Low birth weight is also an intergenerational problem in which low birth weight infants grow to become stunted (undernourished) children and adolescents who ultimately become undernourished women of childbearing age, and eventually become undernourished pregnant women who also deliver infants with low birth weight (ACC/SCN, 2000).

Even before they are born, low birth weight infants are said to be disadvantaged with evidence of limited catch-up growth in them. (The World Bank, 2006). As a result, many low birth weight infants suffer early death in their first month of life which contributing significantly to neonatal mortality rate which now makes up the greater percentage of infant mortality in developing countries (Alderman and Behrman, 2004). UNICEF and WHO (2004), have indicated that epidemiological studies have shown that low birth weight infants have increased risk of up to about 20 times of death compared with heavier babies. ACC/SCN (2000), also indicated that infants who weighed between 2000g-2499g at birth were 4 times more likely to die during their first month of life compared with those who weighed between 2500g-2999g, and were even much (10 times) more likely to die compared with those who weighed between 3000g-3499g. Therefore the reduction of low birth weight also forms an important contribution to the realization of reduced child mortality.

2.3 Maternal nutrition and low birth weight

Maternal under-nutrition has been identified as a key determinant of low birth weight in developing countries (Alderman and Behrman, 2004). Kramer (1987), concluded in his classic review that factors related to maternal nutrition both before and during pregnancy account for majority of cases of low birth weight in many developing countries. Nutritional factors such as maternal low birth weight, short maternal stature, low pre-pregnancy weight, and low gestational weight gain which have all been identified as predictors for LBW are the results of poor maternal nutrition in terms of both quality and quantity during childhood, before conception and during pregnancy (Ramakrishnan, 2004).

Adequate nutrition throughout the lifecycle is critical in breaking the intergenerational cycle of low birth weight. Ensuring recommended feeding practices for good nutrition such as adequate breastfeeding, appropriate complementary feeding and adequate micronutrient status are therefore critical during infancy, childhood and adolescence to promote adequate growth particularly in height as short maternal stature has been found to be a predictor of low birth weight (ACC/SCN, 2000). Good nutrition during pregnancy especially in the second and third trimesters is also crucial for adequate foetal growth which results in adequate weight gain of at least 1 kg per month for a total of at least 6 kg in the last six months as inadequate gestational weight gain has also been associated with high risk of low birth weight (ACC/SCN, 2000). There is therefore the need for us all to ensure a continuum of care during periconceptional period, pregnancy, and lactation periods to ensure the best outcome and newborn health (Roy, 2016).

Maternal nutrition influences foetal growth, gestational weight gain and for that matter birth weight (ACC/SCN, 1992). In a review, Abu-Saad and Fraser (2010), also found significant associations between energy, dietary protein or multi-nutrient supplements and increased birth weight while Kramer (2003), based on his meta-analysis of controlled trials also concluded that the occurrence of small-for-gestational age infants could be reduced by almost one-third with a balanced protein-energy supplements during pregnancy. In the Gambia, a five year randomized controlled trial also reports that, a high energy, antenatal dietary supplement can increase gestational weight gain and reduce low birth weight by more than one-third (35%) while an underweight mother is said to have 30% higher risk of delivering a LBW baby than her well-nourished counterpart (Dharmalingam, Navaneetham & Krishnakumar, 2010).

2.3.1 Intergenerational correlations in birth weight

Poor maternal nutrition often begins in the intrauterine environment and continues throughout the lifecycle as the nutrition of infants contributes greatly to their success as mothers in the future while the nutrition of mothers also influences their infants' nutrition. Thus low birth weight is said to be an intergenerational problem as a vicious cycle emerges to pass on malnutrition from one generation to another under conditions of deprivation as shown in figure 2.1 below. In this, small maternal stature is seen to lead to low birth weight, leading to growth failure in children resulting in small adults forming an intergenerational cycle of growth failure (ACC/SCN, 2000; Martorell, 1998). According to ACC/SCN (1992), the classic trend that emerges in poor countries is that girls born with low birth weight do not only continue to experience growth failure during their childhood and adolescence but are also most likely to become pregnant at an early age and so give birth to low birth weight infants. Low birth weight as a poor birth outcome can therefore put high cost on societies in terms of health care (Almond et al., 2005) and hinder the economic development of a country due to the potential derail of its human capital (Currie et al., 1999; Maluccio et al., 2006; Walker, 2005).

Several studies have documented intergenerational correlations in birth weight. Emanuel et al. (1992), found a significant positive association between the birth weights of infants and birth weights of parents in a cohort study using data on first born children from the 1958 British births. They further added that the relationship between maternal stature and infant's birth weight has been demonstrated in all populations studied, including Blacks, Chinese, Indians, Europeans, and Central American Indians, and Malays.

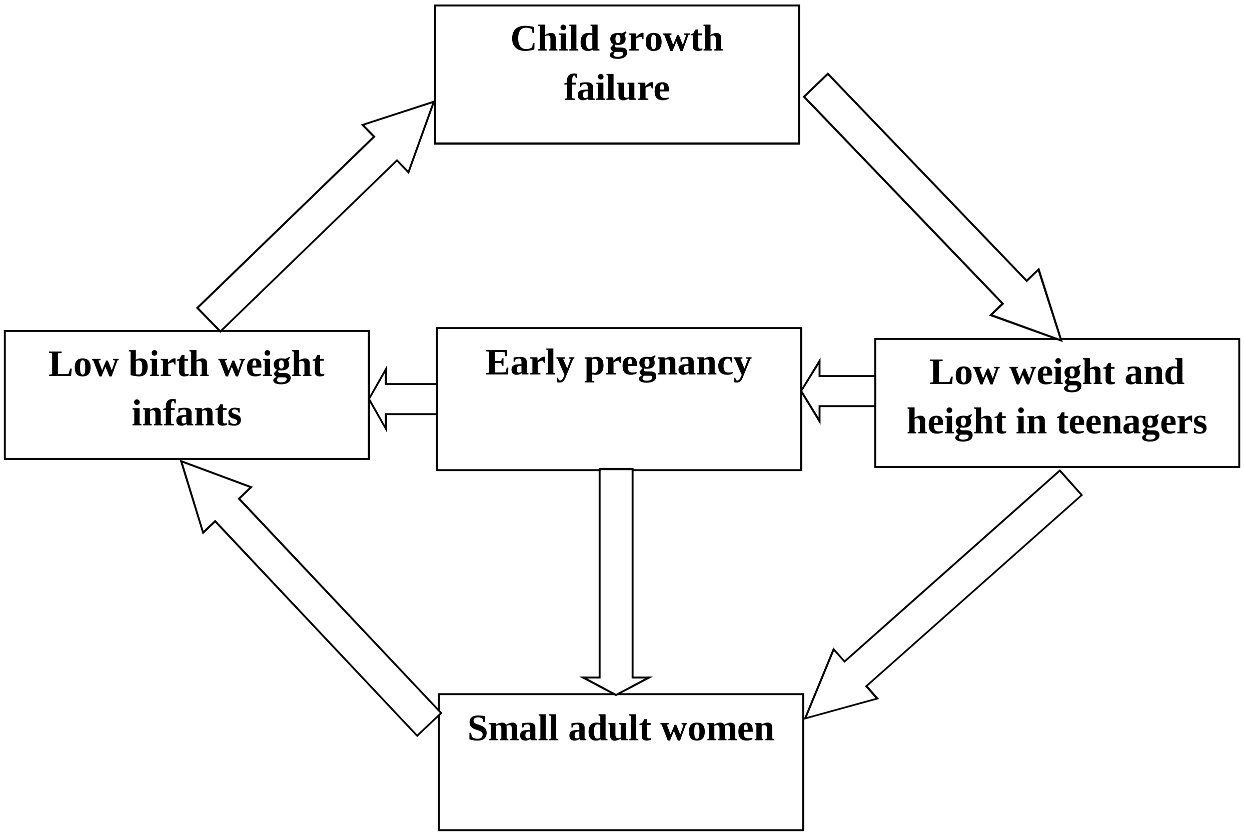


Figure 2.1: Intergenerational cycle of growth failure

Source: ACC/SCN, (1992). Women's nutritional status: Second report on the world nutrition situation. Volume 1: Global and regional results. Geneva.

2.4 Antenatal care and birth weight

Antenatal care is the care received during pregnancy from skilled health personnel (WHO, 2007). It is recommended that pregnant women make at least four ANC visits during their pregnancy (WHO, 1994). Villar et al. (2001), indicated that recent empirical evidence has shown that four ANC visits are enough for pregnancies that are not complicated, and that additional visits are only recommended in cases of complicated pregnancies. According to Radhakrishnan (2010), first ANC visit should be as early as possible in pregnancy. Therefore, the quality of antenatal care depends on a pregnant woman initiating ANC attendance in the first trimester and making at least four ANC visits before delivery.

Prenatal care is one of the well-known public health interventions that help improve birth weight. Antenatal care has been found to be an effective public health intervention tool for reducing the risk of maternal morbidity and mortality especially in places where the general health status of women is poor (Armstrong, 2000). According to Alexander and Korenbrot (1995), antenatal care provides the means of identifying mothers at risk of preterm delivery or intrauterine growth retardation and to provide several recommended nutritional, medical, and educational interventions aimed at preventing the incidence of low birth weight and other undesirable pregnancy outcomes. Antenatal services such as nutrition counseling, iron and folic acid supplementation, tetanus immunization, malaria prevention through the administration of malaria prophylaxis and distribution of insecticide treated bed nets as well as the treatment of STIs help to improve maternal nutrition and lower infections during pregnancy which have been found to increase birth weight. Jeannette et al. (2003), also identified ANC as an opportunity to deliver interventions for improving maternal nutrition as well as providing health education while Swenson et al. (1993), found antenatal care to reduce maternal mortality by improving nutrition.

Antenatal care is said to be one of the recommended interventions to reduce LBW (Merialdi et al., 2003; Zulfiqar et al., 2005). Blankson et al. (1994), also hold the view that, even though many studies have established that women who attend ANC more have better birth outcomes, it is difficult to associate all of the differences observed to antenatal care, even in models like multivariate analysis that control for confounding factors. Krueger and Scholl (2000), have further indicated that, there is no consensus among researchers when it comes to the effect of antenatal care (ANC) on birth weight. Deb and Sosa-Rubi (2005), found that early start of antenatal care had no effect on birth weight, while they found the number of antenatal care visits to have significant positive effect on birth weight. Fosu et al. (2013), further found that one maternal characteristic that had influence on birth weight was antenatal care attendance. The risk of preterm deliveries and low birth weight were also found to reduce with adequate antenatal care (McLaughlin et al., 1992). Coria-Sota et al. (1996 cited in Magadi et al., 2000), further found that fewer number of antenatal care attendance increased the risk of intrauterine growth retardation to about 63%. Studies have also shown that nutrition counseling given during ANC service with the aim of improving energy and protein intake during pregnancy, succeeded in increasing protein intakes and reducing the risk of preterm delivery by 54% (Ota et al., 2012). Antenatal care is therefore a necessary tool for improving birth outcomes by reducing low birth weight and preterm births.

2.4.1 Antenatal care attendance

Despite the positive association between antenatal care attendance and birth weight and other birth outcomes which have been demonstrated by many researchers and the fact that antenatal care is a key strategy to curb maternal mortality and improve birth outcomes, several women in Africa do not receive antenatal care (Simkhada et al., 2008). Unlike in developed countries where prenatal care attendance is around 98%, significant number of expectant women in Africa and Asia are said not to receive antenatal care (Zanconato, Msolomba, Guarenti & Franchi, 2006).

Globally, about 71% of pregnant women are said to use antenatal care while in developed countries 95% of them are said to have access to antenatal care (Lincetto et al., 2006). In sub-Saharan Africa the proportion of pregnant women who receive at least one antenatal care is 67% while in South Asia 54% of pregnant women receive at least one antenatal care before delivery (Lincetto et al., 2006). In Ghana, 97% of all pregnant women are said to receive antenatal care at least once before delivery while 87% of them make the required number of at least four antenatal care visits before they give birth (GDHS, 2014). According to the WHO (2007), antenatal care attendance in developing countries is low at 65 percent as compared to that in developed countries where antenatal care attendance is 97 percent while Ornella et al. (2009), are also of the view that the coverage of antenatal care in Africa is a success as more than two third (69%) of pregnant women make at least one antenatal care visits before delivery.

2.4.2 Determinants of ANC attendance

Several studies have identified a number of factors that influence antenatal care attendance. According to Belay et al. (2006), expectant women who planned their pregnancy are more likely to attend antenatal care in order to ensure healthy birth outcomes than those who did not like their pregnancy. They added that studies of maternal health-care utilization have consistently found that pregnancy that results from a woman's conscious will is an important determinant of using prenatal care. Similarly, Magadi et al (2000), McCaw-Binns et al. (1995), and Raghupathy (1996), also reported a negative association of a pregnancy being unwanted or mistimed with the use of antenatal care. Apparently, such women were less aware of their pregnancy or tried to ignore it for some time, or were actually in circumstances that were less favorable for a pregnancy and for attending antenatal care. It is also said that husband's approval of prenatal care irrespective of his background characteristics increases the uptake of antenatal care significantly (Overbosch, 2002).

The level of education of a pregnant woman and her husband have also been found to have significant positive association with the use of antenatal care (Elo, 1992; Raghupathy, 1996; Becker et al., 1993). Addai (2000), McCaw- Binns et al. (1995), and Wong et al. (1987), further reported significant positive effect of education of the mother on the use of antenatal care. Even though Elo (1992), and Raghupathy (1996), found the correlation between mother's education and the use of antenatal care to be considerably confounded by several factors, including indicators for household living standard and access to health care facilities, they still found significant positive association between mother's educational level and the utilization of antenatal care after controlling for the confounding factors.

Elo (1992), also reported significant positive association between husband's occupation and mother's use of antenatal care services while McCaw-Binnset et al. (1995), also found a significant positive association between antenatal care use and the occupation of the woman and of the main wage earner in the household. Magadi et al. (2000), have also found significant positive association between the ownership of some household amenities and durables and the utilization antenatal care services while Wong et al. (1987), also found some level of positive association between household wealth and income of other household members and the use of antenatal care services. These indicate that the living standard conditions of a pregnant woman to a very large extent influence her use of antenatal care services.

Economic model has also indicated that perceived lower quality and higher costs of antenatal care, including both time and financial costs of treatment and travel would reduce its utilization. Indeed, Acharya and Cleland (2000), Magadi et al. (2000), and Raghupathy (1996), reported a negative effect of distance and/or travel time to antenatal care on its use, while Acharya and Cleland (2000), McCaw-Binns et al. (1995), and Wong et al. (1987), all reported a positive association between the overall quality of antenatal care and mother's uptake of the service. The model used by Wong et al. (1987), is the most detailed as it included factors like treatment costs, waiting time and travel time in the analysis, even though their results are somewhat confusing and do not show the systematic effects of costs. Therefore factors like insurance coverage of antenatal care, which lowers its use costs is important in improving access and utilization of antenatal care services.

Accordingly, Elo (1992), and Raghupathy (1996), have indicated that a higher number of previous pregnancies is associated with less use of antenatal care, while Magadi et al. (2000), and McCaw-Binns et al. (1995), reported a negative association between a higher number of previous pregnancies and early attendance to antenatal care. However, the latter also report that complications experienced during earlier pregnancies have a positive association with early attendance to antenatal care, suggesting that earlier problems with pregnancies make women more aware of the need for antenatal care.

Religion and ethnicity may also influence the attitude of women towards pregnancy and antenatal care, and thus could affect their use of antenatal care services. Addai (2000), reported for Ghana a significant positive association between a pregnant woman being a Catholic and the use of antenatal care, but found a significant negative association between being a believer of traditional religion and the use of antenatal care services, while ethnicity showed no significant effect. However, the study did not include economic variables to explain the use of antenatal care, and religion which might well be correlated with living standard. Raghupathy (1996), also reported a significant negative effect of being a Muslim on the utilization of antenatal care services in Thailand. Several other personal features are included in the above-mentioned studies, some of which showed a significant association with antenatal care use.

2.4.3 Quality of antenatal care

Antenatal care remains one of the interventions among the various pillars of Safe Motherhood that have the potential to significantly reduce maternal morbidity and mortality when properly conducted (World Health Organization,1994). As a result, there is global effort to increase the use of antenatal care services particularly in developing countries to improve maternal health and birth outcomes. However, trends indicate slower progress in sub-Saharan Africa than in other regions, with an increase in coverage of only four percent during the past decade (Lincetto et al., 2006). Many have argued that the quality of antenatal care services is one of the critical factors that seem to impact more in improving maternal health and birth outcome and so influence the use of antenatal services by pregnant women. According to Villar et al. (2001), poor access to basic antenatal care is recognized as a major obstacle to improving pregnancy outcomes, and that there is a growing consensus that access to antenatal care alone is insufficient to alter the present maternal health profile but also the quality of antenatal services may be a key determinant of maternal and perinatal outcomes.

According to the Malawi National Reproductive Health Service Guidelines (2001), quality antenatal care implies the extent to which antenatal care resources and services correspond with antenatal standards of a particular country. Olufemi et al. (2008), are of the view that the attributes of high quality antenatal services includes accessibility, acceptability, effectiveness and suitability for the community as some of the essential ingredients of the primary health care services.

The new WHO guidelines for antenatal care classifies pregnant women into two groups. The first group are those likely to need only routine antenatal care who make up some 75% of the total population of pregnant women while the second group who make up the remaining 25% are those with specific health conditions or risk factors that will require special care. For the first group where majority belong, a standard programme of four antenatal visits is recommended as additional visits are only required when conditions which require special care emerge. The WHO guidelines also specifies the time and content of antenatal care visits based on the gestational age. The guidelines indicate that "only examinations and tests that serve an immediate purpose and that have been proven to be beneficial should be performed". Measurement of blood pressure, testing of urine for bacteriuria and proteinuria, and blood tests to detect syphilis and severe anaemia have been mentioned as examples of such examinations. Routine weight and height measurement at each visit is considered optional. But evidence based programming on the optimal number, timing and content of antenatal visits is not yet routine in most settings.

It is said that essential interventions in ANC include identification and management of obstetric complications such as preeclampsia, tetanus toxoid immunisation, intermittent preventive treatment for malaria during pregnancy (IPT), and identification and management of infections including HIV, syphilis and other sexually transmitted infections (STIs) (Ornello et al., 2009). It is further stated that ANC is also an opportunity to promote the use of skilled attendance at birth and healthy behaviours such as breastfeeding, early postnatal care, and planning for optimal pregnancy spacing (Ornello et al., 2009). This means that where the quality of antenatal care services is high, healthy behaviours and practices such as skilled delivery, early initiation of breastfeeding, exclusive breastfeeding and early postnatal care among others would be improved.

2.5 Anaemia in pregnancy

Anaemia in pregnancy is defined as a haemoglobin (Hb) concentration of less than 11g/dl while severe anaemia in pregnancy is defined as a haemoglobin concentration of less than 7g/dl (WHO, 2001; GHS, 2017). Anaemia during pregnancy is one of the major health conditions of global concern. Globally, about half of all pregnant women which translates to about 56 million pregnant women are said to be anaemic with those in developing countries having greater risk of becoming anaemic than their counterparts in developed countries (Lee & Okam, 2011; Goonwardene, Shehata & Hamad, 2012; Lawson, 1967). In Nigeria, a study among pregnant women attending ANC found that about 20.7% and 2.8% of them were anaemic and severely anaemic respectively (Ogbeide, Wagbatsoma & Orhue, 1994). Mockenhaupt et al. (2000), also found the prevalence of anemia among Ghanaian pregnant women to be 54%. According to the Ghana Health Service, four out of every 10 women are anaemic which means that the figure could even be higher among pregnant women as they are a more vulnerable group with increased risk of becoming anaemic. In India, a study among pregnant women also found the prevalence of anaemia to increase with gestational age, increasing from a prevalence of 13.2% in the first trimester to 28.1% in the second trimester and to 47.0% in the third trimesters (Mayet, 1985).

In terms of pregnancy related complications, anaemia is among the most common ones. Normal physiological changes during pregnancy is said to put higher demand for iron which results into a relative or absolute reduction in Hb concentration (Sifakis & Pharmakides, 2000). Iron deficiency anaemia has been identified as the major cause of anaemia during pregnancy accounting for about three-quarters (75%) of all anaemia cases in pregnancy. This has been linked to poor intake of food and iron/folate supplements during pregnancy (Sifakis & Pharmakides, 2000; GHS, 2017). Malaria, hookworm and other infections also limits the ability of the body to absorb and utilize nutrients needed to make red blood cells which also causes anaemia (Lawson, 1967). Malaria, hookworm and other infections also cause anaemia through blood loss and destruction of the red blood cells (GHS, 2017).

Anaemia in pregnancy results into several poor pregnancy outcomes. Sifakis and Pharmakides (2000), have found that poor pregnancy outcomes such as prematurity, spontaneous abortions, low birth weight and foetal deaths were associated with anaemia with haemoglobin concentration of less than 6 g/dl. Rasmussen (2001), also indicated that there is strong association between maternal haemoglobin levels and weight at birth. Ahmad et al. (2011), have also concluded that maternal anaemia in pregnancy is associated with increased risk of low birth weight deliveries. Imdad and Bhutta (2012), further found iron supplementation during pregnancy to have a significant effect in reducing the risk of anaemia in mothers as well as low birth weight deliveries.

2.6 Socioeconomic status and birth weight

Socioeconomic status is used as an indicator of wealth to measure inequalities in household characteristics. Many studies have found association between maternal poverty and low birth weight, even though such an association does not necessarily translate into causal relationship (Behrman & Mark, 2001). Mothers in deprived socioeconomic conditions are said to deliver low birth weight infants more frequently than privileged ones. Women in poor socioeconomic condition are likely to be undernourished, live in poor housing conditions and are at higher risk of catching infections such as malaria all of which are underpinned by poverty or poor economic status (Tomkins, Murray, Rondo and Filteau, 1993; UNICEF and WHO, 2004). In a longitudinal study in Mexico, Torres-Arreola et al. (2005), concluded that the most important risk factor for low birth weight was socioeconomic level of the mother which was found to be independent of other factors, including reproduction and nutrition factors, morbidity during pregnancy, smoking, accessibility to health services and prenatal care. Spencer et al. (1999), also found in their study that, a significant number of low birth weight infants have significant association with social inequality while the likelihood of being born with a weight of ≥3.5 kg, is significantly higher among the well to do.

Poverty of the mother is said to have an independent effect on the occurrence of low birth weight in babies and that low birth weight in infants is the results of an interaction between maternal low birth weight and poverty (Currie & Moretti, 2005). The GDHS (2014), also found that women in lower wealth index recorded the highest proportion of low birth weight of 11.4%. Low birth weight has also been found to have significant impact on socioeconomic achievement later in life. This means that the intergenerational correlation in low birth weight could contribute in the intergenerational transmission of income as the income of parent affects child's health at birth which also influences future income of the child (Currie & Moretti, 2005). Thus, low birth weight influences socioeconomic status while poor socioeconomic status in turn also influences low birth weight.

2.7 Maternal infection and low birth weight

Maternal infection and inadequate nutrient intake are said to be the two main predictors of intrauterine growth retardation which leads to low birth weight and that the two complement each other to sustain a vicious cycle in pregnancy which result into poor obstetric outcomes including LBW (Roy, 2016). Infection, apart from reducing appetite and dietary intake also affects maternal absorption of nutrient as well. These may result into metabolic stress which will lead to higher maternal nutrient requirement particularly in energy and protein which when not met can precipitate in intrauterine growth retardation (IUGR) (Kramer, 2000). Infections like malaria and urinary tract infections are among the most common infections in pregnancy which many studies have found to increase the risk of low birth weight and other devastating pregnancy outcomes. Urinary tract infections together are said to be the most common complication of pregnancy as pregnancy predispose women to acute upper urinary tract infections (Gilstrap III & Ramin, 2001). Pregnancy also changes the body smell of pregnant women which tends to attract mosquitoes towards them and thus predisposes them to malaria (GHS, 2017)

In areas of Africa where malaria is endemic, up to about 19% of low birth weight deliveries are associated with malaria (Guyatt & Snow, 2004). Another study also found malaria to be associated with 8-36% of preterm low birth weight, 13-70% of IUGR low birth weight and 3-15% of anaemia in pregnancy which in itself has been identified as a risk factor for low birth weight (Steketee, Nahlen, Parise, & Menendez, 2001). Malaria is said to reduce birth weight by either causing malaria induced anaemia or by causing placental infection (Bruce-Chwatt, 1952) which are both thought to cause reductions in birth weight mainly through intrauterine growth retardation (IUGR) (Watkinson & Rushton, 1983). According to Schieve et al. (1994), urinary tract infections increase the risk of low birth weight and preterm low birth weight while Henriksen (1999), and Verhoeff et al. (2001), also indicated that infection such as STDs are noted as risk factors for increased low birth weight. Acute and chronic infections like STDs and urinary tract infections have further been noted as determinants for low birth weight in developing countries (ACC/SCN, 2000).

2.8 Hard physical activity during pregnancy

The importance of physical activity during pregnancy is controversial as it is associated with both benefits and risks (Perkins et al., 2007). For maternal, foetal, and neonatal wellbeing, regular physical activity is recommended for pregnant and postpartum mothers. The recommendation by the American College of Obstetricians and Gynaecolists (ACOG) is for pregnant women to involve in moderate-intensity exercise for a minimum of half an hour on most of the days of the week if not all. Evidence for leisure time physical activity suggests that participation in moderate to intense exercise throughout the period of pregnancy may improve birth weight, while more severe physical activity regimens leads to reduced birth weight (Pivarruk, 1998). Perkins et al. (2007), also found in their study that with low-moderate physical activity level, the adjusted average weight at birth were 100g higher than for those not involved in exercise and that for higher physical activity, the average birth weight increased to 300g higher than for those not involved in exercise.

However, studies have demonstrated that hard manual physical activity during pregnancy has significant association with small-for-gestational age (SGA) babies, lower birth weights and gestational weight gain, especially when energy intake is poor (Launer et al., 1990; Tafari, Naeye & Gobezie, 1980). Pregnant women who engaged in hard physical work and whose energy intake were below 70% of WHO/FAO recommended standards were found to have infants with an average birth weight of 3060±355 (SD)g while infants whose mothers engaged in less physically demanding work but had similar energy intake, had an average birth weight of 3270±368 (SD)g ($p<0.01$). The mothers who were involved in hard physical work also had an average gestational weight gain of 3.3±2.4 (SD)kg which is independent of their infant's birth weight, as against the average gestational weight gain of 5.9±3.3 (SD)kg for mothers who were less engaged in hard physical work ($p<0.001$) (Tafari, Naeye & Gobezie, 1980). Dwarkanath et al. (2007), after adjusting for mother's energy intake and weight found that hard physical activity had significant association with low birth weight in babies in India. A cohort study of rural Indian women many of whom were engaged in high level physical activity related to farming and household work also found a negative association between hard physical work and birth weight.

2.9 Early childhood growth and its effects

Early childhood growth is very crucial as growth deficit before age two is associated with increased risk of chronic diseases in adulthood. However, the period of a child's most rapid growth and development also doubles as the period they are faced with the highest form of vulnerability to growth faltering (UNICEF, 2009). It is also now a common knowledge that the period of growth up to around two to three years of age serves as a window of opportunity to ensure adequate nutrition, growth and development in children (ACC/SCN, 1993; Grantham-McGregor et al., 1991). Low birth weight children are also said to have the greatest form of vulnerability to growth faltering as they are said to be disadvantaged even before they are born and evidence indicates that catch-up growth in such children is rare (World Bank, 2006; UNICEF, 2009).

Early childhood malnutrition and poor growth have both short and long-term effects and implications for health with long-term effect on educational achievement, life-time earnings and the development of human capital (Black et al., 2008; Victora et al., 2008). Longitudinal studies have also demonstrated that in adulthood, the cumulated effects of malnutrition during childhood reduces worker productivity, income, and health (Victora et al., 2008; Hoddinott et al., 2008). The cumulated effects of poor growth are also said to be intergenerational as infants born to mothers who in their early life were themselves stunted (malnourished) are smaller than infants born to mothers who were well nourished in their early life (Villar & Rivera, 1988). Maternal and child under-nutrition together are said to be the cause of more than 30% of deaths among children and as such is the single largest contributor to child mortality as well as constitute over 10% of the total disease burden in the world (Lutter & Champarro, 2008).

Among all the nutrition related factors, stunting, severe wasting and intrauterine growth retardation are said to pose the greatest risk for child death (Black et al., 2008; Jones et al., 2003).

2.9.1 Poor early childhood growth and its prevalence

Birth weight, length/height-for-age, weight-for age, weight-for-length/height and growth rate are the nutritional indicators used in this study to measure childhood growth. Length/height-for-age (LAZ), weight-for-age (WAZ) and weight-for-length/height (WLZ) z-scores of less than -2 standard deviations are indications of growth faltering (or poor nutrition) as they specifically indicate stunting, under-weight and wasting respectively (WHO, 2006). A birth weight of <2.5kg which is considered as low birth weight and the result of intrauterine growth retardation was also used as an indicator of poor growth. Growth rate (g/month) which was calculated based on the following formula below was also used as a growth indicator.

$$Growth\ Rate = \frac{[Current\ weight\ - Birth\ weight\ ](g)}{Age\ of\ Child\ (month)}$$

Close to one-third of the children in the world are said to either be underweight or stunted (The World Bank, 2006) while about the same fraction which translates into

178 million of under-five children in developing countries are said to be too short for their age (de Onis, 2015) while 43% of children in Sub-Saharan Africa are also said to be too short for their age which is the highest prevalence of stunting in the world (Keino et al., 2014). In a study in Western Kenya among children under five, 47% of them were found to be stunted while 30% and 7% of them were respectively found to be underweight and wasted (Bloss, Wainaina & Bailey, 2004).

According to the Ghana Demographic and Health Survey (2014), 18.8%, 4.7% and 11.0% of children under five in Ghana are respectively stunted, wasted and underweight while 33.1%, 6.3% and 20.1% of the children under five in Northern Region of Ghana are respectively stunted, wasted and underweight which are in each case higher than the national prevalence with stunting rate even increasing from 32.4% in 2008 to 33.1% in 2014 (GDHS, 2008; GDHS, 2014). The GDHS, 2014, further determined the prevalence of stunting, underweight and wasting among children 18-23 months in Ghana to be 21.9%, 14.6% and 8.1% respectively. Another study in Northern Ghana also found the prevalence of stunting, wasting and underweight among children 6-23 months to be 20.5%, 11.5% and 21.1% respectively (Saaka et al., 2015).

2.10 Relationship between maternal height and early childhood growth indicators

Maternal height has been found to be a predictor of stunted growth in children (Varela-Silva et al., 2009) while Addo et al. (2013), also identified significant positive association between maternal height and birth weight. Similar findings were also made by Saaka and Abaah (2015), who identified a positive association between maternal height and height-for-age z-score of children. In adjusted models, it was observed that for every 1-cm increase in maternal height there was an associated decreased in the risk of a child becoming underweight, stunting and wasting with children born to mothers with maternal height of less than 145 cm found to have increased risk of about 1.71 times of becoming stunted, underweight and wasted compared with those of mothers with maternal height of at least 160 cm (Subramanian et al., 2009). Christian (2010), after adjusting for confounding factors, also observed the risk of stunting and underweight in offspring to be two-folds higher among short mothers (<145 cm) whereas the risk of wasting was just about 17% higher similar to the findings of Özaltin et al. (2010), who also found that compared with mothers of height of at least 160 cm, each lower height category associated with substantially higher risk of child stunting and underweight but not wasting, with the risk being highest for mothers less than 145 cm tall.

2.11 Optimal infant and young child feeding recommendations

Adequate nutrition particularly from birth to two years of age is critical as the period serves as a window of opportunity to ensure adequate physical, mental, and cognitive growth, health and development (ACC/SCN, 1993; GDHS, 2014). Appropriate infant and young child feeding practices as recommended by the World Health Organization ensures adequate nutrition and promotes proper growth and development in the first two years of life. The World Health Organization recommends among others the following as optimal infant and young child feeding practices;

Early initiation of breastfeeding: It is recommended that breastfeeding is initiated within the first hour of birth. This helps the baby to get the first thick yellowish breast milk called colostrum which is rich in antibodies and nutrients. Colostrum protects the baby as it serves as the first immunization against many diseases (WHO, 2012).

Exclusive breastfeeding: It is recommended that infants are breastfed exclusively with no other food or drink including water for the first six months of life except medications prescribed by a qualified health practitioner. Exclusive breastfeeding ensures adequate nutrition and reduces infections like diarrhea in infants to allow for adequate and proper growth and development within the first six months (WHO, 2012).

Timely introduction of complementary feeding: It is recommended that solid, semi-solid or soft foods are fed to infants starting at six month in addition to breast milk. This is because around six months, an infant's need for energy and nutrients starts to exceed what is provided by breast milk, thus the need for complementary foods to help meet the nutrient requirements of the infant (WHO, 2012).

Continuous breastfeeding: It is recommended that at six months when complementary feeds are introduced, breastfeeding continues for a minimum of two years. During the complementary feeding period, breast milk continues to give a significant amount of energy and nutrients to promote good growth and also helps protect babies from illness (WHO, 2012)

Minimum frequency of feeding: It is recommended that children 6 to 9 months are fed at least two times a day while those 9 to 24 months are fed at least 3 times a day in addition to breast milk. This helps to ensure adequate supply of energy and nutrients from complementary foods to complement that from breast milk to promote adequate growth (WHO, 2012).

Minimum dietary diversity: It is recommended that children 6 to 23 months eat from at least four food groups within a 24 hour period. Dietary diversity is a proxy for adequate micronutrient-density in foods and indicates a high likelihood of consuming at least one animal-source food and at least one fruit or vegetable in addition to a staple food. It therefore measures diet quality (WHO, 2010).

Minimum acceptable diet: It is recommended that children 6 to 9 months eat at least two times and also eat from at least four different food groups in a day while children 9 to 23 months eat at least three times and also eat from at least four food groups in a day. This emphasizes the need for such children to meet both their minimum meal frequency and minimum dietary diversity to ensure diet adequacy in terms of both quantity and quality for proper growth and development (WHO, 2010).

2.11.1 Infant and young child feeding practices in Ghana

Appropriate infant and young child feeding practices promote adequate nutrition in the first two years of life as such feeding practices are said to be the major predictors of nutritional status of children (GDHS, 2014), and is also one of the major causes of poor growth among infants and young children (UNICEF, 2009). In spite of these, many infants are still poorly fed in Ghana and other developing countries even though some little gains have been made.

The practice of early initiation of breast feeding within one hour of birth as recommended by the WHO dropped from 52.3% from the GDHS (2008), to 45.9% in the MICS (2011), which later increased to 55.6% in the GDHS (2014). Exclusive breastfeeding rate at age 4 to 5 months also declined consistently from 49.4% in GDHS (2008), to 45.7% in MICS (2011), and finally to 36% in GDHS (2014), while early weaning of children from breast at age 18 to 23 months increased from 46.6% in GDHS (2008), to 50% in GDHS (2014). According to the GDHS (2014), exactly 71.1% of Ghanaian children 12-23 months were also still breastfeeding with 8.1% of them being fed with feeding bottles. The percentage of children who received prelacteal feeds increased from 18.1% in GDHS (2008), to 18.8% in MICS (2011), which later decreased to 15.1% in GDHS (2014), while timely introduction of complementary foods at age 6 months also reduced from 72.8% in GDHS (2008) to

70.8% in MICS (2011), which later increased to 73% in GDHS (2014). The percentage of children 6-23 months fed from at least 4 food groups within 24 hours also decreased from almost 70% in GDHS (2008), to 46.5% in MICS (2011), which further decreased to below 30% in GDHS (2014). The percentage of children fed the minimum frequency of feeding per day decreased from 45.8% in GDHS (2008), to 43.3% GDHS (2014), while the percentage of children fed with the minimum acceptable diet also decreased consistently from 36.2% in GDHS (2008) to 34.0% in MICS (2011), which further decreased to 13.3% in GDHS (2014). In Northern region of Ghana, the percentage of children 6-23 months who were fed with the minimum frequency of feeding per day and those fed from at least 4 food groups were respectively 45.2% and 17.9% while 41.1% of the children met the minimum acceptable diet (GDHS, 2014).

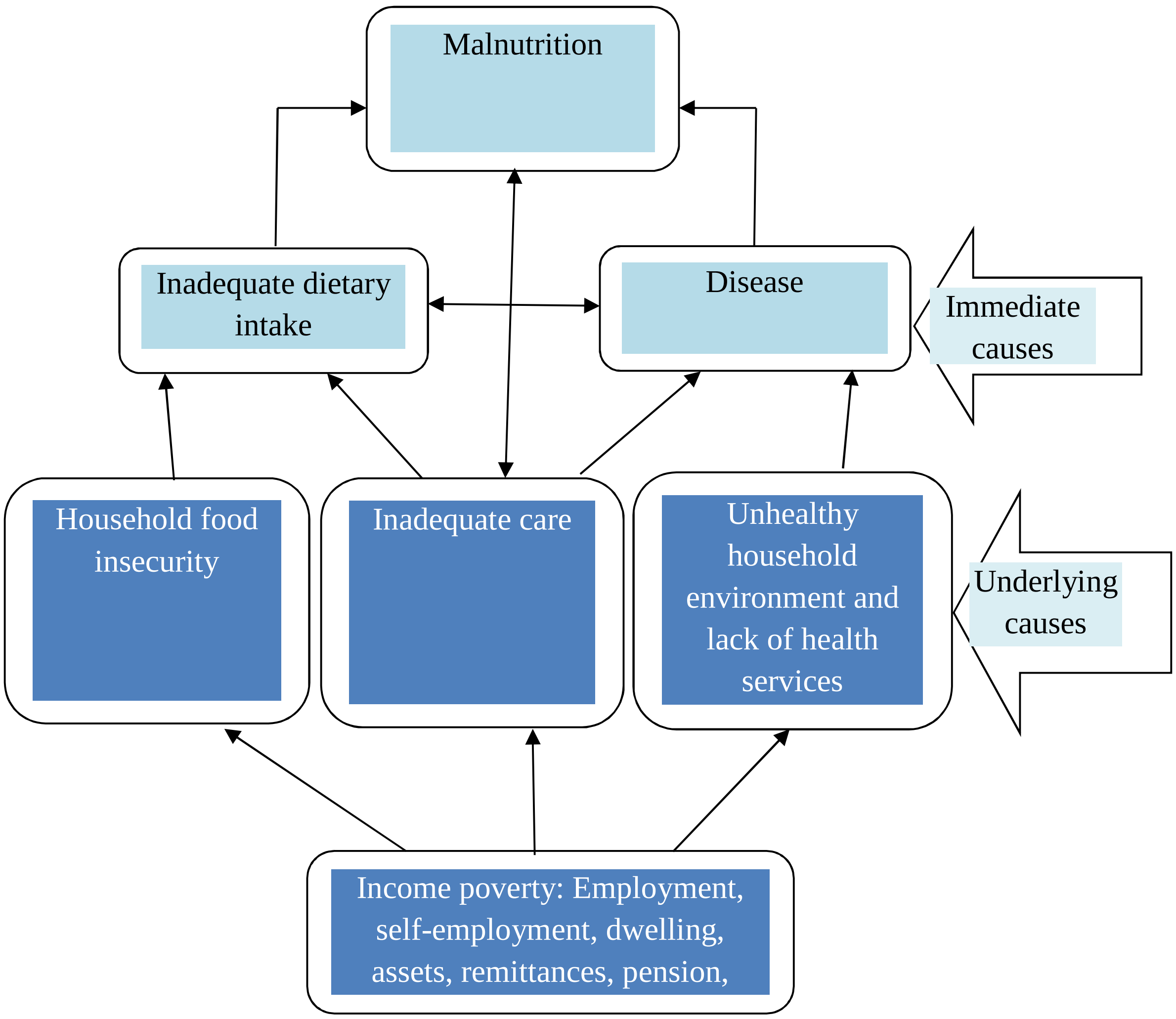
2.12 Factors that influence early childhood growth indicators

Early childhood growth has been found to be influenced by a number of factors. Maternal under-nutrition during pregnancy which leads to foetal growth retardation, and poor infant and young child feeding practices by mothers have been found to be the leading causes of under-nutrition and growth faltering in children less than two years (UNICEF, 2009). Inadequate breast feeding and complementary feeding practices as well as infectious diseases have also been identified as the proximal cause of growth faltering in children (Lutter, 2003; Martorell, Yarbough & Klein, 1980). Poverty and household food insecurity are said to mediate between inadequate dietary intake and poor growth in children (Gibson, Ferguson & Lehrfeld, 1998; Lutter & Chaparro, 2008).

Generally, the prevalence of under-nutrition in rural areas is found to be generally higher than in urban areas (Ghosh & Shah, 2004) while studies in Ghana (Armar-

Klemesu et al., 2000; Monteiro et al., 2010), Brazil (Monteiro et al., 2010), Peru (Ruel & Menon, 2002), and Thailand (Limwattananon et al. 2010) have also identified positive association between higher maternal educational level, better feeding practices and child growth. Rietmeijer-Mentink et al. (2013), made similar finding of association between maternal education and childhood growth while Aheto et al. (2015), also indicated that small size at birth, multiple births, longer breast-feeding duration, experience of diarrhoeal episodes, and poor households as factors associated with increased risk of childhood malnutrition and that increase in mother's educational level and body mass index were rather associated with decreased risk of malnutrition.

UNICEF (1990), in their conceptual model of the causes of malnutrition categorized all the causes of malnutrition into three levels which include the immediate, underlying and basic causes. The immediate causes consist of inadequate dietary intake and disease which affect the individual directly while the underlying causes consist of household food insecurity; inadequate care; and unhealthy household environment and lack of health services which affect the household of the individual. The basic causes also consist of income poverty, lack of capital as well as social, economic and political context which affect the community and country in which the individual lives. All other causes of malnutrition can therefore be classified into the immediate, underlying and basic causes. The basic causes lead to the underlying causes which in turn lead to the immediate causes as indicated in figure 2.2 below.



Malnutrition
Inadequate dietary intake
Disease
Immediate causes
Household food insecurity
Inadequate care
Unhealthy household environment and lack of health services
Underlying causes
Income poverty: Employment, self-employment, dwelling, assets, remittances, pension,

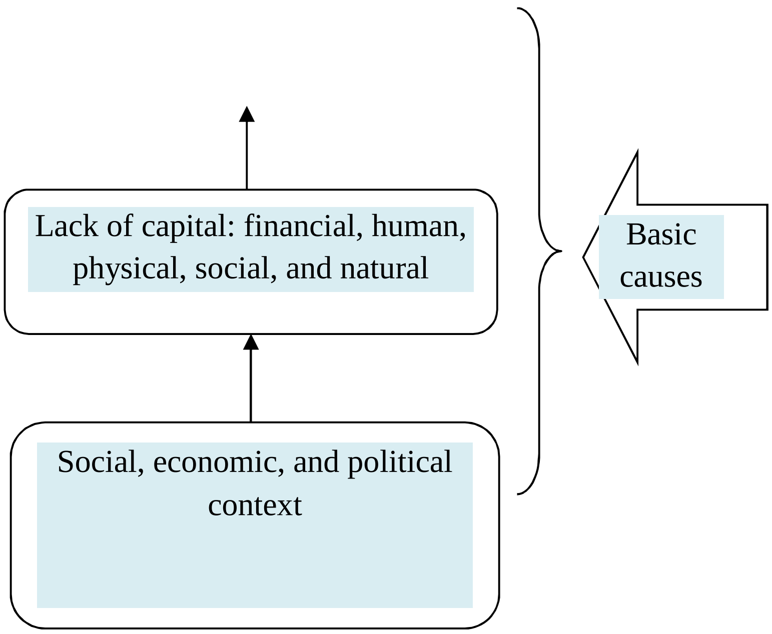


Figure 2.2: Conceptual framework of causes of malnutrition

Source: UNICEF, (1990). Conceptual model of the causes of malnutrition

2.12.1 Factors that influence early childhood stunting

A number of factors related to feeding practices and socioeconomic characteristics of mother and child have been found by different studies to influence linear growth in early childhood in different ways.

A study in Ethiopia identified denial of colostrum, length of breastfeeding, pre-lacteal feeds, food type, age at which complementary food is introduced and feeding methods as the major factors that contribute to stunting in children and thus concluded that bad feeding practices is the main risk factor that leads to nutritional deprivation in children (Teshome et al., 2009). Keino et al. (2014), also found exclusive breastfeeding for the first six months to be an important factor in preventing stunted growth while Saaka and Abaah (2015), also identified bottle feeding to be associated with significant risk of stunted growth. Timely introduction of complementary food between 6-8 months and overall diet quality including having higher dietary diversity score were also found to have significant positive association with height-for-age (Ali et al., 2013; Disha et al., 2012).

In a multiple logistic regression analysis, Saaka et al. (2015), further found that introducing complementary food at the right time reduces the risk of stunted growth by 25% while an analysis of pooled DHS data from 14 low-income countries also identified meeting any of the 8 core IYCF indicators (early initiation of breastfeeding, exclusive breastfeeding for the first 6 months, continued breastfeeding at 1 year, timely introduction of complementary food, minimum dietary diversity, minimum meal frequency, minimum acceptable diet and consumption of iron-rich foods) except minimum meal frequency was found to reduce the risk of a child becoming stunted and underweight (Marriotte et al., 2012).

Factors related to the mother, such as age, educational level, maternal height, large family size and lower socioeconomic status have also been associated with stunted growth (Keino et al., 2014). Black et al. also identified poor living conditions which include low level of education, household food insecurity, unhealthy living environment and poor access to quality health care to have significant association with stunted growth in children. In adjusted models, the likelihood of being stunted or underweight were found to be significantly higher among children from food-insecured households in Bangladesh, Ethiopia and Vietnam (Ali et al., 2013; Tiwari, Ausman & Agho, 2014). Empirical evidence have also demonstrated that, a strong association exist between stunted growth and low level of maternal education, with stunting rates decreasing as levels of education increases (de Onis, 2003). Maternal height of less than 160cm is also said to be associated with increased risk of stunted growth in children (Espo et al., 2002). Similarly, shorter mothers also have increased likelihood of their children exhibiting stunted growth at two years of age compared to mothers of height of at least 160cm (Addo et al., 2013; Hambidge et al., 2014). Saaka and Abaah (2015), further made similar finding that shows increased maternal height was associated with reduced risk of stunted growth in children. In a study in Zimbabwe, higher maternal body mass index was found to lower the risk of stunting while multiple birth was rather associated with increased risk of stunting in children. Among children 6-23 months, the odds of exhibiting stunted growth was found to increase by more than 10% with each additional age in month while LBW children were also found to have higher risk of becoming stunted in early childhood (Mbuya et al., 2010).

The Ghana Demographic and Health Survey (2014), also found children of mothers with lower education to be more likely to be stunted compared with those of mothers with higher educational attainment while children from rural areas and poorest households were also more likely to be stunted compared with those from urban areas and wealthier households respectively. The GDHS (2014), further identified sex of child and size at birth to also influence stunted growth in children with male children at higher risk of become stunted compared with their female counterparts while children who were small at birth were also more likely to become stunted compared with those who were bigger at birth.

Contrary to the above positive associations between height-for-age and various feeding and socioeconomic factors, other studies found negative or no association between some of these factors and height-for-age. Factors related to breastfeeding were found to be associated with increased risk of stunted growth in children (Ali et al., 2013) while prolonged breastfeeding beyond 12 months was also found to be associated high likelihood of stunting in early childhood (Tiwari, Ausman & Agho, 2014). In Ethiopia, exclusive breastfeeding under 6 months was also found to significantly lower the height-for-age Z-scores of children (Disha et al., 2012). Saaka et al. (2015), also found that none of the WHO recommended IYCF indicators including bottle feeding, minimum dietary diversity, minimum meal frequency and minimum acceptable diet were associated with linear growth except timely initiation of complementary feeding at six months similar to the findings of another study in Mumbai which found no association between LAZ scores and the achievement of any of the eight indicators for infant and young child feeding practice recommended by the WHO (Bentley et al., 2015).

2.13 Relationship between birth weight and early childhood growth indicators

Birth weight is said to be a powerful indicator of growth and survival in infants (ACC/SCN, 2000; MICS, 2011) and that low birth weight children are found to have higher vulnerability to faltering growth as they are said to be disadvantaged even before they come into the world and there are evidence to the effect that catch-up growth in such children is rare (World Bank, 2006; UNICEF, 2009). Most studies have also found stunting to be high in preterm and/or small for gestational age children (Knops et al., 2005). The birth weight of children was found to have positive association with linear growth at age two years (Silva et al., 2002) similar to the findings of Varela-Silva et al. (2009), who also found birth weight to be a determinant of stunted growth. Binkin et al. (1988), further indicated that a strong predictor of weight and height in early childhood is birth weight, and it’s applicable to all infant whether born with low birth weight, normal or high birth weight as more infants with lower birth weights were found to stunted and underweight throughout childhood, especially those who were small for gestational age rather than premature.

Aheto et al. (2015), further identified low birth weight to be associated with high risk of malnutrition in early childhood similar to the findings of the GDHS (2014), which also found children with low birth weight to have increased risk of being stunted, wasted and underweight compared with those who were born with normal birth weight. Saaka and Abaah (2015), however identified a positive association between weight at birth and stunting in children and suggested that low birth weight babies probably gained weight and height faster than normal birth weight babies.

2.14 Summary of literature review

The review of literature revealed that a number of studies have been conducted in the area of determinants of birth weight and early childhood growth even though no study was found to have looked at the determinants of birth weight and early childhood growth together in one study. Most of the works reviewed were conducted outside Ghana with very few found to have been conducted in Ghana and in the Northern Region of Ghana which means that more research needs to be conducted on the determinants of birth weight and early childhood growth in Ghana particularly in the Northern Region to better understand the determinants of birth and early childhood growth in Ghana and the Northern region to inform policy direction.

The review also revealed that there is more consistency in the findings of researchers on the determinants of birth weight than there is in the findings on the determinants of childhood growth indicators (stunting, underweight and wasting) which are rather mixed findings. Additionally, the review revealed that in terms of the relationship between maternal height and childhood growth indicators, most of the studies focused on the relationship between maternal height and stunting while few and very few of the studies reviewed looked at the relationship between maternal height and underweight and wasting respectively. These further indicate research gaps that need to be studied more to better understand the relationship between maternal height and growth indicators in Ghana particularly in the Northern Region of Ghana.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was conducted in the Tamale Metropolis which is one of the 26 districts of the Northern Region of Ghana. The Metropolis shares boundaries with the Sagnarigu district to the North and North-West, East and West Gonja districts to the South and West respectively and Mion district to the East. Tamale metropolis occupies approximately 1011 square kilometers of land that is 13% of the total land area of the Northern Region. Although the capital has attained a metropolitan status, the geographical setting still has a blend of typical rural communities embedded within the urban settlements. The Metropolis has a total of 267 communities made of both rural and urban communities (TMA, 2012).

Tamale has a projected population of 263,082 based on the 2010 population census regional growth rate of 2.9% with a population density of 261 persons per square kilometer which is over 10 times higher than the regional average density of 25.9 persons per square kilometer. There exists a vast difference between the densities of the urban and rural settlements in Tamale. This is an indication of movement into urban Tamale, giving credence to the assertion that facilities and opportunities for modern employment are concentrated in few localities (TMA, 2012).

Most of the inhabitants are mainly Dagombas with minority groups from the other two Northern Region (Upper East and Upper West). Tamale, the capital of the metropolis is also noted for good number of settlers from Burkina Faso, Mali and Niger. Most of the inhabitants are Muslims. Roman Catholic population remarkably dominates over other denominations of Christianity. African traditional religion is still practiced by a handful of people in the metropolis.

3.1.1 Vegetation

The Metropolis has a vegetation cover which is typical of a guinea savanna zone with tall grasses interspersed with drought resistant tress such as nim, sheanut, parkia and mahogany. During the rainy season, the vegetation becomes luxuriant providing green scenery (TMA, 2012).

In the dry season however, water becomes scarce as a result of poor vegetation cover that leads to the evaporation of water from the water bodies. The grasses also dry up and the bush fires that accompany it destroy the soil nutrients and also expose the soil to serious erosion. The crops cultivated include maize, rice, sorghum, millet, cowpea, groundnuts, soya bean, yam and cassava. The animals reared include goats, sheep, chicken, guinea fowls and cattle. However the crops and animals are reared mostly in the peri-urban rural areas. There is one major forest reserve in Tamale, located at Sinsab-gi-gbini. Other forest plantations include the Water Works Plantation, Kogni fuel wood Plantation and Ministry Of Food And Agriculture Area Fuel Wood Plantation (TMA, 2012).

3.1.2 Climate

The Metropolis experiences one rainy season from April/May to October, with peak in July/August, which is influenced by the South-west monsoon winds and a long dry season (November to March) influenced by the north-east trade winds from the savanna desert. It records a mean annual rainfall of 1100 mm with only 3 months of intense rainfall. Average maximum and minimum temperatures ranges between 20^0C to 39^0C respectively (TMA, 2012).

3.1.3 Food Consumed

In both the urban and peri-urban areas, maize based porridge or tea is taken at breakfast whist "tuo-zaafi" (TZ) is usually the meal taken at supper. In these areas, lunch is not usually prepared at home hence the people choose from a wide variety of foods available. In the rural areas, TZ is usually the lunch and supper meal with a maize or guinea corn-based porridge at breakfast (TMA, 2012).

3.1.4 Occupation

The main categories of occupation of the people of Tamale are agriculture, sales and services, professional/technical/managerial, clerical, skilled and unskilled manual work (GDHS, 2008). However, agriculture is the main occupation of the people with almost all the people involved through the, practice of subsistence agriculture. Majority of the people in the agricultural sector are women in the peri-urban and rural areas and those who have never been to school. Majority of the women in the urban area and those who have had secondary or higher education levels are engaged in sales and services and non-agricultural occupations respectively. Very few women are into professional/technical/managerial and clerical work (GDHS, 2008).

Men are more into agricultural and skilled manual work. In addition, the number of men who are into professional/technical/managerial, clerical and unskilled manual work out number the women (PHC, 2000).

3.1.5 Health administration

Health administration in the metropolis is done by the Metropolitan Health Management Team (MHMT) which is responsible for the overall planning, implementation, monitoring, supervision, evaluation, training and co-coordination of all health issues and programmes in the Metropolis. It is also responsible for conducting operational research and linking up with other agencies and NGOs in health provision and promotion and report administratively to the Metropolitan Chief Executive (MCE) and technically to the regional Director of Health Service. For effective health administration, the metropolis is divided into four sub-districts namely Bilpeila, Nyohini, Tamale Central and Vitting sub-districts which have Sub-district Health Management Team each, responsible for programme planning and implementation of health activities in communities under their catchment area. Key among the health activities the sub-districts conduct in their communities include integrated static and outreach activities, immunization, reproductive health, disease control, growth monitoring and promotion, health education/promotion and clinical care. They also conduct training and supervision of community based health workers such as traditional birth attendants (TBAs), Community Based Surveillance (CBS) volunteers, village Health Committees (TAM, 2012; TMHD, 2017).

The sub-district health staff deliver health services at the community with the support of traditional birth attendants (TBAs), Community Based Surveillance (CBS) volunteers and village Health Committees. The metropolis has 36 health facilities which deliver health care to the people of the metropolis and beyond. They include the Tamale Teaching Hospital and eight (8) other hospitals (including 5 private and 1 CHAG hospitals), five (5) health centres, six (6) clinics and seventeen (17) functional CHPS zones out of which only eight (8) have physical structures. The metropolis also has one (1) nutrition rehabilitation centre and two (2) private maternity homes (TAM, 2012; TMHD, 2017).

3.2 Study Design

A retrospective cohort study design was used in the study which allowed for data to be collected on both past and present events on the subject matter which was used in the analysis to establish existing relationship between maternal characteristics and birth weight and early childhood growth. The exposed group was mothers with height <160 cm while the non-exposed group consisted of mothers with height (≥ 160 cm).

3.3 Study Population

The study population included mothers with children from 12 to 24 months of age.

To qualify for recruitment, the mother's last delivery should be full term (≥ 37 weeks gestation) single live birth.

3.4 Sample Size Determination

The sample size for this study was calculated using Pocock's formula for sample size for dichotomous or continuous response as follows:

$$n= \frac{D[(Z\alpha+Z\beta)^2 \text{ X } (P1(1-P1)+P2(1-P2)]}{(P2-P1)^2}$$

KEY:

- n = required minimum sample size per survey round or comparison group
- D = design effect (assumed in the following equations to be the default value of 2)

- P1 = the estimated level of an indicator measured as a proportion at the time of the first survey or for the control group (non-exposed)
- P2 = the expected level of the indicator either at some future date or for the exposed group such that the quantity (P2 - P1) is the size of the magnitude of change it is desired to be able to detect
- Zα = the Z-score corresponding to the degree of confidence with which it is desired to be able to conclude that an observed change of size (P2 - P1) would not have occurred by chance (α - the level of statistical significance), and
- Zβ = the z-score corresponding to the degree of confidence with which it is desired to be certain of detecting a change of size (P2 - P1) if one actually occurred (statistical power).
- Zα and Zβ have “standard” values depending on the reliability desired.
- In this study , Zα will be 1.96 and Zβ = 0.842

Where D, design effect = 2

- $Z\alpha = 1.96$
- $Z\beta = 0.842$
- $P_1 = 0.4$ (estimated to be 40%)
- $P_2 = 0.6$ (estimated to be 60%).

Inserting the above figures into the formula, the sample size is calculated as follows;

$$n = \frac{2[(1.96 + 0.842)2 \times (0.4\,(1 - 0.4) + 0.6\,(1 - 0.6)]}{(0.6 - 0.4)2}$$

$$n = \frac{2[(7.851204) \times (0.24+0.24)]}{(0.04)}$$

$$n = \frac{7.53715584}{0.04} = 188.43 = 188$$

Therefore 188 mother-child pair was sampled each from the exposed and control groups giving a total of 376. An attrition value of 10% (38 mother-child pair was added to make the total sample size of 414 mother-child pairs.

3.5 Sampling Techniques

A systematic random sampling technique was used to select mother-child pairs at CWC clinics in the district. The sampling technique was used to select lactating women attending (CWC) at the Tamale Central and Tamale Teaching hospitals. The active registrant in the CWC register at each hospital was used as the sampling frame which was divided by the number of mother-child pairs to be sampled from the hospital to determine the sampling interval used as the skip pattern during the selection process.

3.6 Type of Data collected

Both primary and secondary data were collected for analysis in the study. The primary data was the main data that was collected on background information, maternal household food security, economic status, ANC/CWC attendance, maternal infant and young child feeding practices, and maternal and child nutritional status. Secondary data was also collected from the Tamale Metropolitan Assembly on the population size, vegetation, occupation and foods consumed in the metropolis as well as the data on maternal Hb, gestational weights, birth weight and number of ANC attendance which were extracted from health records of mothers through their ANC books.

3.7 Data Collection Techniques and Tools

The main techniques of data collection included questionnaire administration, anthropometric measurements, and observation. Questionnaire administration was used to collect data on background information, maternal household food security, economic status, ANC/CWC attendance, and infant and young child feeding practices among others. Anthropometric measurements was also used to collect data on the weight and height of children and their mothers while observation was used to collect data on housing type to help determine maternal household economic status.

The main tools that were used in the data collection included a semi-structured questionnaire, an infantometer, a microtoise and a Seca-uni scale. The semi-structured questionnaire was used to collect data on background information, maternal household food security, economic status, ANC/CWC attendance, maternal infant and young child feeding practices among others. The infantometer and microtoise were used to collect data on the length and height of children and mothers respectively while the Seca-uni scale was used to collect data on the weight of children and their mothers.

3.8 Dependent and Independent Variables

The dependent variables in the study were the nutritional status of the children12-24 months of age which were measured by weight-for-age, height-for-age and weight-for-height, growth rate and birth weight of children.

The independent variables among others were:

i. Socio-demographic variables including maternal educational level, age, marital status, religion and wealth index
ii. ANC/CWC attendance
iii. Height of mother
iv. Gestational weight gain
v. Gestational age at delivery
vi. Parity
vii. Hb levels during pregnancy
viii. Maternal BMI
ix. Number of under-five children
x. Infant and young child feeding practices of mothers (including initiation of breastfeeding, giving prelacteal feeds, giving colostrum, timely introduction of

complementary foods, dietary diversity score, minimum frequency of feeding and minimum acceptable diet of children).

3.9 Recruitment and Training of Research Assistants

For effective and successful study, two (2) research assistants were engaged during the data collection. These were people who had exposure and experience in both qualitative and quantitative research including data collection techniques, ethical consideration and research procedures. In addition, they were also given special training on the purpose and focus of this study with emphasis on the tools used in the study to help them better understand all the issues related to this study and how to properly use the various data collection tools to ensure good, quality work on the field.

There was a pre-test session as part of the training for the research assistants to help test their ability to collect the needed information as well as the appropriateness and accuracy of the questionnaire and other data collection tools to collect the required information to allow for amendments and standardization of the tools and procedures before the actual data collection begun.

3.10 Data Analysis

The anthropometric data was entered into Emergency Nutrition Assessment (ENA for SMART 2011) for analysis. WHO reference means (WHO flags) was used and data that fell outside the range were excluded. The results (Z-scores) were then transported into excel, copied and added to the main and final SPSS data set for further analysis.

All other primary data apart from anthropometric data collected were first cleaned manually and then entered into computer software known as Epi-info (version 3.4.1). The data was then imported into Statistical Package for the Social Sciences (SPSS) version 18 using start transfer and analyzed with Statistical Package for the Social

Sciences (SPSS). Bivariate analysis was done to establish associations between the dependent variables and some collected independent variables. Correlation analysis was used to determine relationships between birth weight and some selected variables while hierarchical multiple regression analyses were used to determine the independent predictors of child birth weight, height-for-age Z-scores and growth rate after controlling for confounders.

Pearson chi-square test was performed to test the statistical significance of associations between variables at a significance level of $p<0.05$.

Analyzed data are reported in frequencies, percentages and means and presented in frequency distribution tables and charts.

3.11 Ethical Consideration

Permission was sought from the Ghana Health Service (Tamale Metropolitan Health Directorate) and the managements of the Tamale Central and Tamale Teaching hospitals where the participants were recruited before the commencement of data collection. Participation in the study was voluntary as consent was sought from mothers of all selected children for them to either agree or disagree to be part of the study. Children whose mothers agreed to be part of the study were included in the study while those whose mothers declined to be part of the study were exempted from the study. In seeking for mothers' consent, the purpose of the study was explained to mothers as being purely for academic purpose as well as the relevance of their participation in the study. Mothers were assured of confidentiality while the anonymity of participants was also guaranteed. Mother who eventually agreed for their children to be part of the study were made to sign or thumb print an informed consent form before the commencement of each interview session.

CHAPTER FOUR
RESULTS

4.1 Introduction

This section presents the findings of the study. It covers findings on the socio-demographic characteristics of the respondents, prevalence of low birth weight and macrosomia, nutritional status of mothers and children, maternal household food security, infant and young child feeding practices of mothers, diet quality of mothers and children, maternal gestational weight gain, maternal antenatal clinic and child welfare clinic attendance as well as the relationships between these maternal characteristics and birth weight, monthly growth rate and nutritional status of children among others.

4.2 Socio-demographic characteristics

Table 4.1 compares the details of the socio-demographic characteristics of the respondents in the study groups. The baseline characteristics of the study participants in the study groups were significantly different with respect to age distribution of the children and the frequency of ANC visits during previous pregnancy. The study group of mothers of height ≥160 cm had a significantly higher proportion of women who initiated ANC in the first trimester of pregnancy compared with those of height <160 cm. A greater proportion of higher household wealth index were mothers whose height was ≥160 cm. The greater proportion of women who were also married were those with height ≥160 cm.

Table 4.1: Comparison of socio-demographic characteristics by study groups (N =414)

		Study Groups		
Variable		Maternal height < 160 cm	Maternal height ≥160 cm	Test Statistic
Age of mother (years)		n (%)	n (%)	
Under 25	86	38 (44.2)	48 (55.8)	χ^2 = 1.8 , p = 0.4
25-34	225	92 (40.9)	133 (59.1)	
35^+	103	36 (35.0)	67 (65.0)	
Maternal education				
None	118	54 (45.8)	64 (54.2)	χ^2 = 3.2 , p = 0.2
Low (Primary & JHS)	129	53 (41.1)	76 (58.9)	
High (At least SHS)	167	59 (35.3)	108 (64.7)	
Marital status				
Married	410	162 (39.5)	248 (60.5)	χ^2 = 6.0 , p = 0.03
Single	4	4 (100.0)	0 (0.0)	

Religion				
Islam	363	144 (39.7)	219 (60.3)	$\chi^2 = 0.2$,
Christianity	51	22 (43.1)	29 (56.9)	$p = 0.6$
Trimester of first ANC visit				
First	340	124 (36.5)	216 (63.5)	$\chi^2 = 10.4$,
Second	74	42 (56.8)	32 (43.2)	$p = 0.001$
Frequency of ANC visits				
Less than 4	48	20 (41.7)	28 (58.3)	$\chi^2 = 0.6$,
At least 4	366	146 (39.9)	220 (60.1)	$p = 0.8$
Classification of parity				
Primiparous	122	59 (48.4)	63 (51.6)	$\chi^2 = 5.8$,
Secundiparous	123	49 (39.8)	74 (60.2)	$p = 0.05$
Multiparous	169	58 (34.3)	111 (65.7)	
Classification of wealth index				
Low	209	109 (52.2)	100 (47.8)	$\chi^2 = 25.5$,
High	205	57 (27.8)	148 (72.2)	$p < 0.001$

Source: Field survey, 2016

4.3 Nutritional status and the infant and young child feeding (IYCF) practices

The nutritional status and dietary practices of children are presented in Table 4. 2. The negative z-scores for the entire study population indicate that the children in the study sample are less well-nourished relative to the WHO standard population. The prevalence of low birth weight and macrosomia among children were 21% and 7.7% respectively. The prevalence of chronic, acute and underweight was 16.7 %, 15.7 % and 17.9 % respectively. Less than 10 % of the babies had macrosomia (birth weight > 4000g).

The mean dietary diversity score (DDS) was 4.25±1.10 and less than 80.0 % of the children met the minimum dietary diversity (≥ 4 food groups). Children who met the acceptable diet and also started complementary feeding at six months were considered to have appropriate complementary feeding. Therefore, the overall appropriate complementary feeding prevalence was only 35.7 %.

Most of the mothers gave their new born babies colostrum and did not give anything to the babies before the initiation of breastfeeding. More than half of the respondents introduced complementary foods to their children at six (6) months.

Table 4.2: Nutritional status and dietary intake of children under-two years (n = 414)

Characteristics	Mean ± SD	Frequency (n)	Percentage (%)
Nutritional status			
Birth weight (g)	3,044.2±564.6		
Monthly growth rate ((g/month)	383.0±76.4		
Height-for age-z-score (HAZ)	-0.93±1.26		
Weight-for-height-z-score (WHZ)	-0.84±1.23		
Weight-for-age-z-score (WAZ)	-1.05±1.14		
Birth weight categories (kg)			
< 2.5		87	21.0
2.50-3.99		295	71.3

At least 4		32	7.7
% Stunted (HAZ < -2)		69	16.7
% Wasted (WHZ < -2)		65	15.7
% Underweight (WAZ < -2)		74	17.9
Currently breastfeeding		394	95.2
Timely initiation of breast feeding within one hour		219	52.9
Bottle feeding in the past 24 hours		26	6.3
Pre-lacteal feeding		16	3.9
Introduction of complementary foods at 6 months		219	52.9
Child received colostrum		398	96.1
*Minimum meal frequency (children aged 12 – 23 months)		274	66.2
*Minimum dietary diversity (≥ 4 food groups)		297	71.7
*Minimum Acceptable diet (children aged 6 – 23months)		266	64.3
Appropriate complementary feeding rate		148	35.7

Source: Field survey, 2016

4.4 Magnitude of household food insecurity

The food consumption score of almost all (98.6%) the mothers sampled were within the acceptable limit. Only 1.4% of the mothers had their food consumption score within the unacceptable limit as indicated in Figure 4.1 which gives details of household food security.

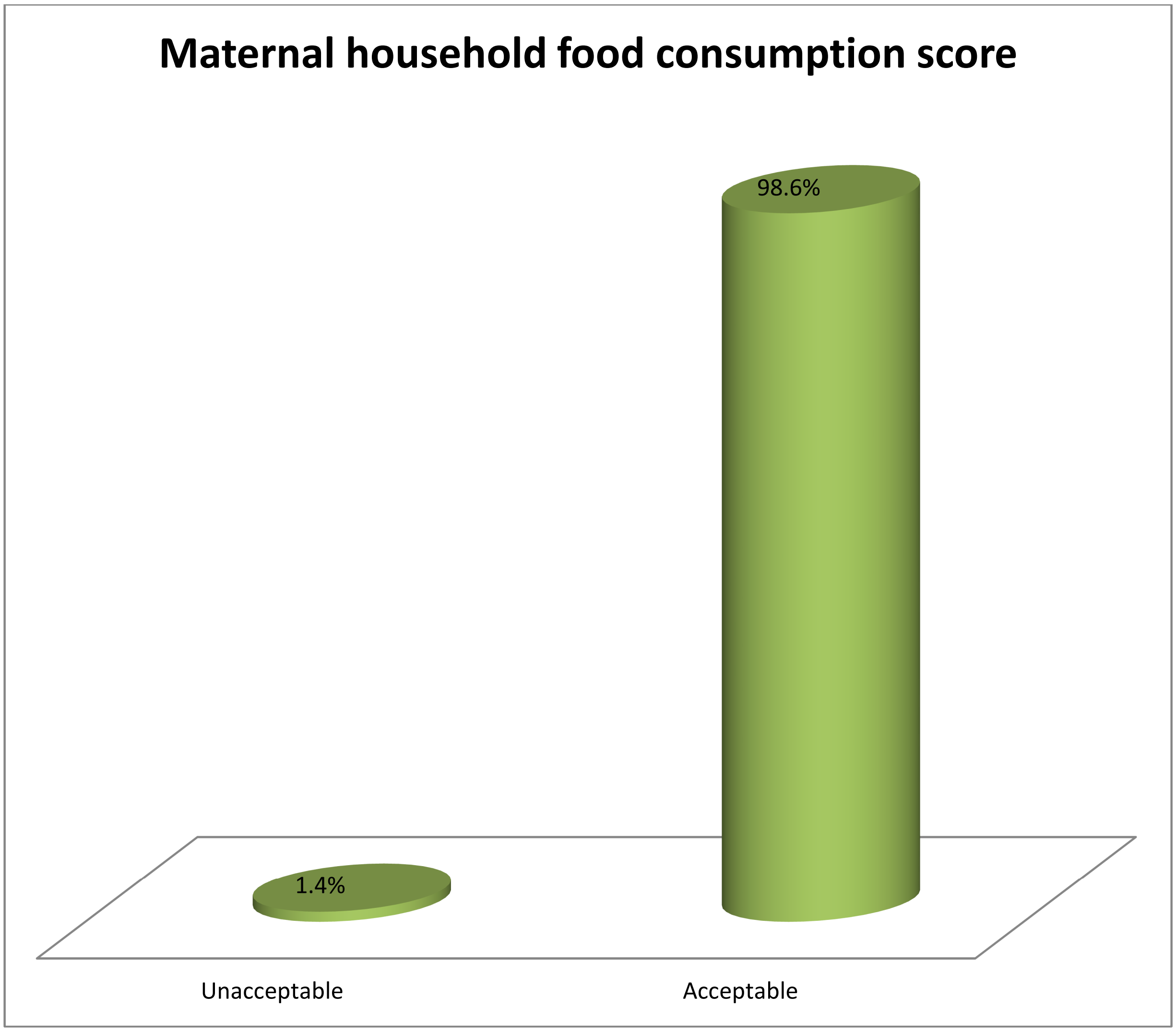


Figure 4.1: Maternal household food security

Source: Field survey, 2016

4.5 Maternal nutritional status during pregnancy

In the first trimester of pregnancy, about 15% of the mothers were severely anaemic while majority (70.7%) of them were free from severe anaemia. The anaemia status of exactly 15% of the mothers could not be determined in the first trimester. About 8% and slightly above half (55.6%) of the mothers respectively were severely anaemic and free from severe anaemia while more than one-third (36.7%) of the mothers' anaemia status could not be determined in the second trimester. In the third trimester of pregnancy, about 15% and more than half (57.5%) of the mothers were respectively severely anaemic and free from severe anaemia while about 30% of the mothers' anaemia status could not be determined.

In terms of body mass index, over 40 % and close to 20 % of the mothers were normal and obese respectively while slightly above one-third (34.8%) of them were overweight. Most (86.7%) of the mothers were at least 155cm tall with few (13.3%) measuring below 155cm. More than two-third (66.9%) and 15.2% of the mothers respectively had adequate and inadequate gestational weight gain while almost 18% of the mothers' gestational weight gain could not be determined due to incomplete information. Table 4.3 gives details on the nutritional status of mothers during pregnancy.

Table 4.3: Maternal nutritional status during pregnancy

Indicator	Frequency	Percent
Maternal BMI in first trimester		
Normal	182	43.9
Underweight	12	2.9
Overweight	144	34.8
Obesity	76	18.4
Maternal height (cm)		
<150	4	1.0
150–154	51	12.3
155–159	111	26.8
At least 160	248	59.9
Gestational weight gain		
Inadequate (<6 Kg)	63	15.2

Adequate (≥6 Kg)	277	66.9
Unknown	74	17.9
1st trimester Hb levels		
<9 g/dl (severe anaemia)	59	14.3
Hb of 9-16g/dl	293	70.7
Unknown Hb	62	15.0
2nd trimester Hb levels		
<9 g/dl (severe anaemia)	32	7.7
Hb of 9-16g/dl	230	55.6
Unknown Hb	152	36.7
3rd trimester Hb levels		
<9 g/dl (severe anaemia)	56	13.5
Hb of 9-16g/dl	238	57.5
Unknown Hb	120	29.0

Source: Field survey, 2016

4.6 Maternal involvement in hard physical activity during pregnancy

More than 15% of the sampled mothers indicated that they were involved in one form of hard physical activity or the other during their pregnancy while over 80% of them said they were not involved in any form hard physical activity during their pregnancy as indicated in Figure 4.2 which gives more on maternal involvement in hard physical activity during pregnancy.

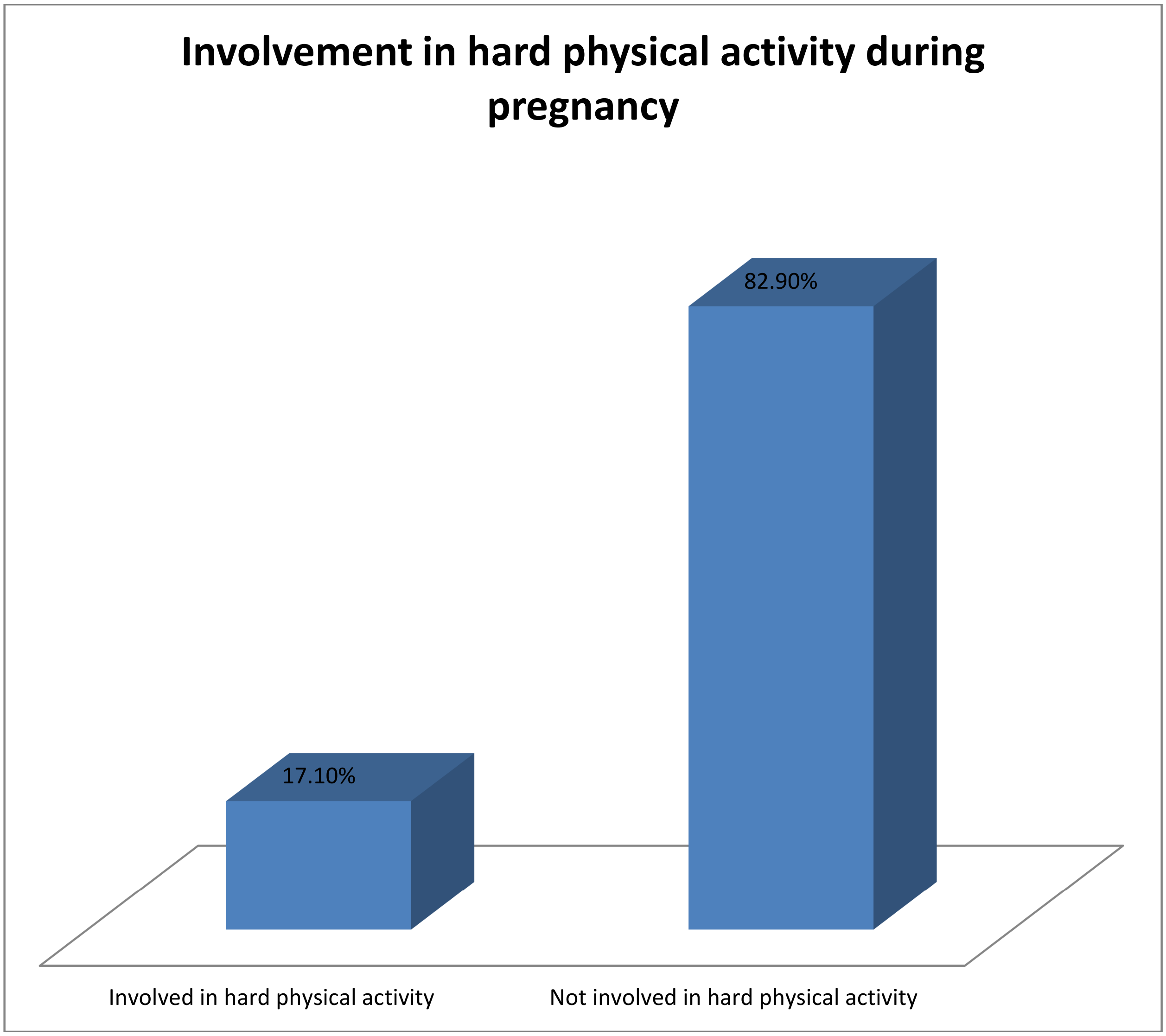


Figure 4.2: Maternal involvement in hard physical activity during pregnancy

Source: Field survey, 2016

4.7 Comparison of child growth indicators according to maternal height

The mean child's growth rate was 383.0±76.4 g/month among children aged 12-24 months. Maternal height associated positively with three growth indicators of mean birth weight, height for age of child and weight for height of child (Table 4.4). Taller pregnant women (≥ 160 cm) gave birth to significantly heavier babies than shorter women (3.10 kg versus 2.10 kg). Whereas, children of mothers whose height was < 160 cm had lower HAZ, compared to mothers whose height was ≥ 160 cm, their growth rate was rather higher. Women whose height was ≥ 160 cm however had lower WHZ, compared to those of height <160 cm.

Table 4.4: Comparison of child growth indicators according to categories of maternal height

Categories of maternal height (cm)	Child growth indicator	N	Mean HAZ	Std. Deviation	95% Confidence Interval for Mean		Test Statistic
					Lower Bound	Upper Bound	
< 160	Birth weight of child (kg)	166	2.10	.46767	2.8952	3.0385	F (1, 412) = 2.87, p = 0.09
At least 160		248	3.10	.61656	3.0189	3.1731	
< 160	Height for age of child	166	-1.2443	1.06120	-1.4069	-1.0817	F (1, 412) = 18.57, p < 0.001
At least 160		248	-.7125	1.33167	-.8790	-.5459	
< 160	Weight for height of child	166	-.5797	1.23328	-.7687	-.3907	F (1, 412) = 13.03, p < 0.001
At least 160		248	-1.0184	1.19709	-1.1681	-.8687	
< 160	Weight for age of child	166	-1.0128	1.00843	-1.1674	-.8583	F (1, 412) = 0.33, p = 0.57
At least 160		248	-1.0790	1.23219	-1.2331	-.9249	
< 160	Growth rate of child in grams/ month	166	390.7885	72.36134	379.6994	401.8776	F (1, 412) = 2.87, p = 0.09
At least 160		248	377.8327	78.77690	367.9800	387.6854	

Source: Field survey, 2016

4.8 Determinants of mean height-for-age Z-scores (HAZ) and child growth rate per month among children aged 12-23 months (Bivariate analysis)

Table 4.5 shows the predictors of mean height-for-age Z-scores (HAZ) and child growth rate per month. Bivariate analyses showed that there was a significant association between minimum dietary diversity of the child and mean HAZ. Similarly, growth rate associated positively with both minimum dietary diversity and minimum acceptable diet. The predictors of HAZ and growth rate were not the same.

Variables that associated with HAZ but were not in any way associated with growth rate were the educational level of the mother, mother's BMI and birth weight.

Table 4.5: Relationship between mean height-for-age Z-scores (HAZ), child growth rate per month and selected variables among children aged 12 -24 months

Indicator	Mean height-for-age Z-scores (HAZ)					Mean child's growth rate (g/month)				
	N	Mean ± Std.	95% Confidence Interval for Mean		Test Statistic	**N**	Mean ± Std.	95% Confidence Interval for Mean		Test Statistic
			Lower Bound	Upper Bound				Lower Bound	Upper Bound	
Child MDD										
Low (< 4)	117	-1.89 ±1.07	-2.08	-1.69	F(1,413) = 124.0, p<0.001	117	320.14 ±44.9	311.92	328.36	F(1,413) = 150.3, p<0.001
High (≥ 4)	297	-0.55 ±1.11	-0.67	-0.42		297	407.80 ±72.0	399.58	416.02	
Child met minimum acceptable diet?										
No	148	-1.67 ±1.13	-1.85	-1.48	F(1,413) = 99.0, p <0.001	148	339.58 ±63.6	329.25	349.91	F(1,413) = 90.5, p<0.001
Yes	266	-0.51 ±1.13	-0.65	-0.38		266	407.20 ±72.3	398.48	415.93	
Classification of birth weight										
Low birth weight (< 2.5 kg)	87	-1.47 ±1.11	-1.71	-1.23	F(1,413) = 21.6, p <0.001	87	389.67 ±80.2	372.59	406.75	F(1,413) =0.8, p = 0.4
Normal (≥ 2.5 kg)	327	-0.78 ±1.25	-0.92	-0.65		327	381.26 ±75.5	373.05	389.47	
Age of child (months)										
12-17 months	279	-0.86 ±1.19	-1.001	-0.72	F(1,413) = 2.3, p = 0.1	279	397.87 ±76.1	388.91	406.84	F(1,413) = 34.9, p <0.001
18-24 months	135	-1.06 ±1.38	-1.29	-0.83		135	352.35 ±67.8	340.80	363.89	

Table 4.5: Relationship between mean height-for-age Z-scores (HAZ), child growth rate per month and selected variables among children aged 12 -24 months (Continuation)

Maternal education										
No formal education	118	-1.24 ±1.03	-1.43	-1.05	F (1, 413) = 6.7,	118	380.40 ±71.9	367.28	393.53	F(1,413) =0.64,
Primary-Middle/JHS	129	-0.94 ±1.42	-1.19	-0.69	p = 0.001	129	389.36 ±84.0	374.72	404.004	p = 0.5
SHS-Tertiary	167	-0.69 ±1.22	-0.88	-0.51		167	379.99 ±73.4	368.77	391.21	
Maternal height (cm)										
< 150 cm	4	0.33 ±0.0	0.33	0.33	F(1, 413) = 11.7,	4	515.38 ±0.0	515.38	515.38	F(1,413) = 4.8,
150-154 cm	51	-1.70 ±0.86	-1.95	-1.46	p <0.001	51	384.01 ±60.7	366.94	401.08	p=0.003
155-159 cm	111	-1.09 ±1.07	-1.29	-0.89		111	389.41 ±74.8	375.35	403.48	
≥160	248	-0.71 ±1.33	-0.88	-0.55		248	377.83 ±78.8	367.98	387.69	
Maternal BMI										
BMI <18.5 kg/m^2 (Underweight)	12	-0.56 ±0.95	-1.16	0.05	F(1, 413) = 3.39, p = 0.02	12	372.50 ±32.46	351.88	393.12	F(1,413) = 1.35, p = 0.3
BMI 18.5–25 kg/m^2 (Normal)	197	-1.11 ±1.18	-1.28	-0.95		197	377.73 ±77.38	366.86	388.60	
BMI 25$^+$ - 30 (Overweight)	129	-0.69 ±1.20	-0.90	-0.48		129	383.38 ±64.42	372.15	394.60	
BMI> 30 kg/m^2 (Obesed)	76	-0.90 ±1.51	-1.24	-0.55		76	397.83 ±94.77	376.17	419.48	

Table 4.5: Relationship between mean height-for-age Z-scores (HAZ), child growth rate per month and selected variables among children aged 12 -24 months (Continuation)

Parity										
1-2	245	-0.85 ±1.19	-0.10	-0.70	F(1,413) = 2.35, p = 0.13	245	389.72 ±74.31	380.37	399.08	F(1,413) =4.65, p = 0.03
At least 3	169	-1.04 ±1.34	-1.24	-0.84		169	373.32 ±78.64	361.38	385.26	

Source: Field survey, 2016

4.9 Distribution of maternal characteristics and their correlation with birth weight

Correlation analysis showed that overall maternal Hb level in all trimesters of pregnancy had a positive correlation with birth weight (Table 4.6). Lower parity correlated positively with birth weight whilst higher parity (at least 3) correlated negatively with birth weight.

The results also showed significant positive correlations between maternal weight and birth weight (r = 0.37, $p < 0.001$), maternal height and birth weight (r = 0.27, $p < 0.001$), maternal body mass index and birth weight (r = 0.32, $p < 0.001$)

Table 4.6: Distribution of maternal characteristics and their correlation with birth weight

Parameter	Frequency	Percentage	Mean±SD	Correlation coefficient (r)	*p*- value
Maternal weight (kg)					
41-50	60	14.5	66.14±14.85		
51-60	95	22.9			
61-70	132	31.9		0.37	p<0.001
71-80	47	11.4			
81-90	60	14.5			
> 90	20	4.8			
Maternal height (cm)					
<150	12	2.9	161.48±5.90		
150–154	197	47.6		0.27	p<0.001
155–159	129	31.2			
At least 160	76	18.4			
Maternal BMI (Kg/m^2)					
BMI <18.5 kg/m^2 (Underweight)	12	2.9	25.27±4.99		
BMI 18.5–25 kg/m^2 (Normal)	197	47.6		0.32	p<0.001
BMI 25$^+$ - 30 (Overweight)	129	31.2			
BMI> 30 kg/m^2 (Obesed)	76	18.4			
Maternal haemoglobin (Hb) level					
First trimester	352		11.0±1.55	0.69	p<0.001
Second trimester	262		11.1±1.49	0.60	p<0.001
Third trimester	294		10.9±1.59	0.74	p<0.001
Parity					
1-2	245	59.2	1.5±1.5	0.15	P= 0.018
At least 3	169	40.8	4.3±1.67	-0.21	P= 0.006

Source: Field survey, 2016

4.10 Predictors of height-for-age Z-score (HAZ): Multivariable Regression Analysis

After controlling for potential confounding factors, children whose mothers' height was ≥160 cm had 0.18 higher HAZ than children whose mothers were shorter <160 cm (p <0.0001). Table 4.7 shows "coefficients" with the predictors which were statistically significant.

Considering the beta coefficients (β), children who initiated breastfeeding within 1 hour of birth had mean HAZ which was 0.15 standard units significantly higher than their counterparts who did not [beta = 0.15 (95% CI: 0.17, 0.57)]. A unit increase in the age of child led to reduced HAZ of 0.18 standard units. The strongest predictor was minimum DDS (> 4) with a standardized beta (β) weight of 0.43, p < 0.001. The second highest contributor was mother's first trimester Hb with beta (β) weight of 0.30, p < 0.001. The set of variables accounted for 44.8 % of the variance in mean HAZ (Adjusted R Square = 0.448).

Table 4.7: Predictors of height-for-age Z-score (HAZ)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for β		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-3.53	0.48		-7.39	<0.001	-4.47	-2.59		
	Age of child	-0.09	0.02	-0.21	-4.68	<0.001	-0.13	-0.05	0.827	1.210
	Mother's educational level	0.31	0.11	0.12	2.79	0.006	0.09	0.52	0.895	1.117
	Minimum DDS	1.12	0.12	0.40	9.26	<0.001	0.88	1.36	0.878	1.138
	Birth weight	0.47	0.13	0.22	3.58	<0.001	0.21	0.73	0.458	2.182
	First trimester Hb	0.21	0.05	0.26	4.20	<0.001	0.11	0.31	0.429	2.333

Table 4.7: Predictors of height-for-age Z-score (HAZ) continued

	Initiation of breastfeeding within 1 hour	0.39	0.11	0.15	3.73	<0.001	0.19	0.60	0.971	1.030
	Feeding colostrum to child	-1.33	0.29	-0.22	-4.66	<0.001	-1.90	-0.77	0.746	1.340
	Timely introduction of complementary food	0.27	0.11	0.11	2.47	0.01	0.06	0.48	0.895	1.117
	(Constant)	-6.54	0.86		-7.60	<0.001	-8.24	-4.85		
	Age of child	-0.08	0.02	-0.18	-3.94	<0.001	-0.11	-0.04	.798	1.252
2	Mother's educational level	0.26	0.11	0.10	2.45	.015	0.05	0.47	.887	1.127
	Minimum DDS	1.20	0.12	0.43	10.01	<0.001	0.96	1.44	.857	1.167
	Birth weight	0.26	0.14	0.12	1.85	0.065	-0.02	0.53	.395	2.532
	First trimester Hb	0.25	0.05	0.30	4.89	<0.001	0.15	0.35	.418	2.389
	Initiation of breastfeeding within 1 hour	0.37	0.10	0.15	3.59	<0.001	0.17	0.57	.968	1.034
	Feeding colostrum to child	-1.30	0.28	-0.21	-4.64	<0.001	-1.85	-0.75	.746	1.341
	Timely introduction of complementary food	0.23	0.11	0.09	2.12	0.034	0.02	0.44	.887	1.127
	Height of mother in meters	1.18	0.28	0.18	4.16	<0.001	0.62	1.73	.819	1.221
a. Dependent Variable: Height for age of child										

Using the hierarchical multiple regression approach, the covariate predictor variables (main effects) were entered in the first step. In the second step, the main explanatory variable of interest (that is, maternal height) was added.

The percent of variability in the dependent variable that can be accounted for by all the predictors together is measured by R-square. The change in R^2 is a way to evaluate how much predictive power was added to the model by the addition of another variable. In step 2 when the explanatory variable (that is, maternal height) was added to the model, the % of variability accounted for went up from 43.5% to 46.2 % (R^2 Change =0 .027, p < 0.001), (Table 4.8).

Table 4.8: Regression model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.659[a]	0.435	0.421	0.96603	0.435	32.953	8	343	<0.001
2	0.680[b]	0.462	0.448	0.94381	0.027	17.341	1	342	<0.001

a. Predictors: (Constant), Timely introduction of complementary food, Birth weight of child, Initiation of breastfeeding, Maternal education of mother2, Minimum DDS, Feeding colostrum to child, Age of child, First trimester Hb

b. b. Predictors: (Constant), Timely introduction of complementary food, Birth weight of child, Initiation of breastfeeding, Maternal education of mother2, Minimum DDS, Feeding colostrum to child, Age of child, First trimester Hb, Height of mother in meters

4.11 Predictors of growth rate/month: Multivariable Regression Analysis

After controlling for potential confounding factors, it was observed that maternal height had no effect on growth rate/month (Table 4.9). The most consistent predictors of growth rate of children aged 12-24 months were birth order, minimum DDS, age of mother, number of pregnancies, number of under-five children; the highest contributor to high growth rate being meeting minimum dietary diversity of 4. The regression model was significant, F (9, 351) = 32.95, p < 0.001.

Table 4.9: Predictors of growth rate/month among children aged 12-24 months

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	358.22	24.86		14.41	<0.001	309.35	407.09		
	Number of under-five children	-37.93	7.84	-.20	-4.84	<0.001	-53.34	-22.52	.869	1.151
	Trimester of first ANC attendance	18.83	6.95	.11	2.71	.007	5.16	32.49	.920	1.087
	Number of pregnancies	-22.81	9.94	-.25	-2.30	.022	-42.35	-3.27	.131	7.627
	Timely introduction of complementary food	17.07	6.38	.11	2.67	.008	4.52	29.62	.865	1.156
	Minimum DDS	81.77	6.97	.48	11.74	<0.001	68.07	95.46	.892	1.121
	Classification of birth weight	-26.54	7.99	-.14	-3.32	.001	-42.25	-10.84	.829	1.207
	BMI of mother	2.43	.65	.16	3.72	<0.001	1.15	3.71	.832	1.203
	Birth order classification	31.44	9.87	.34	3.19	.002	12.03	50.85	.129	7.740
	Age of mother	-24.39	5.54	-.22	-4.40	<0.001	-35.28	-13.50	.629	1.589
2	(Constant)	362.24	46.73		7.75	<0.001	270.38	454.10		
	Number of under-five children	-37.90	7.85	-.20	-4.83	<0.001	-53.34	-22.46	.867	1.153
	Trimester of first ANC attendance	18.69	7.10	.11	2.63	.009	4.74	32.64	.885	1.130
	Number of pregnancies	-22.70	10.01	-.25	-2.27	.024	-42.37	-3.03	.130	7.709

Table 4.9: Predictors of growth rate/month among children aged 12-24 months continued

	Timely introduction of complementary food	17.08	6.39	.11	2.67	.008	4.52	29.65	.865	1.157
	Minimum DDS	81.72	6.99	.48	11.69	<0.001	67.98	95.46	.889	1.125
	Classification of birth weight	-26.47	8.03	-.14	-3.30	.001	-42.260	-10.69	.823	1.216
	BMI of mother	2.44	.66	.16	3.69	<0.001	1.14	3.73	.813	1.229
	Birth order classification	31.42	9.89	.34	3.18	.002	11.98	50.85	.129	7.746
	Age of mother	-24.40	5.55	-.22	-4.40	<0.001	-35.30	-13.49	.629	1.589
	Height of mother in meters	-1.69	16.58	-.00	-.10	.919	-34.29	30.91	.882	1.134
a. Dependent Variable: Growth rate of child in grams/month										

Source: Field survey, 2016

4.12 Predictors of birth weight: Multivariable Regression Analysis

The percent of variability in the dependent variable that can be accounted for by all the predictors together as measured by the adjusted R-square (R^2) was 72.7 %. The change in R^2 is a way to evaluate how much predictive power was added to the model by the addition of another variable. In step 2 when the explanatory variables were added to the model, the % of variability accounted for went up from 59.5 % to 73.4 % (R^2 Change = 0 .138, $p < 0.001$), (Table 4.10). This means gestational weight gain and maternal height alone accounted for 13.8 % of the variance in birth weight.

Table 4.10: Regression model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.772[a]	.595	.588	369.91633	.595	78.733	6	321	.000
2	.856[b]	.734	.727	301.14357	.138	82.678	2	319	.000

a. Predictors: (Constant), Sex of child, Number of attendance, Number of pregnancies, First trimester Hb, Mother's weight, Gestational age at delivery

b. b. Predictors: (Constant), Sex of child, Number of attendance, Number of pregnancies, First trimester Hb, Mother's weight, Gastational age at delivery, Height of mother in meters, Gestational weight gain

Using the hierarchical multiple regression analysis, the covariate predictor variables (main effects) were entered in the first step. In the second step, the main explanatory variables of interest (that is, maternal height and gestational weight gain) were added. The independent predictors of birth weight are shown in Table 4.11 below. The key maternal anthropometric factors were maternal height, gestational weight gain. Other factors were increased gravidity, increased haemoglobin levels of mother in the first trimester, increasing gestational age at delivery, frequent ANC attendance and sex of child being male. The regression model was highly significant F (8, 327) = 109.8, P < 0.001 and the strongest predictor was gestational weight gain. After controlling for potential confounding factors, children whose mothers' height was ≥160 cm had 0.10 higher mean birth weight than children whose mothers were shorter <160 cm (p = 0.005). Female children had mean birth weight which was 0.09 standard units significantly lower than their male counterparts (beta = -0.09, p = 0.007).

Table 4.11: Predictors of birth weight

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-2555.27	643.28		-3.97	<0.001	-3820.85	-1289.70		
	Number of pregnancies	70.24	25.49	.10	2.76	.006	20.11	120.38	.898	1.114
	First trimester Hb	188.48	16.12	.48	11.69	<0.001	156.77	220.19	.758	1.320
	Mother's weight	6.64	1.44	.18	4.62	<0.001	3.82	9.47	.852	1.174
	Gastational age at delivery	77.84	18.36	.19	4.24	<0.001	41.71	113.97	.603	1.658
	Number of ANC attendance	54.49	21.51	.10	2.53	.012	12.19	96.80	.773	1.294
	Sex of child	-166.82	42.93	-.15	-3.89	<0.001	-251.27	-82.36	.911	1.097
2	(Constant)	-1179.39	548.91		-2.15	.032	-2259.32	-99.45		
	Number of pregnancies	55.28	20.97	.08	2.64	.009	14.03	96.53	.879	1.137
	First trimester Hb	61.45	17.03	.16	3.61	<0.001	27.94	94.96	.450	2.224
	Mother's weight	1.08	1.36	.03	.79	.428	-1.59	3.75	.634	1.577
	Gastational age at delivery	45.25	15.53	.11	2.91	.004	14.70	75.80	.559	1.789
	Number of ANC attendance	42.77	17.61	.08	2.43	.016	8.11	77.43	.763	1.310
	Sex of child	-98.36	36.52	-.08	-2.69	.007	-170.22	-26.51	.834	1.199
	Height of mother in meters	305.63	106.90	.10	2.86	.005	95.30	515.95	.649	1.541
	Gestational weight gain	86.77	7.00	.56	12.40	<0.001	73.01	100.54	.405	2.469
a. Dependent Variable: Birth weight in grams										

Source: Field survey, 2016

4.13 Morbidity occurrence among children

Over three-quarters (35.7%), 25% and 30% of the respondents indicated their children experienced cough, diarrhoea and malaria respectively in the past two weeks preceding the data collection while 6.3% of the index children showed high levels of morbidity as indicated in Table 4.12 below which gives details on morbidity occurrence among children.

Table 4.12: Morbidity occurrence among children

Type of condition	Frequency	Percent
Occurrence of cough in the past two weeks		
Yes	148	35.7
No	266	64.3
Total	**414**	**100.0**
Occurrence of diarrhoea in the past two weeks		
Yes	110	26.6
No	304	73.4
Total	**414**	**100.0**
Occurrence of malaria in the past two weeks		
Yes	130	31.4
No	284	68.6
Total	**414**	**100.0**
Level of child morbidity		
High	26	6.3
Low	388	93.7
Total	**414**	**100.0**

Source: Field survey, 2016

4.14 Relationship between maternal socio-demographic characteristics and low birth weight (LBW) of children

The results shows a significant relationship (p=0.015) between maternal age and birth weight of children as teenage mothers were found to be more than two (2) times more likely to give birth to low birth weight babies compared to older women. A significant (p=0.007) association was also found between religion and birth weight with Muslim mothers found to be about three (3) times more likely to give birth to low birth babies compared to their Christian counterparts who were found to be more likely to deliver babies with normal birth weight. Mothers with no or low formal education were also found to be more likely to give birth to babies with low birth weight compared to those with higher educational levels (p=0.047). Similarly, unemployed and non-salary working mothers were also found to be more likely to give birth to low birth weight babies compared to salary workers even though not statistically significant (p=0.116). Rural/peri-urban mothers were also more likely to give birth to low birth weight babies compared to those in urban settings (p=0.005). Table 4.13 gives more details on the relationship between maternal socio-demographic characteristics and birth weight of children.

Table 4.13: Relationship between maternal socio-demographic characteristics and birth weight of children

Socio-demographic characteristic	Birth weight category			Test statistic
Maternal age	**Low birth weight n (%)**	**Normal birth weight n (%)**	**Total n (%)**	
15-19	8 (50.0)	8 (50)	16 (100.0)	χ^2 =8.4402, p = 0.015
20-34	59 (20.0)	236 (80.0)	295 (100.0)	
35+	20 (19.4)	83 (80.6)	103 (100.0)	
Total	**87 (21.0)**	**327 (79.0)**	**414 (100.0)**	
Religion				
Islam	83 (22.9)	280 (77.1)	363 (100.0)	χ^2 =6.079^2, p = 0.007
Christianity	4 (7.8)	47 (92.2)	51 (100.0)	
Total	**87 (21.0)**	**299 (72.2)**	**414 (100.0)**	
Marital status				
Married	87 (21.2)	323 (78.8)	410 (100.0)	χ^2 =1.075^2, p = 0.388
Single	0 (0.0)	4 (100.0)	4 (100.0)	
Total	**87 (21.0)**	**299 (72.2)**	**414 (100.0)**	
Maternal educational level				
No/low educational level	60 (24.3)	187 (75.7)	247 (100.0)	χ^2 =3.962, p = 0.047
High level of education	27 (16.2)	140 (83.8)	167 (100.0)	
Total	**87 (21.0)**	**327 (79.0)**	**414 (100.0)**	
Maternal occupation				
Unemployed	8 (17.4)	38 (82.6)	46 (100.0)	χ^2 =4.304, p = 0.116
Non-salary worker	68 (23.7)	219 (76.3)	287 (100.0)	
Salary worker	11 (13.6)	70 (86.4)	81 (100.0)	
Total	**87 (21.0)**	**327 (79.0)**	**414 (100.0)**	
Partner's occupation				
Unemployed	0 (0.0)	6 (100.0)	6 (100.0)	χ^2 =20.970, p = <0.001
Non-salary worker	68 (28.9)	167 (71.1)	235 (100.0)	
Salary worker	19 (11.0)	154 (89.0)	173 (100.0)	
Total	**87 (21.0)**	**327 (79.0)**	**414 (100.0)**	
Maternal place of residence				
Peri-urban	28 (31.8)	60 (68.2)	88 (100.0)	χ^2 =7.859, p = 0.005
Urban	59 (18.1)	267 (81.9)	326 (100.0)	
Total	**87 (21.0)**	**327 (79.0)**	**414 (100.0)**	

Source: Field survey, 2016

4.15 Infection during pregnancy and birth weight

The results also show that the occurrence of candidiasis and malaria during pregnancy were both significantly associated with the delivery of low birth weight babies (p=0.012 and 0.000 respectively) with mothers who experienced malaria during pregnancy about 18 times more likely to give birth to low birth weight babies compared to those with no episode of malaria during pregnancy while mothers who experienced candidiasis were also about two (2) times more likely to give birth to low birth weight babies compared to those who did not experience candidiasis during their pregnancy. It was also observed that repeated episodes of both candidiasis and malaria also increased the chances of giving birth to low birth weight babies even though not significant for repeated episodes of candidiasis with p-values of 0.481 and 0.000 respectively for repeated episodes of candidiasis and malaria as shown in table 4.14 which gives more on the relationship between infection during pregnancy and birth weight of children.

Table 4.14: Infection during pregnancy and birth weight

Infection type	**Birth weight category**			**Test statistic**
Candidiasis	**Low birth weight n (%)**	**Normal birth weight n (%)**	**Total n (%)**	
Yes	36 (28.3)	91 (71.7)	127 (100.0)	χ^2 =5.933^2,
No	51 (17.8)	236 (82.2)	287 (100.0)	p = 0.012
Total	**87 (21.0)**	**327 (79.0)**	**414 (100.0)**	
Frequency of candidiasis				
Once	24 (28.6)	60 (71.4)	84 (100.0)	χ^2 =0.062^2,
More than once	12 (30.8)	27 (69.2)	39 (100.0)	p = 0.481
Total	**36 (29.3)**	**87 (70.7)**	**123 (100.0)**	
Malaria				
Yes	79 (55.2)	64 (44.8)	143(100.0)	χ^2 =1.542E^2,
No	8 (3.0)	263 (97.0)	271 (100.0)	p = <0.001
Total	**87 (21.0)**	**299 (72.2)**	**414 (100.0)**	
Frequency of malaria				
Once	4 (6.7)	56 (93.3)	60 (100.0)	χ^2 =98.66,
More than once	75 (90.4)	8 (9.6)	83 (100.0)	p = <0.001
Total	**79 (55.2)**	**60 (42.0)**	**143 (100.0)**	

Source: Field survey, 2016

4.16 Relationship between birth weight and hard physical activity during pregnancy

Involvement in hard physical work by mothers during pregnancy has also shown a very strong association with the birth weight of children as it can be seen from the results that mothers who were involved in hard physical work during pregnancy were more than ten (10) times more likely to give birth to low birth weight babies compared to those who were not involved in such hard physical work during their pregnancy (p=0.000) as illustrated in Figure 4.5 which give more on the relationship between involvement in hard physical activity during pregnancy and birth weight of children.

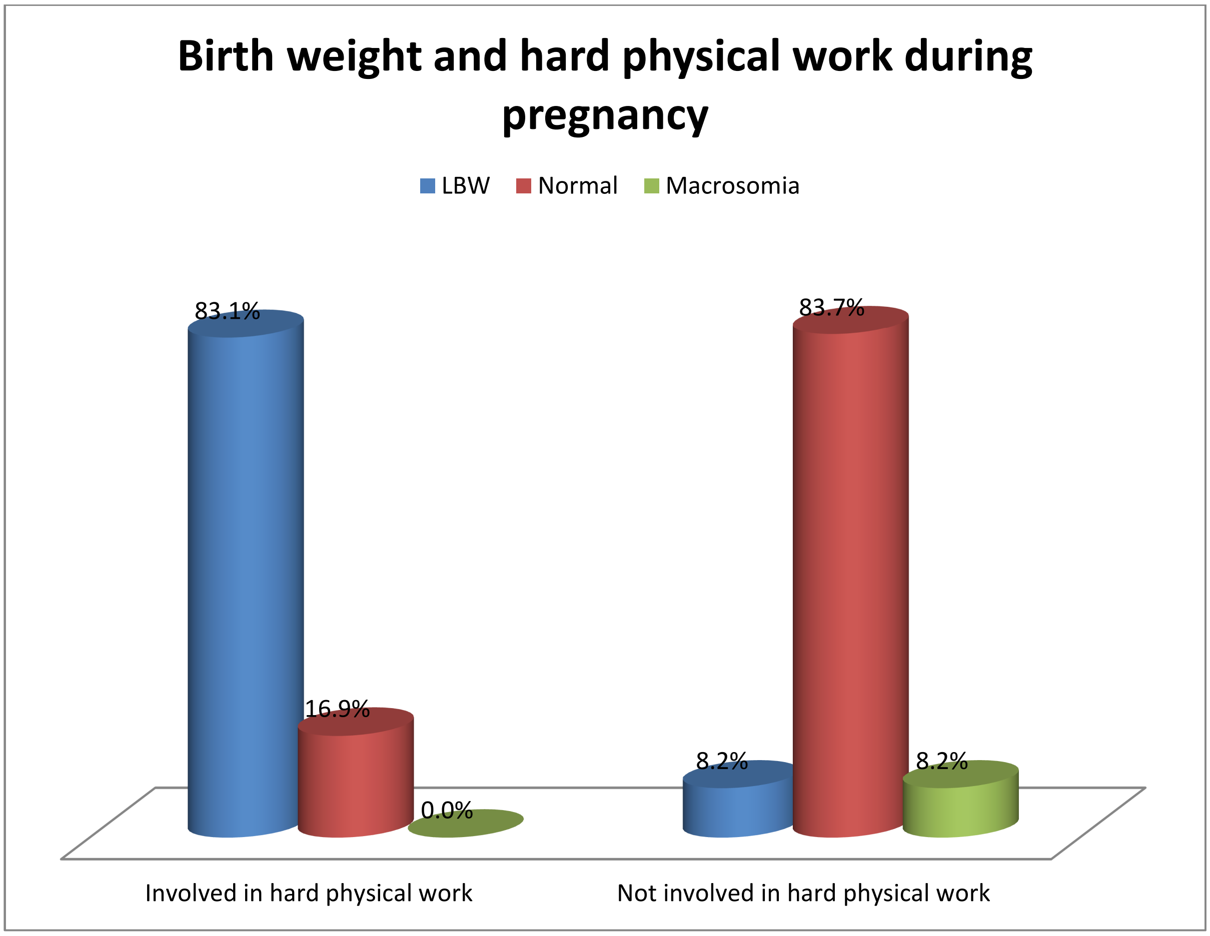


Figure 4.3 Relationship between birth weight and hard physical activity during pregnancy

Source: Field survey, 2016

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter discusses the results of the study by highlighting the key findings and comparing them to the findings of other studies to see the extent to which the findings of the study are consistent with or differ from the findings of other researchers on the same subject matter. The chapter also offers possible explanations to some findings of the study as well as their possible implications and effects based on established and known facts and literature on the subject matter. This is aimed at bringing out the value and meaning of the findings of the study to help policy makers and other readers to better understand, appreciate and use the findings of the study appropriately to inform decisions and policies going forward. To achieve these, references are made to the reviewed literature and results of the study in chapter two and four respectively.

5.2 Prevalence of low birth weight and nutritional status of children 12-23 months

The results showed that the prevalence of low birth weight in the Tamale Metropolis was 21% which is higher than the 17% prevalence in 2012 (Saaka, 2012) as well as the total prevalence of the entire Northern region of 12.9% in 2014 (GDHS, 2014). Available data shows that the proportion of low birth weight in Northern region increased from 11.9% in the 2011 MICS survey to 12.9% in the 2014 GDHS survey while data from the Northern Regional Health Directorate also shows a similar increasing trend in the proportion of LBW children from 9.2% in 2012 to 9.4% in 2013 to 10.2% in 2014 in the Northern region. Data from the Tamale Metropolitan Health Directorate also shows a similar increasing trend in the proportion of children with low birth weight in the Tamale metropolis from 10.1% in 20 13 to 12.6% in 2014. Therefore, the increase in the proportion of LBW in this current study is in line with the increasing trend of low birth weight in the Northern region and the Tamale metropolis.

The increased prevalence of low birth weight in this study could be due to increases in facility delivery as a result of the increase in education and awareness creation among mothers on the need for every expectant woman to deliver in a health facility. This is so because it has been said that, the rates of low birth weight in developing countries like Ghana could be under estimated due to the fact that more than half of infants in developing countries are delivered outside the health facilities and so are not weighed (UNICEF and WHO, 2004). This means that any time facility delivery improves, the proportion of low birth weight could increase as a result of that and not necessarily because there is actual increase in the number of children born with low birth weight.

The prevalence of stunting among children 12-23 months in the Tamale Metropolis in this current study was 16.7% which is lower compared with the 21.9% prevalence of stunting among children 18-23 months in Ghana (GDHS, 2014) and the 20.5% prevalence among children 6-23 months in Northern Ghana (Northern region, Upper East and Upper West regions of Ghana) (Saaka, 2015). Children living in rural areas are said to have higher prevalence of stunting than those in urban areas (GHS, 2014). Therefore, the lower prevalence of stunting in this study could be due to the fact that the current study covers only Tamale Metropolis which is more urban in nature compared with the GDHS (2014), and the study by Saaka (2015), which covered the whole of Ghana and the three regions in Northern part of Ghana respectively which have more rural communities involved. The prevalence of underweight among children 12-23 moths was also 17.9% which is almost consistent with the 14.6%

prevalence among children 18-23 months in Ghana according to the GDHS (2014). Wasting prevalence was 15.7% which is about twice higher than the GDHS (2014), prevalence of 8.1%. The higher prevalence of wasting in this study could be due to the fact that the data was collected during the planting season (June-July) during which most households do not have enough food as wasting is said to be influenced by such direct seasonal short term factors due to its acute nature.

5.3 Relationship between child growth indicators and maternal height

The results showed that maternal height associated positively with birth weight with taller mothers (≥ 160 cm) giving birth to significantly heavier children than shorter mothers (<160 cm) (3.10 versus 2.10 Kg). This finding of the study is consistent with the findings of Deshmukh et al. (1996), and ACC/SCN (2000), who also found maternal stature to be positively associated with birth weight. Maternal height also associated negatively with stunting with children of mothers of height of <160 cm found to be significantly more stunted than children of mothers of height ≥ 160 cm which is consistent with the findings of Varela-Silva et al. (2009), Subramanian et al. (2009), and Özaltin et al. (2010), who also found that children of shorter mothers to be more likely to have stunted growth. Saaka and Abaah (2015), also made similar findings as they found negative association between maternal height and stunted growth in children which indicates that children of taller mothers were less likely to have stunted growth compared with those of shorter mothers.

The results however showed a positive association between maternal height and wasting in children with taller mothers having significantly more wasted children compared with shorter mothers contrary to the findings of Subramanian et al. (2009), who rather found shorter mothers to significantly have more wasted children compared with taller mothers. A negative association was also found between maternal height and growth rate of children where children of shorter mothers rather grew faster in weight compared with those of taller mothers. There was however no significant association found between maternal height and underweight contrary to the findings of Christian (2010), Subramanian et al. (2009), and Özaltin et al. (2010), who found that children of shorter mothers had higher risk of underweight compared with those of taller mothers. The inconsistencies of some of the findings of this study with those of other studies on the relationship between maternal height and growth indicators such as stunting, wasting and underweight shows that other hiding factors could be playing a role and so further studies would be needed to better understand the relationship between maternal height and such growth indicators.

5.4.1 Infant and young child feeding practices of care givers

The results of the study shows that slightly above half (52.9%) of the children were introduced to breastfeeding within one hour of birth as recommended by the WHO (2012). This finding is consistent with that of GDHS (2014), which also indicated that slightly above half (55.6%) of children in Ghana are put to breast within hour of birth. This means the practice of early initiation of breastfeeding is relatively low in the Tamale Metropolis as close to half (47.1%) of children are not put to breast early and are likely not to be given the first breast milk, colostrum which is rich in nutrients and antibodies for protection. The rate of giving prelacteal feeds to infants was very low (3.9%) compared with the 17% rate in Northern region of Ghana (GDHS, 2014). The decrease in giving prelacteal feeds is good because prelacteal feed is not recommended as it increases the risk of infection in infants and also reduces the frequency of breastfeeding (GDHS, 2014) which can lead to malnutrition in infancy. The results further showed that the rate of using feeding bottle among mothers of children 12-23 months was 6.3% and it’s consistent with the national rate of 8.2% in

Ghana. Most (95.2%) of the children in the study were still breastfeeding as compared to the 71.1% of children of the same age in Ghana who were still breastfeeding in 2014 (GDHS, 2014). This means that most children in the Tamale Metropolis are more likely to be breastfed for a minimum of two years as recommended by the WHO as compared to children from other parts of the country.

About two-third (66.2%) of the children were fed their minimum meal frequency as recommended by the WHO which is higher than the less than half (45.2%) of children 6-23 months who were fed the minimum meal frequency in Northern region in the 2014 (GDHS, 2014). Similarly, more (71.7%) children in this study were fed with at least four food groups within the past 24 hours preceding the data collection, compared to the 17.9% of children 6-23 months who received same in Northern region (GDHS, 2014). The proportion (64.3%) of the children in this study who met the minimum acceptable diet was far greater than the 14.1% of the children 6-23 months who met the minimum acceptable diet in Northern region (GDHS, 2014). The higher percentage of children in this study who met their minimum dietary diversity, minimum meal frequency and minimum acceptable diet as compared with those in the Northern region in the 2014 GDHS could be due to the fact that the study area of this study (Tamale metropolis) is more urban in nature relative to the entire Northern region which has more rural communities. This is because children in urban areas are said to be more likely to meet their minimum meal frequency, dietary diversity and minimum acceptable diet compared with those in rural areas (GDHS, 2014). Another reason could be due to the fact that the children in this study were between the ages of 12-23 months who depend more on complementary food to meet their nutritional need as such parents paid more attention to their complementary feeding. The children in the 2014 GDHS however were between the ages of 6-23 months some of whom depended more on breast milk for their nutritional needs as such parents paid little attention to their complementary feeding.

Slightly above half (52.9%) of the mothers practiced timely introduction of complementary food in the Tamale Metropolis from the results which is lower compared with the national rate of 73% in Ghana (GDHS, 2014). The low rate of timely introduction of complementary food in the Tamale Metropolis in this study compared with the national rate for Ghana could be due to the fact that this study measured timely introduction of complementary food by the introduction of complementary food at age six months as recommended by the WHO while the GDHS (2014), measured same by the introduction of complementary food at age 6-8 months which has a wider range to accept more mothers for the practice. The rate of appropriate complementary feeding among mothers in the study was low (35.7%) compared with the 44.5% rate in Northern region of Ghana (Saaka & Abaah, 2015) and this reflected in the nutritional status of the children which showed that the children in the study were less well-nourished relative to the WHO standard population. This is so because infant and young child feeding practices are said to directly affect the nutritional status of children under two years (MICS, 2011).

5.4.2 Relationship between infant and young child feeding practices and child growth

In a multivariable regression analysis, initiating breastfeeding within the first hour of birth was found to have a significant positive association with height-for-age Z-scores of children as a unit increase in early initiation of breastfeeding increases height-for-age Z-scores by 0.15 folds with p-value of <0.001. This finding is consistent with the findings of Marriotte et al. (2012), who also found early initiation of breastfeeding within one hour of birth to be associated with less likelihood of stunting and underweight in children. Similarly, timely introduction of complementary feeding also showed a significant positive association with height-for-age Z-scores of children which is also consistent with the findings of Saaka et al. (2015), who in a multiple logistic regression analysis, also identified timely introduction of complementary food to offer 25% protection against stunting. A unit increase in minimum dietary diversity score was also found to increase height-for-age Z-scores of children by 0.43 folds with a p-value of <0.001which is also an indication of a positive association between minimum dietary diversity score and height-for-age of children. This finding of the study is also consistent with those of Ali et al. (2013), and Disha et al. (2012), who also found dietary diversity score and overall diet quality to be positively associated with height-for-age. In a bivariate analyses, minimum acceptable diet also associated positively with mean height-for-age as children who met their minimum acceptable diet were found to have significantly higher height-for-age Z-scores compared with those who did not meet their minimum acceptable diet who had significantly lower height-for-age Z-scores. This finding of the study is also consistent with that of Marriotte et al. (2012), who also found meeting the minimum acceptable diet to be associated with less likelihood of stunting and underweight in children. Feeding colostrum to children on the other hand was found to have negative association with height-for-age Z-score of children as a unit increase in feeding colostrum to a child was found to decrease height-for-age of children by 0.21 folds with a p-value of <0.001. This findings of the study is contrary to those of Teshome et al. (2009), who found deprivation of colostrum as one of the main contributing factors for stunting in children.

The results of the study further showed that, minimum dietary diversity score of children associated positively with their growth rate with children who met the recommended minimum dietary diversity of ≥4 food groups having significantly higher growth rates than those who did not meet the minimum dietary diversity score who had significantly lower growth rates. Meeting the minimum acceptable diet of children was also found to have positive significant association with their growth rates as children who met the minimum acceptable diet were found to have significantly higher growth rates compared with those who did not meet the minimum acceptable diet. These findings of the study are also consistent with those of other studies as poor infant and young child feeding practices including not meeting the minimum dietary diversity and minimum acceptable diet by mothers have been identified as main causes of growth faltering and under-nutrition in children under two years (UNICEF, 2009). Timely introduction of complementary feeding also showed significant positive association with the growth rate of children as a unit increase in timely introduction of complementary feeding increases height-for-age Z-score of children by 0.112 folds with a p-value of 0.008. This finding is also consistent with those of other studies as inadequate complementary feeding practices have been identified as part of the proximal causes of poor growth (Lutter, 2003; Martorell, Yarbough & Klein, 1980)

5.5 Determinants of mean height-for-age Z-scores (HAZ) among children aged 12-23 months

Bivariate analyses showed a significant association between the minimum dietary diversity of children and their height-for-age Z-scores with children with higher dietary diversity (≥4 food groups) having significantly higher height-for-age Z-scores while those with lower dietary diversity (< 4 food groups) had significantly lower height-for-age Z-scores. This finding of the study is consistent those of Ali et al. (2013), and Disha et al. (2012), who also found dietary diversity score and overall diet quality to be positively associated with height-for-age. Minimum acceptable diet also associated positively with mean height-for-age with children who met their minimum acceptable diet having significantly higher height-for-age Z-scores compared with those did not meet their minimum acceptable diet who had significantly lower height-for-age Z-scores. This finding of the study is also consistent with that of Marriotte et al. (2012), who also found that meeting any of the 8 core IYCF indicators (early initiation of breastfeeding, exclusive breastfeeding under 6 months, continued breastfeeding at 1 year, timely introduction of complementary food, minimum dietary diversity, minimum meal frequency, minimum acceptable diet and consumption of iron-rich foods) except minimum meal frequency was associated with less likelihood of stunting and underweight in children. These findings are however contrary to that of a study in Mumbai which found no association between linear growth and the achievement of any of the eight indicators (including dietary diversity and minimum acceptable diet) for infant and young child feeding practice recommended by the WHO (Bentley et al., 2015).

The results of the study further showed that the birth weight of children associated positively with the height-for-age Z-scores with children who were born with normal birth weight (≥ 2.5 kg) having significantly higher height-for-age Z-scores than those born with low birth weight (< 2.5 kg) who had significantly lower height-for-age Z-scores. This finding is also consistent with that of Mbuya et al. (2010), and the assertion that low birth weight is an intergenerational problem in which low birth weight infants grow to become undernourished and stunted children and adolescents and, ultimately, undernourished women of childbearing age, and undernourished pregnant women who also deliver low birth weight infants (ACC/SCN, 2000). Children whose mothers had low educational attainments had significantly lower height-for-age Z-scores compared with those whose mothers had higher educational attainments which means maternal education also had significant positive association with height-for-age Z-scores of children consistent with the position of de Onis (2003), who indicated that empirical evidence shows a strong association between low height-for-age and a lack of maternal education, with rates of stunting decreasing as levels of education increases.

Maternal height also showed a significant positive association with height-for-age of children as children of mothers of height ≥ 160 cm had significantly higher height-for-age Z-scores compared with those of mothers with height <160 cm who had significantly lower height-for-age Z-scores. This finding is also consistent with that of Espo et al. (2002), who found maternal stature (<60cm) to be associated with the risk of stunted growth. Similarly, shorter mothers have also been found to be more likely to have children with stunted growth at age two years compared to taller mothers (Addo et al., 2013; Hambidge et al., 2014). Similar findings were also made by Saaka and Abaah (2015), who found negative association between maternal height and stunted growth in children. The study further found a positive significant association between maternal BMI and height-for-age of children with children of mothers with lower BMI having significantly lower height-for-age Z-scores. This finding of the study is consistent with the findings of a study in Zimbabwe which found higher maternal body mass index to be protective against stunting (Mbuya et al., 2010).

5.6 Determinants of mean growth rate per month among children aged 12-23 months

The results of the study showed that minimum dietary diversity score of children associated positively with their growth rate with children who met the recommended minimum dietary diversity of ≥4 food groups having significantly higher growth rates than those who did not meet the minimum dietary diversity score who had significantly lower growth rates. Meeting the minimum acceptable diet of children was also found to have positive significant association with their growth rates as children who met the minimum acceptable diet were found to have significant higher growth rates compared with those who did not meet the minimum acceptable diet. These findings are consistent with those of other studies as poor infant and young child feeding practices including not meeting the minimum dietary diversity and minimum acceptable diet by mothers have been identified as main causes of growth faltering and under-nutrition in children under two years (UNICEF, 2009). Inadequate complementary feeding practices have also been identified as part of the proximal causes of poor growth (Lutter, 2003; Martorell, Yarbough & Klein, 1980) while association between better feeding practices and growth outcomes have also been demonstrated in Peru (Ruel & Menon 2002), Ghana (Armar-Klemesu et al. 2000; Monteiro et al., 2010), Brazil (Monteiro et al., 2010) and Thailand (Limwattananon et al., 2010). This is so because meeting the minimum dietary diversity and minimum acceptable diet ensure nutrient adequacy both in terms of quality and quantity are critical to ensure adequate growth in children (WHO, 2012). Furthermore, not meeting the minimum dietary diversity and minimum acceptable diet would amount to inadequate dietary intake which has been identified by UNICEF (1990), as one of the immediate causes of malnutrition.

Child’s age also showed a significant association with growth rate as younger children (12-17 months) had significantly higher growth rate compared with older ones (18-23 months) which is consistent with the pattern of association most researchers found between child’s age and other growth indicators like stunting. Among children 6-23 months, the odds of being stunted increased by 11% with each additional month of age (Mbuya et al., 2010). This finding could be due to the fact that nutrient demand increases as a child grows older due to physiological changes and increased level of activity with a potential decrease in responsive feeding and care practices from care givers making it difficult for the older child to meet their nutrient requirements for adequate growth. Significant associated was also found between parity and child growth rate with lower parity (1-2) children having significantly higher growth rate compared with those of higher parity (≥3). This finding is consistent with the general finding of Aheto et al. (2015), who identified multiple births to be associated with increased risk of poor growth. This finding could be due to the fact that higher parity could influence family size which has also been found to influence childhood growth as it determines the ability of a household to meet the nutritional needs of its members especially children.

5.7.1 Predictors of birth weight

Maternal age had a positive significant association with birth weight of their children as younger mothers were found to be more likely to have low birth weight children than older ones with teenage mothers found to even be more than two time likely to have low birth weight children. This finding is consistent with the findings of the GDHS (2014), which also reports that the highest proportion of low birth weight children were recorded among teenage mothers. Deshmukh et al. (1996), also identified low maternal age as a risk factor for delivering low birth weight babies. Maternal education also showed positive significant associations with birth weight as mothers with higher level of education were found to have lower risk of delivering low birth weight babies which is consistent with the findings of many other researchers like Fosu et al. (2013), who identified educational level to significantly influence birth weight.

The results further showed a significant association between occupation of fathers and birth weight of children. Mothers whose partners were salary workers had lower risk of delivering low birth weight babies than those whose partners were not salary workers. This is finding could be due to the fact that salary workers are more likely to be more educated and have reliable source of income to meet the nutritional needs of their pregnant women as family income and maternal nutrition have both been found to influence birth weight (GDHS, 2014; Verhoeff et al., 2001 & Henriksen, 1999).

It was also revealed in correlation analyses that maternal Hb level in all trimesters of pregnancy had positive correlations with birth weight as mothers with higher Hb levels in all trimesters had bigger babies similar to the findings of Rasmussen (2001), who also found strong positive association between maternal haemoglobin concentration and birth weight with lower Hb increasing the risk of low birth weight. This could be due to the higher demand for iron during pregnancy for normal physiological changes (including the growth of the foetus) to take place (Sifakis & Pharmakides, 2000). The study also found significant correlation between parity and birth weight with higher parity (at least 3) increasing the risk of low birth weight similar to the findings of Deshmukh et al. (1996), who also identified parity as one of the risk factors for low birth weight.

Maternal height also correlated positively with birth weight as mothers whose height was at least 160 cm were found to have lower risk of delivering low birth weight babies compared with those whose height were less than 160 cm. Similar to the findings of this study, short maternal stature has also been found to increase the risk of delivering low birth weight children in other studies (Addo et al., 2013; Ramakrishnan, 2004; ACC/SCN, 2000). Maternal body mass index and weight also had significant positive correlations with birth weight with mothers with higher weight and body mass index having protection against low birth weight compared with those with lower weights and body mass index. Deshmukh et al. (1996), also identified low maternal body mass index as one of the risk factors for low birth weight. This shows that finding of this study is consistent with that of Deshmukh et al. (1996).

In a hierarchical multiple regression analysis, maternal gestational weight gain was identified as the strongest predictor of birth weight with low gestational weight gain increasing the risk of low birth weight. Many other studies have also found maternal gestational weight gain to influence birth weight. UNICEF and WHO (2004), found gestational weight gain to influence birth weight while Deshmukh et al. (1996), also identified low pregnancy weight gained as a risk factor for low birth weight. The Administrative Committee on Coordination and Sub-Committee on Nutrition of the United Nations (2000), also mentioned poor maternal nutritional status at conception, low gestational weight gain due to inadequate dietary intake during pregnancy as a major determinant of low birth weight. The finding of this study is therefore consistent with those of UNICEF and WHO (2004); ACC/SCN (2000); and Deshmukh et al. (1996).

The study also identified frequent ANC attendance as an independent predictor of birth weight. Frequent ANC attendance was found to offer significant protection against low birth weight which is consistent with the findings of Fosu et al. (2013), who also found antenatal care to significantly influence birth weight. This finding is in line with the purpose of antenatal care to serves as a means of identifying mothers at risk of low birth weight infants and to provide several available medical, nutritional and educational interventions intended to alleviate the incidence of low birth weight and other adverse pregnancy outcomes (Alexander and Korenbrot, 1995). It is for this reason that antenatal care is seen as one of the recommended interventions to reduce LBW (Merialdi et al., 2003; Zulfiqar et al., 2005).

5.7.2 Infection during pregnancy and birth weight

The results also showed that the occurrence of candidiasis and malaria during pregnancy were both significantly associated with the delivery of low birth weight babies. Repeated episodes of malaria were also found to significantly increase the risk of delivering low birth weight babies. These findings are consistent with the findings of other studies. Malaria and infections such as STDs have also been noted as risk factors for low birth weight (Verhoeff et al., 2001 & Henriksen, 1999). The Administrative committee on Coordination and Sub-Committee on Nutrition of the United Nations (2000), also mentioned infections (acute and chronic like STDs and urinary tract infections) as part of the major determinants for low birth weight in developing countries.

5.7.3 Relationship between hard physical activity during pregnancy and birth weight

The results showed a very strong significant association between the involvement in hard physical work by mothers during pregnancy and birth weight of children with mothers who were involved in hard physical work during pregnancy being more than ten (10) times more likely to give birth to low birth weight babies compared to those who were not involved in such hard physical work during their pregnancy. This finding of the study is consistent with that of UNICEF and WHO (2004), who indicated that involvement in physically demanding work during pregnancy underpinned by poverty also contribute to low birth weight.

5.8 Maternal nutritional status during pregnancy

The results shows that 14.3%, 7.7% and 13.5% of the mothers in the study were anaemic in the first, second and third trimesters of their pregnancy respectively as compared with the results of a study in Nigeria in which the a prevalence of anaemia was found to be 13.2%, 28.1%, and 47.0% in the first, second and third trimesters respectively (Mayet, 1985). The prevalence of anaemia in the first trimester of pregnancy in this study is therefore consistent with the findings of Mayet (1985). The prevalence of anaemia in the second and third trimesters of pregnancy in this study is however much lower compared with the findings of Mayet (1985). The reduction in the prevalence of anaemia in the second and third trimesters of pregnancy in this study could be due to good quality ANC services by health staff to deal with anaemia during ANC as it is one of the key components of ANC (GDHS, 2014). The results also shows that the anaemia status of 15% of the mothers could not be determined in the first trimester which is largely due to late start of antenatal care contrary to the WHO recommendation which says antenatal care should start in the first trimester. The anaemia status of 36% and 29% of the mothers could not also be determined in the second and third trimesters respectively which is an indication that repeated Hb checks are not either requested by health staff or are not done by the mothers contrary to the Ghana Health Service Policy which says the Hb of all pregnant women should be checked at registration and repeated at 28 and 36 weeks of gestation.

About 40% of the women in the study measured below 160 cm in height which indicates poor maternal childhood nutrition (ACC/SCN, 2000; Martorell, 1998) and also constitute a risk factor for low birth weight children (ACC/SCN, 2000; Addo et al. 2013) and stunted growth in children (Subramanian et al., 2009). Good nutrition during pregnancy particularly the last two trimesters is also critical for adequate foetal growth which results in adequate weight gain of 1 kg per month for a total of 6 kg in the last two trimesters which has also been associated with high risk of low birth weight (ACC/SCN, 2000). The result however also shows that 15% of the mothers could not obtain this recommended minimum gestational weight gain which is an indication of poor maternal nutrition during pregnancy (ACC/SCN, 2000). This is a risk factor for delivering low birth weight children (Ramakrishnan, 2004). The gestational weight gain of about 18% of the mothers could not be determined which was largely due to late start of antenatal care (after the first trimester) which made it difficult for their first trimester gestational weight to be determined which is a key factor in determining gestational weight gain.

5.9 Summary of discussions of results

The discussions of the results of the study showed that the findings of this study are to a very large extent consistent with the findings of other researchers and established known facts on the subject matter. Few findings however contradicted the findings of other researchers on the subject matter. The inconsistencies of some of the findings of this study with those of other studies shows that the findings are not conclusive as further studies would be needed to better understand the relationship between those variables.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Main Findings

The main aim of the study was to assess the relationship between maternal characteristics and the weight of a baby at birth and growth in the second year of life in the Tamale Metropolis. To do this, data was collected, analyzed and presented on socio-demographic characteristics by categories of maternal height, the prevalence of low birth weight and macrosomia among children aged 12-23 months, the distributions of two nutritional indexes of children, height-for-age (HAZ) and growth rate by categories of maternal height, the infant and young child feeding practices of mothers and their relationship with child growth, the growth of children less than two years in the study population and the independent determinants of birth weight, stunting and growth rate among others. The main findings of the study included the following;

- The prevalence of low birth weight and macrosomia among children in the Tamale metropolis were relatively high at 21% and 7.7% respectively

- The mean HAZ scores of children of mothers who were less than 160cm tall was lower (-1.2443) compared with those (-0.7125) of children whose mothers were at least 160cm tall while the mean growth rate of children whose mothers were <160cm tall was rather higher (390.7885 grams/month) compared with those (377.8327 grams/month) of children whose mothers were at least 160cm tall.
- In terms of infant and young child feeding practices of mothers, most (96.1% and 95.2%respectively) of the children were given colostrum and were still being breastfed as at the time of the data collection respectively.
- A little above half (52.9%) of the children were introduced to breast within one hour of birth. More than two-thirds of the mothers met the minimum meal frequency (66.2%) and minimum acceptable diet (64.3%) of their children while majority (71.7%) of the mothers also had their children meeting a minimum dietary diversity score of at least four food groups. Generally, appropriate complementary feeding practices of mothers was low, at a rate of 35.7%.
- Infant and young child feeding practices such as initiating breastfeeding within the first hour of birth, timely introduction of complementary food, minimum dietary diversity scores and minimum acceptable diet were all found to have significant positive association with height-for-age Z-scores of children. Feeding colostrum to children on the other hand was found to have negative association with height-for-age Z-score of children.
- Infant and young child feeding practices such as minimum dietary diversity score, minimum acceptable diet and timely introduction of complementary

feeding were also found to have significant positive association with the growth rate of children.

- ❖ The prevalence of stunting, wasting and underweight among children less than two years in the study population were 16.7 %, 15.7 % and 17.9 % respectively.
- ❖ Number of pregnancies, first trimester Hb level, number of ANC attendance, sex of child, maternal height, gestational weight gain and gestational age at delivery were found to be the independent determinants of birth weight.
- ❖ In terms of child growth, maternal educational level, maternal first trimester Hb level, maternal height, age of child and maternal infant and young child feeding practices such as early initiation of breastfeeding within the first one hour of birth, giving colostrum to child, timely introduction of complementary food and minimum dietary diversity score of child were also found to be the independent determinants of height-for-age of children while number of under five children under mother's care, trimester of first ANC attendance, number of pregnancies, maternal BMI, maternal age, birth order of child, and maternal infant and young child feeding practices such as timely introduction of complementary feeding and minimum dietary diversity score of child were also found to be the independent determinants of child growth rate.

6.2 Conclusion

Based on the findings of the study, it can be concluded that there are significant associations between some maternal characteristics and birth weight and growth of children in the second year of life in the Tamale metropolis. Maternal factors such as number of pregnancies, first trimester Hb levels, number of ANC attendance, maternal height, gestational weight gain and gestational age at delivery were found to influence birth weight of children as they had significant positive associations with birth weight of children. Similarly, maternal educational level, maternal first trimester Hb levels, maternal height, number of under-five children under mother's care, trimester of first ANC attendance, number of pregnancies, maternal BMI, maternal age were found to influence early childhood growth.

6.3 Recommendations

Based on the findings of the study, the following recommendations are made to help reduce the prevalence of low birth weight and poor early childhood growth in the Tamale metropolis;

- The Tamale Metropolitan Health Directorate should help train all their ANC and CWC staff on infant and young child feeding practices to help promote appropriate infant and young child feeding practices among mothers and care givers to help reduce under-weight, stunting and low birth weight among children under two years in the metropolis.
- The Tamale Metropolitan Health Directorate should ensure the formation of community health committees in each of their communities to work closely with the community health volunteers and the community members to ensure the continuous sensitization of mothers on the need for early (within the first trimester) and sustained antenatal care attendance during pregnancy to help reduce the prevalence of low birth weight in the Metropolis.
- The Tamale Metropolitan Health Directorate should work to improve the quality of antenatal care services delivered by health staff in the Metropolis to meet the standards of the Ghana Health Services to ensure early detection and resolution of anemia and other danger signs of low birth weight in pregnancy to promote good maternal health and desirable birth outcomes.

- The Tamale Metropolitan Health Directorate should work to improve the quality of CWC services delivered by health staff in the Metropolis to meet the standards of the Ghana Health Services to ensure early detection and resolution of growth faltering among children under five years to help reduce the prevalence of stunting and under-weight among them.
- Government should collaborate with all relevant stakeholders in education to promote girl child education to ensure they are well educated before going into motherhood to promote adequate growth and development of children.
- The Ghana Health Service should develop effective policy guidelines to support care givers to ensure adequate and appropriate nutrition for the girl child from birth through childhood to adolescence and adulthood to ensure proper and adequate growth particularly in height at all stages to ensure adequate maternal height during adulthood and motherhood.
- The Ghana Health Service, NGOs, civil society organizations and other relevant organizations and institutions should strengthen their collaborations and efforts in sensitizing the general public on the need to ensure appropriate birth spacing of their children, at least 39 months between two immediate siblings and the need to plan their families as recommended by the World Health Organization to help reduce the number of under-five children under one care giver as well as the number of pregnancies a woman carries to ensure proper growth and development of children.
- The Ministry of Gender, children and Social Protection, Ghana Health Service, NGOs, civil society organizations and other relevant institutions and organizations should intensify their efforts at ending teenage pregnancy and early marriages among young girls and also include education on the need for

women to avoid giving birth at older age (above 40 years) to ensure adequate birth weight, growth and development of children.

- The Ghana Health Service should intensify its community sensitization on the need for husbands and family members to support their pregnant women to help promote early and sustain antenatal care attendance and ensure adequate nutrition to improve birth outcomes including birth weight.

6.4 Limitation of the study

The study was not without limitations. Like many other studies, the following are the limitations of study;

- Recall bias as respondents may not be able to remember correctly everything they were be asked
- The tendency to impress data collectors may also lead to false information by some respondents.
- Recruitment of study participants at the facility level (at the child welfare clinic), has the tendency to limit the participation of care givers who do not like attending CWC sessions which can also bias the study results.

REFERENCES CITED

Abu-Saad, K. and Fraser, D. (2010). Maternal nutrition and birth outcomes. *Epidemiology review, 32(1)*, 5-25.

ACC/SCN. (1992). *Second report on the world nutrition situation*. Geveva: ACC/SCN, WHO, and Washington, DC: IFPRI.

ACC/SCN. (1992). *Women's nutritional status.* Chapter 4 in: Second report on the world nutrition situation. Volume 1: Global and regional results. ACC/SCN, Geneva.

ACC/SCN. (1993). ACC/SCN *Statement on the Benefits of Preventing Growth Failure in Early Childhood*. P. 36 in: Nutritional Issues in Food Aid. ACC/SCN Symposium Report, Nutrition Policy Discussion Paper No. 12. ACC/SCN, Geneva.

ACC/SCN. (2000). *Low birth weight: Report of a meeting in Dhaka, Bangladesh on 14-17 June, 1999*. Eds. Pojda J. and Kelley L. Nutrition policy paper No.18. Geneva: ACC/SCN in collaboration with ICDDR,B.

Acharya, L. B., & Cleland, J. (2000). Maternal and child health services in rural Nepal: does access or quality matter more? *Health Policy and Planning, 15*, 223 – 229

Addai, I. (2000). Determinants of use of maternal-child health services in rural Ghana. *Journal of Biosocial Science, 32*(1), 1–15

Addo, O. Y., Stein, A. D., Fall, C. H., Gigante, D. P., Guntupalli, A. M., Horta, B. L., Kuzawa, C.W., Lee, N., Norris, S. A., Prabhakaran, P., Richter, L. M., Sachdev, H. S., Martorell, R. (2013). Maternal height and child growth patterns. *Journal Pediatrics, 163*(2), 549 – 554.

Aheto, J. M. K., Keegan, T. J., Taylor, B. M., & Diggle, P. J. (2015). Childhood malnutrition and its determinants among under-five children in Ghana. *Paediatric and Perinatal Epidemiology*, 29(6), 552-561.

Ahmad, M. O., Kalsoom, U., Sughra, U., Hadi, U., & Imran, M. (2011). Effect of maternal anaemia on birth weight. *Journal of Ayub Medical College Abbottabad, 23*(1), 77-79.

Alderman, H. and Behrman, R. J., (2004). Estimated Benefits of Reducing Low Birth Weight in Low-Income Countries. Health, Nutrition and Population (HNP) Discussion Paper. The World Bank, Washington, DC.

Alexander, G. R., & Korenbrot, Carol, C. (1995). The Role of Prenatal Care in Preventing Low Birth Weight. *The Future of Children, 5*(1), 103-120

Ali, D., Saha, K. K., Nguyen, P. H., Diressie, M. T., Ruel, M. T., Menon, P., & Rawat, R. (2013). Household food insecurity is associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam, but the effect is not mediated by child dietary diversity. *The Journal of nutrition*, *143*(12), 2015-2021.

Almond, D., Chay, K. Y., & Lee, D. S. (2005). The Costs of Low Birth Weight. *Quarterly Journal of Economics*, *120*(1), 1031–1083.

American College of Obstetricians & Gynaecologists. (2002). Exercise during pregnancy and the postpartum period: ACOG committee opinion No. 267. *International Journal of Gynecology & Obstetrics*, *99*, 171-173.

Armar-Klemesu, M., Ruel, M. T., Maxwell, D. G., Levin, C. E. & Morris, S. S. (2000). Poor maternal schooling is the main constraint to good child care practices in Accra. *The Journal of Nutrition*, *130*, 1597–1607.

Armstrong, R. J. (1972). A study of infant mortality from linked records by birth weight, period of gestation, and other variables. United States, 1960 live-birth cohort. Washington, DC, U.S. Government Printing Office, 1972 (Vital Health Statistics Series 20(12), DHEW Publication No. (HSM) 72-1055).

Bank, W. (2006). Repositioning nutrition as central to development: a strategy for large-scale action. *Directions in Development (EUA).*

Barker, D. J. P. (2004). The developmental origins of chronic adult disease. *Acta Paediatrica, international journal of paediatrics, Suppl 93*, 26-33.

Becker, S., Peters, D. H., Gray, R. H., Gultiano, C., & Black, R. E. (1993). The determinants of use of maternal and child health services in Metro Cebu, the Philippines. *Health Transition Review*, *3*, 77-89

Behrman, J., & Mark, R. (2001). The retuns to increasing body weight.

Belay, A. & Dosanjh-Matwala, N. (2006). Pregnancy and antenatal care: Attitudes and experiences of Asian women. *Child Care Health and Development*, 2006, *16*, 63-78.

Bentley, A., Das, S., Alcock, G., Shah More, N., Pantvaidya, S. & Osrin, D. (2015), Malnutrition and infant and young child feeding in informal settlements in Mumbai, India: findings from a census. *Food Science Nutrition*, *3*(3), 257–271. doi:10.1002/fsn3.214.

Bernstein, I. M., Horbar, J. D., Badger, G. J., Ohlsson, A. & Golan, A. (2000). Morbidity and mortality among very low-birth-weight neonates with intrauterine growth restriction. The Vermont Oxford Network. American *Journal of Obstetrics and Gynecology 182*, 198-206.

Binkin, N. J., Yip, R., Fleshood, L., & Trowbridge, F. L. (1988). Birth weight and childhood growth. *Pediatrics*, *82*(6), 828-834.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M. et al., & maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: Global and regional exposures and health consequences. *The Lancet*, *371*(9608), 243 – 260.

Blankson, M., Goldenberg, R., Keith, B. (1994). Noncompliance of high-risk pregnant women in keeping appointments at an obstetric complications clinic. *Southern Medical Journal 87*, 634–638.

Bloss, E., Wainaina, F., & Bailey, R. C. (2004). Prevalence and predictors of underweight, stunting and wasting among children aged 5 and under in Western Kenya. *Journal of Tropical Pediatric*, *50*(5), 260 – 270.

Breslau, N., DelDotto, J. E., Brown, G. G., Kumar, S., Ezhuthachan, S., Hufnagle, K. G., & Peterson, E. L. (1994). A gradient relationship between low birth weight and IQ at age 6 years. *Archives of Pediatric and Adolescent Medicine 148*, 377-383.

Brooks-Gunn, J., Klebanov, P., & Duncan, G. (1996). Ethnic differences in children's intelligence test score: Role of economic deprivation, home environment and maternal characteristics. *Child Development*, *67*, 396-408.

Bruce-Chwatt, L. J. (1952). Malaria in African infants and children in southern Nigeria *Annals of Tropical Medicine Parasitology*, *46*(2), 173-177.

Caulfield, L. E., Stoltzfus, R. J., Witter, F. R. (1998). Implications of the institute of medicine weight gain recommendations for preventing adverse pregnancy outcomes in black and white women. *American Journal of Public Health*, *88*(8), 1168-1174.

Ceesay, S. M., Prentice, A. M., Cole, T. J., Ford, R., Poskitt, E., Weaver, L. T. & Whitehead, R. G. (1997). Effects on birth weight and perinatal mortality of maternal dietary supplements in rural Gambia: 5years randomized controlled trial. *British Medical Journal: 315*(7111), 786-790.

Cetin, I., Berti, C., & Calabrese, S. (2009). Role of micronutrients in the periconceptional period. *Human Reproduction Update*, *16*(1), 80–95.

Christian, P. (2010). Maternal height and risk of child mortality and undernutrition. *Jama, 303*(15), 1539-1540.

Conley, D. & Bennett N. (2000). Is biology destiny? Birth weight and life chances. *American Sociological Review, 65*, 458-467.

Currie, J., & Hyson R. (1999). Is the impact of health shocks cushioned by socioeconomic status? The case of low birth weight. AEA papers and proceedings. *Child Welfare. 89*(2), 245-250.

Currie, J., & Hyson, R. (1996). Is the impact of health shocks cushioned by socioeconomic status? The case of low birth weight. *American Economic Review, 2*, 19-22.

Currie, J., & Moretti, E. (2005). Biology as destiny? Short and long-run determinants of intergenerational transmission of birth weight. *Journal of Labor Economics, 25*(2), 231-264.

de Onis, M. (2003). Socioeconomic inequalities and child growth. *International Journal of Epidemiology, 32*, 503-505.

de Onis, M. (2005). Child undernutrition based on the new WHO growth standards and rates of reduction to 2015. Department of Nutrition, World Health Organization.

Deb, P., & Sosa-Rubi, S. G. (2005). Does onset or quality of prenatal care matter more for infant health? *Health Econometrics and Data Group Working Paper*. (05/11).

Deshmukh, J. S., Motghare, D. D., Zodpey, S. P., & Wadhva, S. K. (1999). Low birth weight and associated maternal factors in an urban area. *Indian Pediatrics, 35*(1), 33-36.

Dharmalingam, A., Navaneetham, K., Krishnakumar, C. S. (2010). Nutritional status of mothers and low birth weight in India. *Maternal Child Health Journal, 14*, 290–298.

Disha, A. D., Rawat, R., Subandoro, A., & Menon, P. (2012). Infant and young child feeding (IYCF) practices in Ethiopia and Zambia and their association with child nutrition: analysis of demographic and health survey data. *African Journal of Food, Agriculture, Nutrition and Development, 12*(2), 5895-5914.

Dwarkanath, P. Muthayga, S., Vaz, M., Thomas, T., Mhaskar, R., & Kurpad, A., (2007). The relationship between maternal physical activity during pregnancy and birth weight. *Asia Pacific Journal of Clinical Nutrition, 16*(4), 704-710.

Elo, I.T., (1992). Utilization of maternal health-care services in Peru: the role of women's education. *Health Transition Review 2*, 49 -69.

Emanuel, I., Filakti, H., Alberman, E., & Evans, S. (1992). Intergenerational studies of human birth weight from the 1958 birth cohort. Evidence for a multigenerational effect. *British Journal of Obstetrics and Gynaecology, 99*, 67-74.

Espo, M., Kulmala, T., Maleta, K., Cullinan, T., Salin, M. L., & Ashorn, P. (2002). Determinants of linear growth and predictors of severe stunting during infancy in rural Malawi. *Acta Paediatrica, 91*(12), 1364-1370.

Fosu, M. O., Munyakazi, L. & Nsowah-Nuamah N. N. N. (2013). Agriculture and Healthcare. *Journal of Biology, 3*(7), 205-211

Ghana Health Service and SPRING Ghana. (2017). Health Worker Training Manual for Anaemia Control in Ghana. Participant Guide. Arlington, VA:

Strengthening Partinaships, Results and Innovations in Nutrition Globally (SPRING) Project.

Ghana Health Service. (2014). Annual report of the nutrition unit of the Northern Regional Health Directorate. Tamale, Ghana.

Ghana Health Service. (2014). Annual report of the Tamale Metropolitan Health Directorate. Tamale, Ghana.

Ghana Health Service. (2017). Annual report of the Tamale metropolitan health Directorate. Tamale, Ghana.

Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF International. (2015). "2015. Ghana Demographic and Health Survey 2014." Rockville, Maryland, USA: GSS, GHS, and ICF International.

Ghana Statistical Service (GSS). (2008). Ghana Demographic and Health Services 2008. Accra-Ghana: GSS, GHS and ICF Macro.

Ghana Statistical Service (GSS). (2011). Ghana Multiple Indicator Cluster Survey 2010 (MICS)-Monitoring the situation of children, women and men. Accra-Ghana; GSS/MOH/UNICEF.

Ghana Statistical Service. (2012). 2010 Population and Housing Census. Ghana Statistical Service, Accra.

Ghana Statistical Service. (2012). 2010 Population and Housing Census. Ghana Statistical Service, Accra.

Ghosh, S., & Shah, D., (2004). Nutritional problems in urban slum children: Environmental Health Project Special Article Series. *Indian Pediatrics, 41*, 682–696.

Gibson, R. S., Ferguson, E. L., & Lehrfeld, J. (1998). Complementary foods for infant feeding in developing countries: their nutrient adequacy and improvement. *European Journal of Clinical Nutrition, 52*(10), 764.-770.

Gilstrap III, L. C., & Ramin, S. M. (2001). Urinary tract infections during pregnancy. *Obstetrics and gynecology clinics of North America, 28*(3), 581-591.

Goonewardene, M., Shehata, M., & Hamad, A. (2012). Anaemia in pregnancy: Best practice & research. *Clinical obstetrics & gynaecology, 26*(1), 3-24.

Grantham-McGregor, S. M., Powell, C. A., Walker, S. P., & Himes, J. H. (1991). Nutritional supplementation, psychosocial stimulation, and mental development of stunted children: The Jamaica study. *The Lancet, 338*, 1-5.

Guyatt, H. L., & Snow, R. W. (2004). Impact of malaria during pregnancy on low birth weight in sub-Saharan Africa. *Clinical microbiology reviews, 17*(4), 760-769.

Hales, C. N., Barker, D. J., Clerk, P. M., Cox, L. J., Fall, C., Osmond, C., & Winter P. D. (1991). Fetal and infant growth and impaired glucose tolerance at age 64. *British Medical Journal 303*, 1019-1022.

Hambridge, K. M., Mazariegos, M., Kindem, M., Wright, L. L, Cristobal-Perez, C., & Juarez-Garcia, L. (2012). Infant stunting is associated with short maternal stature. Journal of pediatric gastroenterology and nutrition, 54(1), 117 – 119.

Henriksen, T. (1999). Fetal Nutrition, Fetal Growth Restriction and Health Later in Life. *Acta Paediatrica, 88*, 4-8.

Hoddinott, J., Maluccio, J. A., Behrman, J. R., Flores, R., & Martorell, R. (2008). Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *The lancet*, *371*(9610), 411-416.

Imdad, A., & Bhutta, Z. A., (2012). Routine iron/folate supplementation during pregnancy: Effects on maternal anaemia and birth outcomes. *Paediatric and perinatal epidemiology*, *26*(s1), 168-177.

Jackson, A. A., & Robinson, S. M. (2001). Dietary guidelines for pregnancy: A review of current evidence. *Public health nutrition*, *4*(2B), 625-630.

Jaquet, D., Gaboriau A., Czernichow, P., & Levy-Marchal C. (2000). Insulin resistance early in adulthood in subjects born with intrauterine growth retardation. *Journal of Clinical Endocrinology and Metabolism 85*, 1401-1406.

Jeannette, R. I., Kershaw, T. S., Westdahl, C., Rising S. S., Klima, C., Reynolds, H., & Magriples, U. (2003). Group prenatal care and preterm birth weight: Results from a matched cohort study at public clinics. *Obstetrics & Gynecology*, *102*(5), 1051-1057.

Jones, G., Steketee, R. W., Black, R. E., Bhutta, Z. A., Morris, S. S., & Bellagio Child Survival Study Group. (2003). How many child deaths can we prevent this year? *The lancet*, *362*(9377), 65-71.

Keino, S., Plasqui, G., Ettyang, G., & van den Borne, B. (2014). Determinants of stunting and overweight among young children and adolescents in sub-Saharan Africa. *Food and Nutrition Bulletin*, *35*(2), 167-178.

Khoshnood, B., Lee, K. S., Wall, S., Hsieh, H. L., & Mittendorf, R. (1998). Short interpregnancy intervals and the risk of adverse birth outcomes among five racial/ethnic groups in the United States. *American Journal of Epidemiology*, *148*, 798–805.

Knops, N. B., Sneeuw, K. C., Brand, R., Hille, E. T., den Ouden, A. L., Wit, J. M., & Verloove-Vanhorick, S. P. (2005). Catch-up growth up to ten years of age in children born very preterm or with very low birth weight. *BMC pediatrics*, *5*(1), 26.

Kramer, M. (1998). Socioeconomic determinants of intrauterine growth retardation, *European Journal of Clinical Nutrition, 52*(81), S29-S33.

Kramer, M. S. (2000). Balanced protein/energy supplementation in pregnancy. *The Cochrane database of systematic reviews*, (2), CD000032-CD000032.

Kramer, M. S. (2003). Effects of energy and protein intakes on pregnancy outcome: an overview of the research evidence from controlled clinical trials. *The American journal of clinical nutrition, 58*(5), 627-635.

Kramer, M. S., & Victora C. G. (2001). *Low birth weight and perinatal mortality in nutrition and health in developing countries*. Humanas Press, New Jersey.

Kramer, M.S. (1987). Intrauterine growth and gestational determinants. *Pediatrics*, *80*(4), 502-511

Krueger, P. M., & Scholl, T. O. (2000). Adequacy of prenatal care and pregnancy outcome. *The Journal of the American Osteopathic Association*, *100*(8), 485-492.

Launer, L. J., Villar, J., Kestler, E., & de Onis, M. (1990). The effect of maternal work on fetal growth and duration of pregnancy: a prospective study. *BJOG: An International Journal of Obstetrics & Gynaecology*, *97*(1), 62-70.

Lawson, J. B., (1967). Anaemia in pregnancy.

Lee, A. I., & Okam, M. M. (2011). Anemia in pregnancy. *Hamatology/oncology clinics of North America*, *25*(2), 241-259.

Lenders, C. M., McElrath, T. F., & Scholl, T. O. (2000). Nutrition in adolescent pregnancy. *Current opinion in pediatrics*, *12*(3), 291-296.

Limwattananon, S., Tangcharoensathien, V., & Prakongsai, P. (2010). Equity in maternal and child health in Thailand. *Bulletin of the World Health Organization 88*, 420–427.

Lincetto, O., Mothebesoane-Anoh, S., Gomez, P., & Munjanja, S. (2006). Antenatal care. Opportunities for Africa's new-borns: Practical data, policy and programmatic support for new-born care in Africa. *New York: World Health Organization*.

Lincetto, O., Mothebesoane-Anoh, S., Gomez, P., & Munjanja, S. (2010). Antenatal care: Opportunities for Africa's newborns. *New York: World Health Organiation*.

Lutter, C. K. (2003). Macrolevel approaches to improve the availability of complementary foods. *Food and Nutrition Bulletin*, *24*(1), 83-103.

Lutter, C. K., & Chaparro, C. M. (2008). Malnutrition in infants and young children in Latin America and the Caribeans: Achieving the Millennium Development Goals. *Pan American Health Organization: Washington D.C.*

Lutter, C. K., & Rivera, J. A. (2003). Nutrition of Infants and young children and characteristics of their diet. *The Journal of Nutrition*, *133*(9), 2941S-2949S.

Magadi, M. A., Madise, N. J., Rodrigues, R. N. (2000). Frequency and timing of antenatal care in Kenya: explaining the variations between women in different communities. *Social Science and Medicine 51*, 551-561

Magadi, M. A., Madise, N. J., Rodrigues, R. N. (2000). Frequency and timing of antenatal care in Kenya: explaining the variations between women in different communities. *Social Science and Medicine 51*, 551-561

Malawi National Reproductive Health Service (2001). National Family Planning Coordinating Board. Ministry of Health, ORC Malawi *Demographic and Health Survey 2000.* Calverton: MPS and ORC Macro;2000.

Maluccio, J. A., Hoddinott, J., Behrman, J. R., Martorell, R., Quisumbing, A. R., & Stein, A. D. (2009). The impact of improving nutrition during early childhood on education among Guatemalan adults. *The Economic Journal*, *119*(537), 734-763.

Marorell, R. (1992). Long-term effects of improved childhood nutrition. *SCN news, 8*, 10-12.

Marriott, B. P., White, A., Hadden, L., Davies, J. C., & Wallingford, J. C. (2012). World Health Organization (WHO) infant and young child feeding indicators:

associations with growth measures in 14 low-income countries. *Maternal & child nutrition*, *8*(3), 354-370.

Martorell, R., Yarbrough, C., Yarbrough, S., & Klein, R. E. (1980). The impact of ordinary illnesses on the dietary intakes of malnourished children. *The American journal of clinical nutrition*, *33*(2), 345-350.

Mayet, F. G. (1985). Anaemia of pregnancy. *South African medical journal= Suid-Afrikaanse tydskrif vir geneeskunde*, *67*(20), 804-809.

Mbuya, M. N., Chideme, M., Chasekwa, B., & Mishra, V. (2010). Biological social and environmental determinants of low birth weight and stunting among infants and young children in Zimbabwe.

McCaw-Binns, A., La Grenade, J. & Ashley, D. (1995). Under-users of antenatal care: a comparison of non-attenders and late attenders for antenatal care, with early attenders. *Social Science and Medicine 40*, 1003-1012

Mcintire, D. D., Bloom, S. L., Casey, B. M., & Leveno, K. J. (1999). Birth weight in relation to morbidity and mortality among newborn infants. *The New England Journal of Medicine*, *340*(16), 1234-1238.

McLaughlin F. J., Altemeier, W. A., Christensen, M. J., Sherrod K. B., Dietrich M. S., & Stern D. T. (1992). Randomized trial of comprehensive prenatal care for low-income women: Effect on infant birth weight. *Pediatrics, 89,* 128–32.

Merialdi, V., Kogan, M. D., Alexander, G. R., Kotelchuck, M., Nagey, D. A., (2003). Relation of the content of prenatal care to the risk of low birth weight. *Jama*, *271*, 1340-5.

Mockenhaupt, F. P., Rong, B., Grunther, M., Beck, S., Till, H., Kohne, E., & Bienzle, U. (2000). Anaemia in pregnant Ghanaian women: Importance of malaria, iron deficiency and haemoglobinopathies. *Transactions of the Royal Socienty of Tropical Medicine and Hygiene*, *94*(5), 477-483.

Monteiro, C. A., Benicio, M. H. D. A., Conde, W. L., Konno, S., Lovadino, A. L., Barros, A. J., & Victora, C. G. (2010). Narrowing socioeconomic inequality in child stunting: the Brazilian experience, 1974-2007. *Bulletin of the World Health Organization*, *88*, 305-311.

Ogbeide, O., Wagbatsonma, V., & Orhue, A. (1994). Anaemia in pregnancy. *East African Medical Journal*, *71*(10), 671-673.

Ota, E., Tobe-Gai, R., Mori, R., & Farrar, D. (2012). Antenatal dietary advice and supplementation to increase energy and protein intake. *Cochrane Database of Systematic Reviews*, *9*.

Ota, et al. (2010). Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. *Bulletin of the World Health Organization*, *89*, 127-136.

Overbosch, G. B., Nsowah-Nuamah, N. N. N., Van den Boom, G. J. M., & Damnyag, L. (2004). Determinants of antenatal care use in Ghana. *Journal of African Economies*, *13*(2), 277-301.

Özaltin, E., Hill, K., & Subramanian, S. V. (2010). Association of maternal stature with offspring mortality, underweight, and stunting in low-to middle-income countries. *Jama*, *303*(15), 1507-1516.

Perkins, C. C., Pivarnik, J. M., Paneth, N., & Stein, A. D. (2007). Physical activity and fetal growth during pregnancy. *Obstetrics &Gynecology, 109*(1), 81-87.

Pivarnik, J. M. (1998). Potential effects of maternal physical activity on birth weight: brief review. *Medicine and science in sports and exercise, 30*(3), 400-406.

Prada, J. A., & Tsang, R. C. (1998). Biological mechanisms of environmentally induced causes of IUGR. *European Journal of Clinical Nutrition, 52,* S21-S27.

Radhakrishnan A. K., (2010). Antenatal Care

Raghupathy, S. (1996). Education and the use of maternal health care in Thailand. *Social Science & Medicine*, *43*(4), 459-471.

Ramakrishnan, U. (2004). Nutrition and low birth weight: from research to practice. *The American journal of clinical nutrition*, *79*(1), 17-21.

Rao, S., Kanade, A., Margetts, B. M., Yajnik, C. S., Lubree, H., Rege, S., ... & Fall, C. H. (2003). Maternal activity in relation to birth size in rural India. The Pune Maternal Nutrition Study. *European journal of clinical nutrition*, *57*(4), 531-542.

Rasmussen, K., M. (2001). Is there a causal relationship between iron deficiency anaemia and birth weight, length of gestation and perinatal mortality? *The Journal of Nutrition, 131*(2), 590s-603s.

Roy, M. (2016). Maternal infection, malnutrition, and low birth weight. *Journal of Postgraduate Medicine*, *62*(4), 270–271.

Ruel, M. T. & Menon, P. (2002). Child feeding practices are associated with child nutritional status in Latin America: innovative uses of the demographic and health surveys. *The Journal of Nutrition, 132, 1180–1187.*

Saaka, M. & Abaah I. (2015). Maternal and infant factors associated with child growth in the first years of life. *Science Journal of Public Health, 3*(5), 775 – 781.

Saaka, M., Wemakor, A., Abizari, A. R., & Aryee, P. (2015). How well do WHO complementary feeding indicators relate to nutritional status of children aged 6–23 months in rural Northern Ghana? *BMC public health*, *15*(1), 1157.

Schieve, L. A., Handler, A., Hershow, R., Persky, V., & Davis, F. (1994). Urinary tract infection during pregnancy: its association with maternal morbidity and perinatal outcome. School of Public Health, University of Illinois at Chicago 60680. *American journal of public health*, *84*(3), 405-410.

SCN, (2008). SCN News 36: *Accelerating the reduction of maternal and child undernutrition*. Lavenham Press: UK.

Shekar, M., Heaver, R., & Lee, Y. K. (2006). *Repositioning nutrition as central to development: A strategy for large scale action*. World Bank Publications.

Shults, R. A., Arndt, V., Olshan, A. F., Martin, C. F. & Royce, R. A. (1999). Effects of short interpregnancy intervals on small-for-gestational age and preterm births. *Epidemiology, 10*, 250–254.

Sifakis, S., & Pharmakides, G. (2000). Anaemia in pregnancy. *Annals of the New York Academy of Sciences, 900*(1), 125-136.

Simkhada, B., Teijlingen, E. R. V., Porter, M., & Simkhada, P. (2008). Factors affecting the utilization of antenatal care in developing countries: systematic review of the literature. *Journal of advanced nursing*, *61*(3), 244-260.

Spencer, N., Bambang, S., Logan, S., & Gill, L., (1999). Socioeconomic status and birth weight: comparison of an area-based measure with the Registrar Geneal's social class. *Journal of Epidemiology & Community Health, 53*(8), 495-498.

Steketee, R. W., Nahlen, B. L., Parise, M. E., & Menendez, C. (2001). The burden of malaria in pregnancy in malaria-endemic areas. *The American journal of tropical medicine and hygiene*, *64*(1_suppl), 28-35.

Subramanian, S. V., Ackerson, L. K., Smith, G. D., & John, N. A. (2009). Association of maternal height with child mortality, anthropometric failure, and anemia in India. *Jama, 301*(16), 1691-1701.

Swenson, G., Munim, S., Rahbar, M. H., Rizvi, M. & Mushtaq, N. (1993). The effect of grandmultiparity on pregnancy related complications: the Aga khan University experience. *Journal-Pakistan Medical Association, 50*(2), 54-57.

Tafari, N., Naeye, R. L., & Gobezie, A. (1980). Effects of maternal under-nutrition and heavy physical work during pregnancy on birth weight. BJOG: *An International Journal of Obstetrics & Gynaecology, 87*(3), 222-226.

Tamale Metropolitan Assembly, (2012). Profile of the Tamale Metropolis. Tamale Metropolitan Assembly, Tamale.

Teshome, B., Kogi-Makau, W., Getahun, Z., & Taye, G., (2009). Magnitude and determinants of stunting in children under five years of age in food surplus region of Ethiopia: the case of west Gojam zone. *Ethiopian Journal of Health Development*, *23*(2), 98-106.

Tiwari, R., Ausman, L. M., & Agho, K. E., (2014). Determinants of stunting and severe stunting among under-fives: evidence from the 2011 Nepal Demographic and Health Survey. *BMC pediatrics*, *14*(1), 239.

Tomkins, A., Murray, S., Rondo, P., & Filteau, S. (1994). Impact of maternal infection on foetal growth and nutrition. *SCN news*, (11), 18-20.

Torres-Arreola, L. P., Constantino-Casas, P., Flores-Hernández, S., Villa-Barragán, J. P., & Rendón-Macías, E. (2005). Socioeconomic factors and low birth weight in Mexico. *BMC Public health*, *5*(1), 20.

UNICEF. Division of Communication. (2009). *Tracking progress on child and maternal nutrition: a survival and development priority*. UNICEF, New York.

United Nations International Children's Emergency Fund & URC/CHS, (2012). *Community Infant and Young Child Feeding Counselling Package*: *Facilitators' Guide*. UNICEF, New York

United Nations International Children's Emergency Fund & World Health Organization, (2004). *Low birth weight: Country, regional and global estimates.* UNICEF: New York.

United Nations International Children's Emergency Fund, (1998). The state of the world's children 1998: Malnutrition - causes, consequences and solutions. *Nutrition Review*, 56(4), 115-23.

United Nations, (2007). *Guideline for Reproductive Health*. United Nations Population Network, Department of Economic and Social Affairs with the support from the UN Population Fund. UN: Geneva.

Varela-Silva, M. I., Azcorra, H., Dickinson, F., Bogin, B., & Frisancho, A. R. (2009). Influence of maternal stature, pregnancy age, and infant birth weight on growth during childhood in Yucatan, Mexico: a test of the intergenerational effects hypothesis. *American Journal of Human Biology*, *21*(5), 657-663.

Verhoeff, F. H., Brabin, B. J., van Buuren, S. Chimsuku, L., Kazembe, P., Wit. J. M., Broadhead, R. L., (2001). An analysis of intrauterine growth retardation in rural Malawi. *European Journal of Clinical Nutrition*, *55*, 682-689.

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., ... & Maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: consequences for adult health and human capital. *The lancet*, *371*(9609), 340-357.

Villar, J. & Belizan, (1982). The Relative Contribution of Prematurity and Fetal Growth Retardation to Low Birth weight in Developing and Developed Societies. *American Journal of Obstetrics and Gynecology 143*, 793-798.

Villar, J. & Rivera, J. A., (1988). Nutritional supplementation during two consecutive pregnancies and the interim lactation period: effect on birth weight. *Pediatrics*, *81*(1), 51-57

Villar, J., Ba'aqeel, H., Piaggio, G., Lumbiganon, P., Belizán, J. M., Farnot, U., ... & Langer, A. (2001). WHO antenatal care randomised trial for the evaluation of a new model of routine antenatal care. *The Lancet*, *357*(9268), 1551-1564.

Walker, S. P., Chang, S. M., Powell, C. A., & Grantham-McGregor, S. M. (2005). Effects of early childhood psychosocial stimulation and nutritional supplementation on cognition and education in growth-stunted Jamaican children: prospective cohort study. *The lancet*, *366*(9499), 1804-1807.

Watkinson, M., & Rushton, D. I. (1983). Plasmodial pigmentation of placenta and outcome of pregnancy in West African mothers. *British Medical Journal*, 287(6387), 251-254.

WHO Multicentre Growth Reference Study Group. (2006). WHO Child Growth Standards: Methods and development: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age. *Geneva: World Health Organization*.

WHO, (2001). Iron deficiency anaemia: Assessment, prevention, and control: a guide for programme managers, 47-62.

WHO, (2010). Indicators for assessing infants and young child feeding practices: Part 3- Country profile. Geneva.

Wilcox, A. J., & Rosell, I. T. (1983). Birth weight and perinatal mortality: II. On weight-specific mortality. *International Journal of Epidemiology, 12*(3), 319-325.

Wong, E. L., Popkin, B. M., Guilkey, D. K. & Akin, J. S. (1987). Accessibility, quality of care and prenatal care use in the Philippines. *Social Science and Medicine*, *24*(11), 927 -944.

Zanconato, G., Msolomba, R., Guarenti, L., & Franchi, M. (2006, February). Antenatal care in developing countries: the need for a tailored model.

In *Seminars in Fetal and neonatal Medicine* (Vol. 11, No. 1, pp. 15-20). WB Saunders.

Zhang, X., Decker, A., Platt, R. W., & Kramer, M. S. (2008). How big is too big? The perinatal consequences of fetal macrosomia. *American Journal of Obstetrics and Gynecology, 198*(5), 517.e1-517.e6.

Zhu, B. P., Rolfs, R. T., Nangle, B. E., & Horan, J. M. (1999). Effect of the interval between pregnancies on perinatal outcomes. *New England journal of medicine*, *340*(8), 589-594.

Zhu, B.P., Haines, K. M., Le, T., McGrath-Miller, K. & Boulton M. L. (2001). Effect of the interval between pregnancies on perinatal outcomes among white and black women. *American Journal of Obstetrics. Gynecology*, 185(6), 1403–1410.

Zulfiqar S., Savitz D. A., & Pastore L. M., (2005). *Causes of prematurity. McCormick MC, Siegel JE. Eds. Prenatal Care: Effectiveness and Implementation*. Cambridge UK: Cambridge University Press 2005:63-104.

APPENDICES

Appendix 1: Survey Questionnaire

UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

THE GRADUATE SCHOOL

SCHOOL OF MEDICINE AND HEALTH SCIENCES

Questionnaire for a Survey in the Tamale Metropolis

TOPIC: ***Maternal Characteristics Influencing Birth Weight and Early Childhood Growth in the Tamale Metropolis***

Principal investigator: Eliasu Yakubu

Address: P. O. Box DT 11, Tamale

Contact: 0242641436/0209747070

Informed Consent

Hello. My name is……………………………………………. I am working for Mr. Eliasu Yakubu, a master's student at the University for Development Studies. He is conducting a survey on the topic "Maternal characteristics influencing birth weight and early childhood growth in the first two years of life in the Tamale Metropolis". This is in partial fulfillment of the requirement for the award of master's degree in Community Health and Development. You and your child have been selected to be part of the study to respond to a questionnaire which will take about 30 minutes to of your time.

Any information you will give will be treated confidential and will not be shared with anyone else except members of the survey team. All information given will only be used for the purpose of this study and nothing else.

Your participation in the study is purely voluntary and so you are at liberty to opt out. We would however be grateful if you agree to participate since your views are important to the researcher and for the success of the study.

There is no material or monetary benefit for participating in this survey. However, the indirect benefit will be that by participating in the study, you would help contribute to the success of the study whose results can inform policy change to improve health for all including yourself.

There is no any possible health risk identified to be associated with your participation in this study. For more information, you may contact Mr. Eliasu Yakubu on 0242641436/0209747070. If you agree to be part of the study, you need to sign or thumbprint below.

I certify that the purpose, benefit and possible risk associated with the participation in this study has been read/explained to me and my participation is based on my own voluntary decision to be part of the study as a respondent.

………………………………..
……………..………………………

Date Signature /thumbprint of respondent

……………………………….

……………………………………

Date Signature of interviewer

SECTION A: IDENTIFICATION

A1. Date of interview ____ /____ /2015 A2. Questionnaire ID number………………..

A3. Interviewer's name: …………………….. A4. Community Name ………………………

A5. Community type 1. Rural 2. Urban 3. Peri-urban

A6. Household name……………………… A7. Name of facility…………………………

SECTION B: SOCIODEMOGRAPHIC CHARACTERISTICS

B1. What is the name of your hild? ....

B2. Sex of child 1. Male 2. Female

B3. How old is your child? (In completed months).......................

B4. How old are you? ....

B5. What is your level of education? 1. No education 2. Primary
3. JHS/Middle sch. 4. SHS 5. College/Polytechnic 6. Degree

B6. What is your marital status? 1. Married 2. Divorced 3. Single

B7. Which religion do you belong to? 1. Islam 2. Christianity
3. Traditional religion 4. No religion 5. Other, specify……………………….

B8. Aside from your own housework, what is your main source of income?

1. Trader/Vendor
2. Agricultural worker (e.g. farmer)
3. Office worker (Civil Servant)
4. Service worker (e.g. Hair-dresser, seamstress)
5. Education/research (Teacher)
6. Healthcare (e.g. Nurse)
7. Nothing

8. Others, specify

B9. What is your partner's occupation?

1. Trader/Vendor
2. Agricultural worker (e.g. farmer)
3. Office worker (Civil Servant)
4. Service worker (e.g. Hair-dresser, seamstress)
5. Education/research (Teacher)
6. Healthcare (e.g. Nurse)
7. Nothing
8. Others, specify

B10. What is the total number of children under five in your household? ....

B11. What tribe are you? 1. Dagomba 2. Gonja 3. Mosi 4. Grusi 5. Akan

6. Ga-adangme 7. Konkomba 8. Ewe 9. Mamprusi 10. Other……………

SECTION C: MATERNAL CARE AND NUTRITION DURING PREGNANCY

C1. Number of pregnancies---

C2. Number of live deliveries---

C3. Did you ever attend ANC service when you were carrying (Child's Name) pregnancy?

1. Yes 2. No

C4. If yes, where did you attend the ANC services? 1. Teaching hospital 2. District hospital 3. Private hospital 4. Clinic/health centre 5. Private clinic/health center

C5. How many months old was your pregnancy when you first attended ANC

services? (Verify from ANC records)…………

C6. Record from the mother's antenatal card the number of times she visited a health care center for prenatal care services during pregnancy with [child's name]……………………

`SECTION D: HEALTH STATUS ASSESSMENT

D1. Blood pressure at recruitment (first trimester)……………………….

D2. Blood pressure at 36 weeks gestation………………………………..

D3. Number of Malarial infections during pregnancy…………………….

D4. Had candidiasis during pregnancy?..

D5. Did you ever receive education/counseling on your nutritional needs as a pregnant woman during ANC service when you were pregnant with (Child's Name)?
1. Yes 2. No
D6. Did you ever receive /take iron supplements during your pregnancy with (Child's Name) pregnancy? 1. Yes 2. No
D7. Number of tetanus toxoid (TT) injections received during the last pregnancy (Interviewer should check from the maternal health records booklet)…………………………….

D8. Number of sulphadoxine pyremethamine (SP) doses received during the last pregnancy (check from maternal health records booklet)………………………………………………….

D9. Did you have malaria during your pregnancy with (Child's Name)? 1. Yes 2. No

D10. If yes, how many times did you have malaria during the pregnancy?..................

D11. Complete the table below for maternal Hb during the pregnancy with (Child's Name) using mother's ANC book

Stage of pregnancy	**1st trimester**	**2nd trimester**	**3rd trimester**
Hb (g/dl)			

D12. Were you involved in physical hard work during your pregnancy with (Child's Name)?
1. Yes 2. No

D13. If yes, specify the type of physical hard work……………………………………………….

SECTION E: PREGNANCY AND BIRTH INFORMATION

E1. At what gestational age (in weeks) did mother deliver index child? (Check from ANC card) ....

E2. Where did your deliver (Name of child)?

1. At home
2. CHPS Compound
3. Clinic
4. Maternity home
5. Health centre
6. Hospital
7. Traditional Birth Attendant

E3. How did you deliver (Child's Name)? 1. Normal vaginal delivery 2. Caesarean section

E4. Who assisted you during delivery?

1. Doctor
2. Midwife
3. TBA
4. Mother in-law
5. Self delivery.
6. Other relatives

D5. What is the birth order of (Child's Name)

1. 1st 2. 2nd 3. 3rd 4. 4th 5. 5th 6. 6th 7. 7th and more

SECTION E: INFANT AND CHILD FEEDING PRACTICES OF MOTHER

E1. Is your child currently breastfeeding? 1. Yes 2. No

E2. After delivery of the index child, how long did it take you to breastfeed him/her for the first time?

1. Within 30 minutes of delivery
2. During the first hour after delivery
3. 2-8 hours
4. The next day
5. Do not remember

E3. Before putting child to the breast for the first time after delivery, what was child given to drink? (Multiple responses possible)

1. Nothing
2. Milk (other than breast milk)
3. Plain water
4. Sugar or glucose water
5. Gripe water
6. Sugar-salt-water solution
7. Fruit juice
8. Infant formula
9. Tea / infusions
10. Honey
11. Other (specify) _____________

E4. When you delivered (Name of child) what did you do with the first yellowish breast milk?

1. Give it to the baby 2. Discard it/spill it 3. Don't know

E5. Did (name of child) drink anything from a bottle with a nipple during the past 24 hours? 1. Yes 2. No

E6. Is child currently eating other foods apart from breast milk?

1. Yes 2. No

E7. If yes, when did you start complementary feeding?………….

1. Before 6 months 2. At 6 months 3. 7 to 9 months
4. After 9 months 5. Yet to start

SECTION F : DIETARY INTAKE OF MOTHER AND CHILD

Mention how frequent the following foods/food items were consumed by the mother in the past 7 days

How many days did you eat the following foods in the past week?	7 Days per week	4 -6 Days per week	1-3 Days per week	Hardly ever or never	General comments
Flesh meats (beef. Lamb etc)					
Poultry					
Organ meats (e.g. liver)					
Fish					
Cereals					
Roots & tubers (yam, cassava etc.)					
Legumes (e.g. beans, nieri, groundnuts)					
Milk products					
Egg					
Fruits					
Leafy green vegetables					

DIETARY INTAKE OF CHILD

F1. Yesterday did [child's name] eat any solid or semi-solid foods?

1. Yes 2. No 3. Does not apply (child does not eat solid food)
4. Does not know

F2. How many times did (Name of child) eat solid or semi-solid food or soft foods other than liquids yesterday during the day or at night? …………………………….

F3a Please, mention all the foods and drinks that were eaten by (Name of child) over the past 24 hours whether at home or outside the home. (Hint: start with meal eaten at supper yesterday).

Eating moment	**Name of dish**	**Ingredients**
Breakfast		
Snack before lunch		
Lunch		
Snack before dinner		
Dinner		
Snack after dinner		
Drinks		

F3b. From the meals mentioned by the mother above, indicate whether (Name of child), ate from the following food groups during the past 24 hours whether at home or outside the home.

Group	**Food lists**	**No**	**Yes**
Group 1: Grains, roots and tubers	Porridge, bread, rice, T.Z, banku or other foods made from grains		
	White potatoes, white yams, fufu, cassava or any other foods made from roots		
Group 2: Legumes and nuts	Any foods made from beans, peas, lentils, nuts or seeds		
Group 3: Dairy products	Milk and milk products including tinned, powdered or fresh animal milk, yogurt or drinking yogurt, cheese or other dairy products		
Group 4:	Liver, kidney, heart or other organ meats		

Flesh foods	Any meat, such as beef, pork, lamb, goat, chicken or duck		
	Fresh or dried fish, shellfish or seafood		
	Grubs, snails or insects		
Group 5: Eggs	Eggs		
Group 6: Vitamin A fruits and vegetables	Pumpkin, carrots, squash or sweet potatoes that are yellow or orange inside		
	Any dark green vegetables [**bean, cassava, ayoyo etc**]		
	Ripe mangoes (fresh or dried [not green]), ripe pawpaw (fresh or dried **[mangoes**, carrots**]**		
	Foods made with red palm oil, red palm nut or red palm nut pulp sauce		
Group 7: Other fruits and vegetables	Any other fruits or vegetables		

SECTION G: HOUSEHOLD SOCIO-ECONOMIC STATUS *(Housing, Facilities and Assets)*					
G1	**OBSERVE AND RECORD. Do not**	1	SEPARATE HOUSE (Bungalow)	5	SEVERAL HUTS/BUILDINGS [SAME

	ask questions! Describe the housing structure. **Circle one**.				COMPOUND]		
		2	SEMI-DETACHED HOUSE	6	SEVERAL HUTS/BUILDINGS [DIFFERENT COMPOUND]		
		3	FLAT/APPARTMENT	7	OTHER (SPECIFY):………………..		
		4	ROOM(S)/COMPOUND HOUSE				
G2	Do you or your household own or rent this dwelling? **Circle one**	1	Own	4	Don't know		
		2	Don't own but live for free	5	Other, specify: ________________		
		3	Pay Rent				
G3	How many rooms in this dwelling are used for sleeping?	__ __ Rooms					
G4	How many people usually sleep in these units/rooms?	__ __ Persons					
G5	Do not read answers. Circle one. What kind of toilet do members of your household usually use?	1	Flush/Pour Toilet				
		2	Ventilated Improved Pit Latrine (VIP)				
		3	Pit latrine with slap				
		4	Pit latrine without slap/open pit				
		5	Bucket/Pan				
		6	Composting toilet				
		7	No facilities (bush, beach, etc)				
G6	Do not read answers. Circle one. What is the main source of energy for cooking?	1	Electricity	5	Kerosene		
		2	Straw/Shrubs/Grass/wood	6	Charcoal		
		3	Liquefied Petroleum Gas (LPG)	7	Solar		
		4	Animal dung	8	other:____________		
G7	What is the main source of lighting for this house? Circle one.	1	Oil, kerosene or gas lantern	5	Electric company		
		2	Battery flashlights/fluorescent light	6	No lighting		
		3	Electric generator/Invertor	7	Solar		
		4	Candles/firewood	8	Other (specify)………………..		
G8	What is the main source of drinking water for members of your household? Circle one.	1	Piped water in/out side	6	Protected spring		
		2	Tube well/borehole	7	Unprotected spring		
		3	Unprotected dug well	8	Rain water		
		4	Protected dug well	9	Tanker truck		
		5	Surface water (river,dam,lake etc)	10	Other (specify)………………		
G9	Does the household do anything to the water to	1	Yes	2	No	3	Don't know

	make it safer to drink?				
G10	What does the household usually do to make the water safer to drink? Circle all that apply	1	Boil	5	Use water filter
		2	Add bleach/chlorine/alum	6	Let stand and settle
		3	Strain through a cloth	7	Solar disinfection
		4	Other, specify _______________	8	Don't know

G11	Do your household own any of the following assets (should be in good working condition)? Circle all that apply. Also observe.					
	A	Bed	K	Bicycle	U	Refrigerator
	B	Mattress	L	Sofa	V	Freezer
	C	Generator	M	Clock	W	Computer
	D	Sewing machine	N	Radio	X	Digital camera
	E	Car/truck	O	Black-white television	Y	Non-digital camera
	F	Animal-drawn cart	P	Colour television	Z	Video deck
	G	Motorbike/scooter	Q	Land-line telephone	AA	DVD/VCD
	H	Cupboard, Cabinet	R	Electric Fan	BB	Cooker
	I	Mobile phone	S	Tractor	CC	

SECTION H: CHILD MORBIDITY AND UTILIZATION OF HEALTH SERVICES

H1. Has (Name of child) had an illness with a cough that comes from the chest at any time in the last two weeks? (1).Yes (2). No (3). Don't know

H2. Did (Name of child) get diarrhoea in the past two weeks? (Diarrhoea is having loose watery stools more than 3 times). (1). Yes (2). No (3). Don't know

H3. Has (Name of child) had Fever/Malaria: High temperature with shivering/ suspected malaria in the last two weeks? (1) Yes (2) No (3) Don't know

H4. The last time [child's name] was sick, did you offer less, more or the same amount of breast milk as when [child's name] is healthy? (If response is "less", ask additional questions to determine why.)

1. Less, because the child did not want it
2. Less, because mother's decision
3. More
4. The same
5. Child never breastfed or child stopped breastfeeding before last illness

6. Child has never been sick
7. Does not know

H5. During the past 6 months, did [child's name] ever take a vitamin A capsule? (Verify from child's records booklet)

1. Yes 2. No 3. Does not know 4. Not applicable

H6. Record from the Child Health Record Card the number of times in the last 4 months (Name of child) was weighed:.................................

SECTION J: ANTHROPOMETRIC MEASUREMENTS OF MOTHER AND CHILD

MOTHER'S ANTHROPOMETRY

J1. Weight in the first 12 weeks of gestation……………………………………………

J2. Weight in the third 36 weeks of gestation……………………………………………

J3. Gestational weight gain…………………………………………………………………

J4. Weight of mother (in Kg)…………………………………………………………………

J4. Height of mother (in cm)…………………………………………………………………

J5. BMI of mother
……………………………………………………………………………..

J6. Gestational age at delivery (completed weeks)……………………………………

INFANT ANTHROPOMETRY

J7. Sex of child: (1). Male (2). Female

J8. Date of birth: ___/___/____ (dd/mm/yyyy)

J9. Date of birth verified from:

1. Birth certificate
2. Health records booklet
3. Community register
4. Other document
5. Could not verify

J10. Baby's birth weight……………………….(in Kg)

J12. Age of child at the time of study (in complete months):____________

J13. Weight of child: __ __.__(kg)

J14. Height of child: __ __ __ .__ (cm)

J15. Presence of bilateral pitting oedema?: (1) Yes (2). No