## Impact of maternal lifestyle on birth weight and nutrition-related birth outcomes in Ghana

## ABSTRACT

**Background**

The weight of a newborn that is less than 2,500 grams, usually as a result of foetal undernourishment raises grave health risks for the infant. Fetal undernourishment is associated with an increased risk of dying during the infant’s early months or years. Birth weight has emerged as the leading indicator of infant health and welfare and the central focus of infant health policy. Low birth weight (LBW) is a good indicator of the risk of peri-natal death. It also tells us about the health of the population. Maternal-linked indices such as blood pressure, urine protein, preeclampsia, hemoglobin, glucose level and biosocial characteristics are thought to be associated with birth weight. However, there is paucity of empirical data mainly because these issues have not been fully appreciated and comprehensively assessed.

Apart from concerns and uncertainty over future health outcomes, low birth weight babies usually require additional hospital monitoring and care. In West Africa for example, the incidence of low birth weight in sub-Saharan Africa ranges is ranges from 10-20%, and in Ghana the incidence has been estimated at 16%. Notwithstanding, little or no attention is paid to programmes aimed at improving birth weight and LBW continues to be a major public health problem in sub-Saharan Africa.

**Methods**

Nine hundred and forty six mothers aged between14-35+ years were randomly selected for the research. A cross-sectional design study was used to explore the relationship between maternal indices and birth weight among women in two major hospitals in Accra - Korle-Bu Teaching Hospital and Ridge Hospital.

**Results**

The mean birth weight for the current study was 3200g. The average weight was found to be lower for female neonates. The incidence of low birth weight in the current study population was 7.6%. About 13.2% of the low birth weight infants were preterm. Approximately 4.8% of the LBW babies were full term. About 87% of preterm babies were of normal birth weight as compared to 95.2% of full term who were of normal birth weight. Anemia rate for mothers of LBW neonates was 12.5% as opposed to 6.4% of mothers who were non-anemic. Women who experienced low hemoglobin levels during pregnancy were twice as likely to deliver low birth weight babies. Only 0.3% of mothers with urine sugar levels was observed and all their babies were of normal birth weight.

**Conclusions**

After controlling for other variables, the series of bivariate and multiple logistic regression analyses indicated that the likelihood of a woman delivering a newborn of normal birth weight is directly related to the mother’s urine protein, hemoglobin concentration, gestational age, meal frequency and marital status. Additionally, predictors such as blood pressure, antenatal visits and sex of baby were significant but only in the bivariate model.

There is need to enhance the delivery of antenatal health and improve on its intervention components in community health programmes, clinics and hospitals in order to alleviate the burden of birth weight deviances. These findings imply that the promotion of maternal health education at all levels is critical. Health policy should also encourage and emphasize the inclusion of these factors in planned activities.

## Introduction

Weight at birth is a good indicator for the newborn’s chances of survival, growth, development and overall long-term health. The estimated level of low birth weight (LBW) in developing countries at 16.5%, is two folds higher than the 7% observed in developed countries (WHO, UNICEF 2004). Globally, LBW is estimated at 18 million, making up nearly 16% of all live births (Badsha et al., 2008) of which more than 95% are born in developing countries (WHO, UNICEF 2004). In spite of the staggering global estimates and the effort made by the Millennium Development Goals (MDGs), programmes aimed at reducing LBW have not received high priority.

About 70% of all LBW babies are born preterm (Ezugwu et al., 2010). Low birth weight is defined as weight of a baby at birth less than 2500 grams (UNICEF, 2001, Behrman & Kliegman, 2002). Coupled with preterm birth, these are major determinants of perinatal survival, infant morbidity and mortality, and developmental disabilities and general ill-health (WHO, 2004). Apart from the baby’s wellbeing, LBW is a reflection of the health of the population, generally, as infants with healthy birth weights are less likely to get sick or die in their first year of life or have problems with growth and development (ref). Many maternal and fetal factors are significantly associated with weight of the baby at birth (Singh et al., 2009).

The incidence of LBW in West Africa ranges from 10-20% across countries with the incidence in Ghana estimated to be 16%. Socio-demographic factors such as residence (urban-rural difference), mother’s age, educational status and occupation, birth order, the family’s income and maternal conditions such as tobacco use, nutritional and health status are closely linked to LBW (Viengsakhone et al., 2010). Diseases such as malaria, HIV/AIDS and febrile illnesses tend to cause retarded intra-uterine growth thereby lower weight at birth (Aribodor, 2009). Gestational age at birth is also a major determinant of weight of the newborn. Existing evidence suggests that children born with normal weight are more likely to survive and reach adulthood (ref). Apart from concerns and uncertainty over future health outcomes, low birth weight babies usually require additional hospital monitoring and care. Notwithstanding, little or no attention is paid to programmes aimed at improving birth weight and LBW continues to be a major public health problem in sub-Saharan Africa. Reducing birth weight abnormalities not only lowers infant illnesses and overall under-five morbidity and mortality, but also provides benefits over their growth.

Available literature shows inconsistencies in the estimation and reporting of birth weight in Ghana. According to the World Bank, Ghana recorded incidence of 10% LBW in 2002, 7.3% in 2003, 9.1% in 2005 and 13.4% in 2008 (MOH, 2006) whereas UNICEF recorded 16% LBW in Ghana in 2006. Studies from some regions in Ghana also showed variation. Whereas Western Region observed 10.4% of LBW rate in 2006, Brong Ahafo region recorded 7.6% and Greater Accra 9.3% (MOH, 2006).Reliable data on the degree and distribution of birth weight remain scanty.

In West Africa, mean birth weight ranged between 2800g-3000g whereas in North Africa this was 3200-3300g (UNICEF, 2006). There is utter lack of uniformity in the measurement of birth weight often leading to inaccuracies and misclassification. However, attempts to enforce compliance to proper determination and classification of birth weight have yielded only limited positive results (Janssen et al., 2007).It is critical to improve on the weighing and recording of weights of newborns so that proper planning and implementation of programmes can be instituted (Janssen et al, 2007).

According to Romundstad et al, (2007), elevated blood pressure is associated with lower birth weight. Abnormal glucose levels are linked with higher birth weights. Both extremes of birth weights are said to be related to complications (Romundstad et al., 2007).Few data sets have time points such as pre-pregnancy, pregnancy, childhood and adulthood to provide a better understanding of the effects of life course. There is evidence that maternal ill-health as seen within pregnancy such as high blood pressure, obesity, high glucose level and other metabolic disorders predict birth outcomes that present complications (Claussen et al., 2005). Healthy lifestyle such as antenatal visits, nutritious food intake, adequate weight gain, malaria control,dental health, physical activity, social support systems and stress management can enhance the health of women and subsequently offspring birth weight. Interventions to decrease birth weight abnormalities require understanding and knowledge of core influencing factors (WHO, 1980).With the foregoing position, maternal health indicesmay predict birth weight. This research therefore intends to investigate the relationship with a plethora of variables in a Ghanaian cohort.

The main objective of this study was to examine the relationship between nutrition-linked indices such as levels of hemoglobin, blood pressure, glucose and urine protein and LBW among women in the Accra Metropolis of Ghana. It also assessed the impact of maternal behaviours, lifestyle and knowledge on birth weight. The specific objectives were to determine the mean birth weight and low birth weight incidence by sex of baby, gestation, parity and maternal age; evaluate maternal hemoglobin concentration, urine protein, urine sugar, blood pressure, change in weight during pregnancy and socio-demographic status on birth weight; and explore the relationship of behaviours such as antenatal services, meal frequency, physical activity and knowledge about health as related to neonatal weight.

## 1.2 PROBLEM STATEMENT

INTRODUCTION

Adverse birth outcomes remain significant contributors to perinatal mortality as well as developmental disabilities worldwide but limited evidence exists in sub-Saharan Africa (Olusanya and Ofovwe,

2010). Birth weight is the most important proximate determinant of the level of infant and under five mortalities (ref). The weight of the newborn remains the most important predictor of perinatal morbidity and mortality among otherwise healthy infants. Although, there is evidence of increased survival of infants born with low birth weight in developed countries, this is hardly the case in sub-Saharan Africa.

In India, a recent study revealed that pre- pregnancy maternal weight (< 45 kgs), anemia in pregnancy and maternal age less than 20 years were the significant risk factors of low birth weight of term babies (Kumar et al., 2010). In Bangladesh, maternal age, educational level, antenatal care and economic status play an important role in the incidence of low birth weight (Khatun & Rahman, 2008).

There is scanty or no available current local data with a combination of variables investigated together on birth weights. There is a gap created in the availability of relevant information for strategic planning and programming in this area. Therefore, it is critical to generate baseline information on the subject to better define the problems linked with birth weight. The weight of a baby is a critical marker for a mother’s health and nutritional status as well as that of the newborn. Information on birth weight is important to a country’s health and development.

Improvement in birth weight trends could contribute immensely to a reduction in infant and <5 morbidity and mortality. The relationship between birth weight and maternal nutrition and health is not clearly established and research is sparse on the relationship.

Issues of pregnancy outcome are important to global well-being, yet the determinants involved are not comprehensively studied and fully discussed, in part due to lack of adequate empirical data to inform policies in this critical area. There is paucity on current data on birth weight.

Maternal indices such as [high blood pressure](http://www.milesforbabies.org/professionals/14332_1222.asp), [diabetes](http://www.milesforbabies.org/professionals/14332_1197.asp) can reduce neonatal weight (Berghella, 2007).Babies of low birth weight have an increased risk of death during the first year of life. Maternal predictors of preterm delivery and or low birthweight were marital status, occupation, lack of antenatal care, hypertensive disorders in a cross-sectional study carried out in a maternity hospital in Nigeria (Olusanya & Ofovwe, 2010). According to World Health Organization (WHO) review of nationally representative surveys up to 2005, 42% of pregnant women have anemia worldwide (Sanghvi, 2010). Over the last twenty years, anemia among pregnant women in the developing economies have not improved. This condition affects the health of the newborn since nutrient supply depends on the mother’s iron stores. Malnutrition is a major public health and development concern in most developing countries and particularly in deprived communities within these countries.

Inadequate maternal weight gain increases the risk of the delivery of a low-birth weight baby (Goldberg & Culhane, 2007). Maternal under nutrition is a marker in birth weight and is a multi-facetted problem which is associated with a number of socio-economic and environmental variables such as food availability and security at the household level, parents education, employment, poverty, sanitation, urban /rural residence and access to health services.

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## 1.3 JUSTIFICATION/SIGNIFICANCE

The epidemiology of birth weight issues has been largely explored in advanced economies, but in developing economies, lack of reliable data continues to be a concern even in educational and health institutions. The frequency of LBW is an indicator of the risk of perinatal death as well as the populations’ health. Hence, the shorter the gestational age, the smaller the baby and the higher the risk of death and disability (WHO, UNICEF, 2004). Therefore, data on the frequency and risk factors of LBW is crucial for the design of maternal and child health programmes, particularly in developing countries. Though there is limited literature on factors that impact on the health of women and in particular those in reproductive years, few studies so far have focused on plethora of nutrition related indices and their relationships to birth weight. This study intends to contribute to literature on birth weight and appropriate strategies in healthy pregnancy outcome.

Reliable data on the degree and distribution of birth weight remain limited. In many developing countries, determinants of fetal growth and birth weights have not been specifically identified, as a result of scanty data on the subject. There is limited or no current local data on these issues, the incidence and prevalence and the relationship to birth weight. Search for local data yields limited literature. Information from the current study would add to our ongoing researches on maternal and perinatal epidemiology. Data generated from the study would enhance identifying areas of improvement in the prevention and promotion of issues on birth weight in maternal and child health services.

Low birth weight is associated with long term disabilities, such as cerebral palsy, autism, mental impairment, vision and hearing impairments, and other developmental disabilities (Al-saley & Di Renzo, 2009). Search for birth weight studies from Ghana yields very little literature. Considerable emphasis has been placed on predictors of birth weight worldwide. Low birth weight (LBW) infants have increased risk of mortality and morbidity than infants born of normal weight (Goldenberg & Culhane 2007). Understanding the relationship between fetal-neonatal development and its factors, including birth weight, could have vast public health implications.

A key step toward that understanding is a realistic and good framework for analyzing birth weight distributions. There is a gap in the availability of relevant information for strategic planning and programming which has created inefficiencies in pragmatic interventions. The necessity of making available current regional and country data has among other considerations prompted this study. Generation of data from this study will help bridge the gap and strengthen policy.

No study to date has focused on these many factors –biochemical, physical, and behavioural and their associations with birth weight. Current evidence indicates no conclusion in the determinants and their contributions are not well defined as related to birth weight deviances. New studies are therefore required as well as re-evaluation of the already available data. These gaps in literature call for fresh investigation. There is limited country-level data on birth weight distribution in Ghana. Also critical is the scanty data on related issues in the Ghanaian population.

In developed countries, contributory factors have included tobacco smoking, nutrition and weight. In developing countries, determinants such as nutrition and seasonality, maternal stature and malaria have been identified, but limited to date has focused on explanatory variables such as those outlined in this study. At the end of this investigation, predictors would be identified to add to the pool of information on this issue. Data generated would help reduce birth weight abnormalities, as well as provide benefits over the life cycle. There are also economic gains to be derived from avoiding hospital expenses associated with these abnormalities. Effective and sound interventions should be based on readily available information to improve on maternal and child services. Current evidence indicates no conclusion in determinants of birth weight deviances. The findings would add to the understanding of explanatory indices that put women at risk and provide country level data in this direction.

# REVIEW OF RELEVANT LITERATURE

## 2.1 INTRODUCTION

Worldwide, 15.5% of neonates are born with low birth weight with 95.6% of this figure accounted for in developing countries. Prematurity accounts for 10% of neonatal mortality globally (Onwuanaku et al 2011).Birth weight has emerged as the leading indicator of infant health and welfare and the central focus of infant health policy (Badshah, 2008).Birth weight is an important determinant of infant health as well as morbidity and mortality. The birth of a baby with abnormal weight and the problems that follow place emotional and financial stress on the family and the health-care system.

The effects of the strain on the infant, parents, siblings and relationships are enormous. Trends in birth weight predicts the overall population health of countries. Birth weight is a strong indicator not only of a birth mother's health and nutritional status but also a newborn's chances for survival, growth, long-term health and psychosocial development. A low birth weight (less than 2,500 grams) raises grave health risks for children (UNICEF, 2008). Babies who are undernourished in the womb face a greatly increased risk of dying during their early months and years (UNICEF, 2008). This is based on epidemiological observations that infants weighing less than 2,500g are approximately 20 times more likely to die than heavier babies. Birth weight and gestational age are closely related and represent important indicators of a healthy pregnancy and predictors of infant survival.

This is so because low birth weight infants have a greater risk of morbidity and mortality (Uthman 2008, Daynia, 2010). Worldwide, 15.5% of all infants are born with low birth weight, 95.6% of them in the developing countries (UNICEF, 2004). Prematurity, an indicator of neonatal immaturity accounts for 10% of neonatal mortality globally. (Mathew & MacDorman, 2006). Neonates with low birth weight who survive may have impaired immune function and increased risk of disease; they are likely to remain undernourished, with reduced muscle strength, throughout their lives, and to suffer a higher incidence of diabetes and heart disease (UNICEF, 2008). Babies born with LBW are more likely to have health problems and slower development from immediately after birth to later in life.

Low birth weight is a leading cause of neonatal mortality (death before 28 days of age). These infants are more likely to experience long-term disability or die during the first year of life than are infants of normal weight. Each year, out of one hundred and twenty million pregnancies that occur globally, more than half a million women die of pregnancy and childbirth complications, and more than fifty million women suffer from serious pregnancy related ailments or, where as over a million newborns die of neonatal complications, including birth weight abnormalities (United Nations, 2005).

In an analysis of birth weights of a rural hospital in Indian,the low birth weight proportion was about 24% and showed little difference before. The birth weights have hardly changed in this population in the last two decades following the study (Ashtekar et al., 2010). In addition, unfavorable health activities tend tocluster for example women with poor diets often have other potentially detrimental behaviors (Behrman & Butler, 2007). Birth weight is a contribution to newborn health or morbidity and has been associated with increased risk of lifestyle diseases for infants and mothers in later life. However, an association does not establish causality.This association suggests that the risk could be generated during pregnancy and that pregnancy may serve as a metabolic stressor. There is evidence that risk factors such as high blood pressure and obesity predict birth outcomes such as LBW (Mumbare et al., 2011). Opportunities to address problems inherent in birth weight require country level investigation into relevant factors. The importance of data on birthweight cannot be overemphasized for planning, programming and evaluation of interventions. For both known and less certain risk factors in birth weight trends, efforts should be made through research to clarify the links.

Improved understanding of birth weight also depends on timely data analysis and reporting. In addition, priority should be given to studies of selected cohorts of pregnant women. Lifestyle behaviours play a critical role in determining fetal growth and birth weight. There is also the need for increasing promotion of safe motherhood concept at the community level to reduce risk of birth weight abnormalities. Health professionals should target limited resources for interventions such as maternal education and nutrition, improvement in income, social support systems, ante-natal and post-natal care, contraceptives to delay pregnancy and increase intervals between births, in order to enhance birth weights. The increase in survival rates of LBW infants leads to increasing health care costs due to extensive hospital stays.

To evaluate the effect of gestational age and prematurity related morbidities on hospital costs and cost per quality-adjusted life-year, a population-based study using national register data and parental questionnaires in Finland reported thatthe initial hospital care episode accounted for most of the costs (Korvenranta et al., 2010). United Nations have established health goals to reduce LBW rates by a third by 2015 (United Nations, 2005).

In a cross-sectional case study to assess some of the predisposing factors to low birth weight among deliveries in Ethiopia, the incidence of LBW was found to be 11.02%. Mothers younger than 20 years and > or =35 years, short stature, late first antenatal visit and complications during pregnancy were significantly associated with LBW (Gebremariam, 2005). Studies have indicated that LBW infants fall into two major categories: those who are premature or preterm, and those who are small for gestational age, associated with intra-uterine growth retardation (Sareer et al., 2008). The IUGR accounts for 11% of the total babies in developing countries that is 6 times higher compared to developed countries (Allen, 2008).

**Preterm Newborns –Low Gestation**

Few countries have reliable national preterm birth prevalence data. Preterm delivery (low gestation) was defined using the international definition endorsed by the World Health Organization. Preterm delivery was defined as labour before 37 completed weeks of gestation.Prematurity is an important public health problem. It is the greatest cause of morbidity and mortality in obstetrics (Reedy, 2007). However, circumstances leading to preterm birth are still unclear, but its aetiology is believed to be multi-factorial (Beck et al., 2010). Premature increase in corticotrophin-releasing hormone by the placenta has been linked to increased preterm birh rate. Also, the increased low birth weight and preterm birth in primigravid mothers may reflect the general observation that birth weight increases with subsequent births.

Globally, an estimated 13 million babies are born before 37 completed weeks of gestation annually. Rates are generally highest in low- and middle-income countries, and increasing in some middle and high-income countries, particularly the Americas. Preterm birth is the leading direct cause of neonatal death (27%); more than one million preterm newborns die annually. Lack of adequate data impedes effective policies and research. While under-5 mortality rates are improving in many countries worldwide, neonatal mortality rates (deaths in the first 28 days of life) have shown much less progress (Lawn, 2009).

Complications of preterm birth are the leading direct cause of neonatal mortality, accounting for an estimated 27% of the almost four million neonatal deaths every year, and act as a risk factor for many neonatal deaths due to other causes, particularly infections (Lawn, 2006). Preterm birth rate continues to escalate in many countries worldwide because of an increase in the indicated preterm births rate (Goldenberg et al., 2008). In some countries, preterm birth has been high on the maternal, newborn and child health agenda for two decades, but is now starting to receive wider public health attention because of increasing preterm birth rates, particularly in the United States (Behrman et al., 2007). However, only recently has this issue started to reach the attention of higher-level policy makers in low- and middle-income countries.Preterm infants tend to have higher morbidity and mortality than full gestational babies. Preterm birth is also the most important determinant of short and long term morbidity in infants and children, and can have serious long term health consequences such as cerebral palsy, blindness, developmental difficulties, including cognitive and sensory deficits **(**Allen, 2008). Additionally, preterm infants havean increased length of stay in hospital than term newborns (Russell, et al., 2007).

## 2.2 MATERNAL NUTRITION AND MEAL FREQUENCY

Frequency of meals are fundamental aspects of nutrition that can have profound effects on health particularly during pregnancy for both mother and the developing infant. A study indicates that women who experience preterm labor had prolonged periods without food compared to women without preterm labor, and whose meal frequency patterns were adequate and did not change throughout pregnancy (Hennessy et al., 2010). Malnutrition is a major public health problem in developing countries. Reproduction is closely tied to nutritional status of women and both inadequate and excessive intake pose complications in pregnancy outcomes. Adequate meal frequency and maternal nutrient intake during pregnancy are important to ensure satisfactory birth outcomes. A significant relationship was found between infant birth weight and maternal weight gain in pregnancy ( p<0.05) in a study in Nigeria (Fadupin & Pikuda, 2011).

Evidence suggests that a reduced meal frequency leads to low weight in pregnancy and this is associated with an increased risk of preterm birth (Zhong, 2010). Up to 80% of pregnant women experiencing nausea and vomiting of pregnancy. When prolonged or severe, this is known as hyperemesis gravidarum, which can, in individual cases, be life threatening ( [Jueckstock](http://www.ncbi.nlm.nih.gov/pubmed?term=Jueckstock%20JK%5BAuthor%5D&cauthor=true&cauthor_uid=20633258) et al., 2010). Nausea and vomiting in pregnancy is a continuum that ranges from mild discomfort to significant morbidity and may affect adequacy of optimum meal frequency in pregnancy (King & Murphy, 2009). Although nausea and vomiting are common symptoms in early pregnancy, hyperemesis gravidarum is a rare complication of the first trimester of pregnancy.

This condition is defined as intractable vomiting occurring before 20 weeks of gestation, with fluid and electrolyte disturbance, significant weight loss and ketonuria, leading to hospitalization in the absence of other cause than pregnancy ([Macle](http://www.ncbi.nlm.nih.gov/pubmed?term=Macle%20L%5BAuthor%5D&cauthor=true&cauthor_uid=20623888) et al., 2010). Maternal outcome may be severe in the absence of treatment, but pregnancy outcome seems good, as far as the condition has been adequately controlled. The management of hyperemesis gravidarum includes intra-venous rehydration, thiamine supplementation, antiemetic drugs and in severe cases, nasogastric or parenteral nutrition ([Macle](http://www.ncbi.nlm.nih.gov/pubmed?term=Macle%20L%5BAuthor%5D&cauthor=true&cauthor_uid=20623888) et al., 2010).

Nutrition affects ovulation, fertilization, implantation and fetal development. Deficiencies in micronutrients such as folate, iron and zinc and vitamins A, B6, B12, C, E and riboflavin are highly prevalent and may occur concurrently among pregnant women (Black et al., 2008). Micronutrient deficiencies result from inadequate intake of meat, fruits and vegetables, and infections can also be a cause. Multiple micronutrient supplementation in pregnant women may be a promising strategy for reducing adverse pregnancy outcomes through improved maternal nutritional and immune status (Bhutta et al., 2008).

Maternal weight gain through adequate meal frequency is an important predictor of pregnancy outcome. Several variables contribute ultimately to the weight of a new born baby. The maximum growth potential for a particular fetus, which is genetically determined, is important as also is the amount of nutrient which is transferred from the mother through the placenta to the fetus for growth and energy requirement. Additional energy is required during pregnancy to support the metabolic demands of pregnancy and fetal growth. A study aimed to verify a low rate in the incidence of low birthweight reported in the Bhutanese refugee camps in Nepal. Rates of low birthweight comparable to those in developed countries were achieved in an ethnic Nepali population within five years of settlement in refugee camps. These low rates were probably achieved because basic needs of mothers were met, including both the quantity and the micronutrient content of food, water and sanitation, antenatal care, and education (Shrimpton et al., 2009).

Under-nutrition implies inadequate meal intake or faulty assimilation due to low-caloric intake or limited nutritional diversity. Under-nutrition due to eating disorders may affect ovulation and fertility. Maternal caloric and protein requirements are increased in pregnancy. Protein in the diet provides essential amino acids for synthesis of enzymes. It is easy to provide adequate protein from proper mixture of vegetable and meat sources. However, vitamin B12 and zinc deficiency may result if no meat is consumed. Selection of a wide variety of foods, tastefully prepared promotes nourishment for fetal and maternal maintenance. Other nutrients which have been shown to influence fetal well being include folate, riboflavin, ascorbic acid, zinc, iron and some polyunsaturated fatty acids. In a thousand singleton pregnancies, anthropometric measurements were strongly correlated with BW (p< 0.001) (Elshibly, 2008). The mechanisms involved in how calories and other nutrients influence birth weight are not fully elucidated. Maternal undernutrition is one of most neglected aspects of

nutrition in public health globally.

Although relatively few indicators are systematically tracked or reported, a recent review of the global burden of maternal undernutrition concluded, despite limited information, that some 10%–19% of women of reproductive age were seriously undernourished. With a body mass index (BMI) of less than 18.5, these women were at increased risk of delivering low-birth-weight infants ( Black et al 2008). The benefits of interventions to improve maternal nutrition, especially micronutrient supplementation, may well accrue well after the newborn period (Shankar et al., 2008). Poor maternal nutrition and inadequate weight gain are associated with compromised birth weight. Maternal nutrition and adequate progressive weight gain are implicated in delivering normal birth weight neonates.In populations with chronic malnutrition, maternal indicators of past and current nutritional statuses are linked to birth weight. Calorie and protein requirements increase with pregnancy and lactation.

Nutrients such as calcium, iron, folic acid must befurnished in the diet in addition to taking them as upplements. Adequate and not excessiveamount of food should be taken for both maternal and fetal nourishment. This will ensure optimum weight gain, and avoid obesity which has been linked with gestational diabetes, hypertension and poor pregnancy outcome.

**Maternal Obesity**

Higher maternal weight before pregnancy increases the risk of late fetal death, although it protects against the delivery of a small-for-gestational-age infant (Magann et al.,2010). More and more women are entering pregnancy with excess weight. Pregnant women who are obese are at an increased risk for certain complications during pregnancy, labour and delivery and in the post partum period in comparison to non-obese women (Magann et al., 2010). In the United States, 38% (Roman et al., 2008) of pregnant women are overweight and 11% (Sahili et al., 2008) to 40% (Roman et al., 2008) are obese. In India, 8% of pregnant women are obese and 26% are overweight (Saho et al, 2007) and in China, 16% are overweight or obese (Leung et al., 2008). In a systematic review and meta-analyses to determine the relation between overweight and obesity in mothers and preterm birth and low birth weight in singleton pregnancies in developed and developing countries, it was concluded that the beneficial effects of maternal overweight and obesity on low birth weight were greater in developing countries where chronic malnutrition if frequent especially in lean seasons (McDonald et al., 2010).

Excessive gestational weight gain and obesity have been recognized as independent risk factors for maternal and fetal complications of pregnancy. Low gestational weight gain may often be a consequence and not the cause of LBW, and there is a lack of evidence in developed countries that dietary supplementation increases birth weight (Artal et al., 2010). Another research reported that women with a body mass index of 17 had >50% reduction in preeclampsia risk compared with a body mass index of 21. This showed that preeclampsia risk rises through body mass index distribution (Bodnar et al., 2005). Researchers at Brigham and Women’s University found that obesity and physical inactivity are associated with major risks for lifestyle diseases. Specifically, they reported that women with high body mass index have higher poor biomarker levels that affect pregnancy outcome (Scholl, 2011).An urban study in Ghana, revealed higher levels of obesity to be correlated with females, urban dwelling, high class residence, sedentary lifestyle and tertiary education (Amoah, 2003).

The obesity epidemic is of some concern in women of reproductive age. Maternal obesity is associated with many pregnancy complications, especially gestational diabetes and hypertensive disorders. Delivery in obese women is characterized by a high caesarean-section rate and an increased risk of anaesthetic and postoperative complications (Galtier et al., 2008). Optimal management includes preconception counselling, pregravid weight-loss programmes, monitoring of gestational weight gain, repeated screening for pregnancy complications and long-term follow-up (Galtier et al., 2008). To estimate how maternal weight gain and maternal glucose relate to fetal macrosomia risk, Hillier et al., (2008) reported that excessive pregnancy weight gain nearly doubles the risk of fetal macrosomia with each increasing level of maternal glucose (Hillier et al., 2008). Maternal obesity can result in negative outcomes for both women and fetuses.

The fetus is at risk for stillbirth and congenital anomalies (Leddy et al., 2008).Obesity has reached epidemic proportions in developed countries and is gradually becoming a public health concern in developing countries. In developing countries, it is seen as a sign of affluence and good living. Obese pregnant women are also at risk of intrauterine fetal demise. Epidemiological studies in developing and developed countries indicate that the prevalence of obesity is on the increase (Nguyen [and El-Serag](http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=search&db=PubMed&term=%20El-Serag%2BHB%5bauth%5d), 2010). The risks of gestational diabetes mellitus, pregnancy-induced hypertension and cesarean section increase with women who are obese.The rate of overweight and obesity is increasing amongst obstetric populations **(Athukorala et al., 2010).** Women who are overweight and obese have an increased risk of adverse pregnancy outcomes. In particular, obese women are at increased risk of gestational diabetes, pregnancy induced hypertension and pre-eclampsia (Bhattacharya et al.,

2007).

The mechanisms by which overweight increases the risk of pregnancy-induced hypertensive diseases are not clear. An investigation of women who showed high body mass index to be an identifiable risk factor for hypertensive disorders in pregnancy (Bodnar et al., 2007)). To assess pregnancy outcomes in different weight groups, a research group concluded that pregnancy outcomes were impaired in overweight/obese pregnant women (Raatikainen et al., 2006). A case-control study within a cohort of nulliparous women concluded that the rate of cesarean delivery in women with diabetes mellitus is very high and that prepregnancy body weight, gestational weight gain, and accuracy of the prediction of fetal macrosomia are potentially modifiable risk factors for cesarean delivery ([Lepercq](http://www.ncbi.nlm.nih.gov/pubmed?term=Lepercq%20J%5BAuthor%5D&cauthor=true&cauthor_uid=20410777)  et al., 2010).

**Other Nutrient Deficiencies In Pregnancy Outcome.**

**Iodine Deficiency Disorders**

An adequate supply of iodine generated in the fetal brain from maternal stores is needed by the fetus for thyroid hormone neurodevelopment, which begins in the second half of the first trimester of pregnancy (Skeaff, 2011).Around the beginning of the second trimester the fetal thyroid also begins to produce hormones but the reserves of the fetal gland are low, thus maternal thyroid hormones contribute to total fetal thyroid hormone concentrations until birth. In order for a pregnant woman to produce enough thyroid hormones to meet both her own and her baby’s requirements, a 50% increase in iodine intake is recommended (Skeaff, 2011).

Iodine often causes goitre, dwarfism, miscarriages and stillbirth. It is a major cause of mental and intellectual retardation. More women are affected and rates are higher among people who live around mountainous regions and areas removed from source of sea food consumption of the world. Consumption of goitrogenous compounds found in foods such as cabbage, brussel sprouts may reduce bioavailability of iodine which is required for the synthesis of thyroid hormones by the gland.

For nearly all countries, the primary strategy for sustainable elimination of iodine deficiency in pregnancy remains universal salt iodization (WHO/UNICEF, 2007). However, implementation of universal salt iodization is not always feasible, which may result in insufficient access to iodized salt for women of childbearing age and pregnant women. Iodine supplementation of these groups should be considered.

It is recommended that countries assess their salt iodization programs and then decide whether supplementation is indicated (WHO/UNICEF, 2007). To establish iodine status among pregnant women in rural northern Viet Nam, 413 pregnant women who provided data for the study had a median urinary iodine concentration of 70 μg/l; nearly 83% had a urinary iodine concentration lower than the 150 μg/l recommended by the World Health Organization (Fisher et al., 2011).

**Vitamin A**

Maternal vitamin A deficiency appears to be widespread in low-income countries, with the World Health Organization estimating that nearly 20 million pregnant women are vitamin A deficient. This deficiency is linked to gestational night blindness, which during pregnancy is associated with increased risks of maternal anemia (West et al., 2011). Itis needed for immune response, epithelial cell growth and repair, reproduction, maintenance of surface lining of eyes.

It is also important for embryonic development and regulation of adult gene. Symptoms of deficiency include Bitot spot, dry skin, keratomalacia, follicular keratosis, low resistance to infection. High vitamin A foods include liver, eggs, fortified milk, dark green/yellowish fruits and vegetables. Treatment may include vitamin A supplement, intake of dark green /yellow fruits and vegetables (West et al., 2011).

**Folic Acid**

Folic acid supplementation has an established role in early pregnancy for preventing neural tube defects. Pregnancy is related to increased demand for folate because of rapid fetal growth. This continues with lactation, where mammary gland takes up folate at the expense of maternal requirements. Despite some public health effort in reducing the risk of neural tube defects; many countries still have folate deficiency, a result of meal and nutritional inadequacies, nutrition education and the absence of food enrichment and fortification programs (Tamura & Picciano, 2006). Folic acid is well sourced from wholegrains, pulses, nuts and dairy products. Folate is a water soluble B vitamin that must be obtained in the diet or through supplementation. For more than fifty years, it has been known that folate plays an integral role in embryonic development (Tamura & Picciano, 2006). In response to a declining intake of a range of nutrients in modern diets, it has become a routine to recommend vitamin supplements such as folic acid in pregnancy to improve pregnancy outcomes (Bower et al., 2009).To investigate whether folic acid supplementation during pregnancy was implicated as a potential risk factor for atopic diseases in childhood, researchers concluded no meaningful association between folic acid supplement use during pregnancy and atopic diseases in the offspring. Higher levels in pregnancy tended, at most, toward a small decreased risk for developing asthma (Magdelijns et al., 2011).

**Calcium**

Recent evidence indicates that calcium supplementation affects utero-placental blood flow (Carroli, 2010).In nutrition interventions, there is evidence that calcium supplementation reduces premature birth rates and the incidence of LBW. Supplementation in the second half of pregnancy appears to reduce blood pressure directly, rather than preventing the endothelial damage associated with pre-eclampsia (Hofmeyr 2008). The average risk of high blood pressure was reduced with calcium supplementation. AffiliationsThere was also a reduction in the average risk of pre-eclampsia associated with calcium supplementation (Hofmeyr, 2008). A prospective study of first time pregnant subjects were voluntarily recruited without exclusion criteria. The results suggest that an excessive secretion of calcium leading to a functional deficit might be a risk indicator for gestational hypertension and preeclampsia ([Nielsen](http://www.ncbi.nlm.nih.gov/pubmed?term=Nielsen%20TF%5BAuthor%5D&cauthor=true&cauthor_uid=20135136) and Rylander, 2011).  Affiliations

Centro Rosarino de Estudios Perinatales, Rosario, Argentina

The result of a meta analysis of studies from developing countries showed that calcium supplementation during pregnancy is associated with a reduction in risk of gestational hypertension, pre-eclampsia neonatal mortality and pre-term birth in developing countries **(Imdad et al., 2011).**AffiliationsUnited Nations Development Programme (UNDP)/United Nations Population Fund (UNFPA)/World Health Organization /World Bank Special Programme of Research, Development and Research Training in Human Reproduction, Geneva, Switzerland Food selection in pregnancy are influenced by a variety of factors such as cravings and aversions. Culture, beliefs and food availability at the household do dictate the types of food consumed in Ghana. These beliefs are passed down from generation to the next, since they are deeply rooted in traditional norms. Often cravings for or aversion tocertain foods during the early stage of pregnancy are made worse by vomiting in the first trimester deprive women of essential nutrients required for fetal and maternal stores. Affiliations

Department of Obstetrics and Gynecology, Baylor College of Medicine, Houston, TX

Affiliations

Departments of Obstetrics and Gynecology and Medicine, Pritzker School of Medicine, University of Chicago, Chicago, IL

Dietary beliefs, taboos, and practices put pregnant women at risk for poor weight gain. In some part of the country, pregnant women are discouraged from eating meat, with the fear that the animals’ behaviours will be exhibited in the fetus. Others also believe that over-indulging food cravings may cause birthmarks and congenital malformations in the baby. Dietary cravings can change maternal nutrition throughout the course of the pregnancy. Pregnancy is associated with increased sweet food cravings, but the relationship between sweet cravings and dietary intake remains uncertain. While 55% of normal glucose tolerance women reported sweet cravings at 24-28 wk; this percentage fell significantly at term.

Sweet cravings in these women coincided with higher reported sweet food and beverage intake. They appear to be a feature of late pregnancy in gestational diabetes mellitus, but may not threaten dietary adherence in women with mild conditions ([Belzer](http://www.ncbi.nlm.nih.gov/pubmed?term=Belzer%20LM%5BAuthor%5D&cauthor=true&cauthor_uid=20869416)  et al., 2010).Cholesterol is carefully monitored in the non-pregnant adult population, where its association disease is well understood. Although it is known that cholesterol rises in pregnancy, at present it is not routinely measured or treated(Bartels et al., 2011).The effects of maternal high cholesterol on pregnancy and on fetal development are not yet fully understood. However, a growing body of evidence from animal and human studies suggests adverse consequences of high cholesterol levels in pregnancy (Bartels et al., 2011). A study done among women evaluated heart disease risk predictor index, high density

lipoprotein (HDL) cholesterol among women of the same age and demographic profiles (Abubakar et al., 2011).

The findings suggested that African women are more prone to hyperlipidemia and hypercholesterolemia during normal pregnancy and that higher intake of fiber may ward off this increasingly common syndromes (Abubakar et al., 2011). Increased triglycerides levels and delayed triglycerides clearance, decrease high density lipoprotein, severe proteinuria and high blood pressure are the reasons for the development of preeclampsia (Abubakar et al., 2011).

Lifestyle interventions may offer benefits for reducing blood pressure and lipids in this population. Studies show that a diet rich in omega 3 fatty acids may help lower triglycerides and increase HDL cholesterol (the good cholesterol). Omega 3 fatty acids are poly-unsaturated fatty acids and may also act as an anticoagulants to prevent blood from clotting (Makrides, 2009). Polyunsaturated fatty acids are derived from vegetable oils, fish, other seafood and contain linoleic acid. These foods in minimum quantities supply essential fatty acids.

All fish contain omega 3 fatty acids, but they are more concentrated in fatty fish such as mackerel, salmon, sardines and herring. Other sources of omega 3s include, green leafy vegetables, soy, tofu, nuts and seeds.

Other dietary related risk factors include a high intake of energy (calories), sucrose, saturated fatty acids and cholesterol. Findings of reduced preeclampsia risk with higher total fiber intake corroborate an earlier report; and expand the literature by providing evidence, which suggests that dietary fiber may attenuate pregnancy associated dyslipidemia, an important clinical characteristic of preeclampsia (Qiu et al., 2008).

**Fiber**

There is empirical evidence that links fiber with low cholesterol. Increase in fibre intake during [pregnancy](http://ukpmc.ac.uk/abstract/MED/19063767/?whatizit_url_go_term=http://www.ebi.ac.uk/ego/GTerm?id=GO:0007565) may reduce weight gain, [glucose intolerance](http://ukpmc.ac.uk/abstract/MED/19063767/?whatizit_url=http://ukpmc.ac.uk/search/?page=1&query=%22glucose%20intolerance%22), [dyslipidemia](http://ukpmc.ac.uk/abstract/MED/19063767/?whatizit_url=http://ukpmc.ac.uk/search/?page=1&query=%22dyslipidaemia%22), [pre-eclampsia](http://ukpmc.ac.uk/abstract/MED/19063767/?whatizit_url=http://ukpmc.ac.uk/search/?page=1&query=%22pre-eclampsia%22) and constipation (Buss et al., 2009). Few studies have evaluated adequacy of fibre intake during [pregnancy](http://ukpmc.ac.uk/abstract/MED/19063767/?whatizit_url_go_term=http://www.ebi.ac.uk/ego/GTerm?id=GO:0007565). To assess, the dietary fibre intake of pregnant women in a cross-sectional analyses in Brazil, it was concluded that about half failed to meet the recommended fibre intake, especially those not reporting nutritional guidance during [pregnancy](http://ukpmc.ac.uk/abstract/MED/19063767/?whatizit_url_go_term=http://www.ebi.ac.uk/ego/GTerm?id=GO:0007565) (Buss et al., 2009). Fiber intake has also been linked with the relieve of metabolic syndrome, a constellation of factors that increases the chances of developing heart disease and diabetes. These factors include high blood pressure, high insulin levels, excessive weight (especially around the abdomen), high levels of triglycerides, the body's main fat-carrying particle, and low levels of HDL (good) cholesterol. Foods high in complex carbohydrates contain soluble and insoluble fiber, low in caloric density and have a variety of vitamins and minerals.

## 2.3 NUTRITION-LINKED INDICES

**BLOOD PRESSURE, URINE PROTEIN (PREECLAMPSIA), URINE SUGAR, HEMOGLOBIN CONCENTRATION.**

The profile of diseases contributing most heavily to illness, disability and even death in developing countries has changed dramatically during the last century. Today, nutrition-related conditions such as those under study- glucose (diabetes), hemoglobin (anemia), preeclampsia (BP, urine protein) are among the most prevalent, costly and preventable of health problems. These ailments coupled with poor food selection and eating habits influence birth weights and neonatal health.

**Blood Pressure**

Hypertensive disorder of pregnancy is the commonest medical complication of pregnancy. The incidence varies in different populations. Risk factors associated with pre-eclampsia include chronic hypertension, multifetal gestation, maternal age over 35 years and obesity. In South Africa, the incidence of hypertensive disorders of pregnancy was 12% (Prakash et al., 2006). Generally, complications are more common and worse in the under-developed countries; poor pregnancy outcomes are also associated with lack of ANC follow up which is associated with delayed recognition and intervention in the affected mothers (Prakash et al., 2006).

A cross-sectional data from Ghana examined factors associated with treatment and control of blood pressure and the overall prevalence of high blood pressure in the general public was 29.4% (Agyemang et al., 2006). Elevated blood pressure is of public health concern in Africa, particularly in urban and peri-urban environments, with some evidence of under-diagnosis. Rates from African countries such as South Africa, Egypt, Tanzania and Ethiopia vary from 1.8% to 7.1% (Kimbally et al., 2007). Consequently, guidelines recommend the practice of recording blood pressure at every antenatal visit as critical to detection and management of hypertensive disorders of pregnancy.

Early detection is important, as underlying conditions can progress rapidly (Omole-Ohonsi and Ashimi, 2008). It is, however, important to note that the presence of these factors is not a surety to developing preeclampsia (Magnussen et al., 2007). A protein expressed and secreted by adipocytes, has been identified as a novel regulator of insulin resistance. Physiological insulin resistance occurs during pregnancy to accommodate fetal growth, and it has been suggested that insulin resistance and hyperinsulinemia might also be associated with pregnancy-induced hypertension (Inoue et al., 2009).

Hypertension may affect the development of the placenta, which is important for the nourishment and growth of the fetus. Thus, some babies may be affected by low amniotic fluid levels and/or intrauterine growth restriction. How blood pressure progresses in pregnant women is not clearly known because of the lack of longitudinal studies addressing this question. There is a dire need to explore the extent of associated risk factors and strategies. In traditional African societies, blood pressure, once rare, is becoming a health burden and emerging data also show that blood pressure awareness is unacceptably low (Cappucio et al., 2004).Worldwide, hypertension kills more than seven million people each year (Mackay & Mensah, 2004). In a prospective study of 396 women at the Korle–Bu Teaching Hospital, blood pressure accounted for 15.7%.

The study also identified deficiencies in the referral system (Nkyekyer, 2000). To examine concurrent maternal and perinatal mortality at the Korle Bu Teaching Hospital (Ghana), Lassey and Obed (2004) reported 108 concurrent maternal and perinatal mortalities with hypertension as the leading cause. They concluded that the rising trend of maternal morbidities and mortalities in the hospital was due to elevated blood pressure.

Fetal complications of hypertension in pregnancy include intra-uterine growth restriction, pre-maturity, stillbirth and increased risk of other diseases in adult life (Backes et al., 2011). Hypertension is defined as sustained elevated blood pressure above reference of 140/90mm Hg in a pregnant woman after 20 weeks gestation. The most severe form of gestational hypertension presents itself with, hemolysis, elevated liver enzymes and low platelet count (HELLP). This syndrome is a true obstetrical emergency which affects blood clotting abilities and liver function (**Haram et al., 2009).**

[Hypertension](http://ukpmc.ac.uk/abstract/MED/19614806/?whatizit_url=http://ukpmc.ac.uk/search/?page=1&query=%22Hypertension%22) complicates 5% to 7% of all [pregnancies](http://ukpmc.ac.uk/abstract/MED/19614806/?whatizit_url_go_term=http://www.ebi.ac.uk/ego/GTerm?id=GO:0007565) ([Lindheimer](http://ukpmc.ac.uk/search/?page=1&query=AUTH:%22Lindheimer+MD%22+SORT_DATE:y), 2009). Reliable information about the prevalence of elevated blood pressure is essential to the development of policies for prevention and control of this condition. The number of adults with hypertension in the world by 2025 is projected to increase by about 60% to a total of 1.56 billion ([Kearney](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Search&Term=%22Kearney%20PM%22%5BAuthor%5D&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_RVAbstractPlus) et al., 2005). Women who develop high blood pressure during pregnancy have a higher risk of cardiovascular and kidney diseases later, according to a US study (Garovic, 2006).

Improved screening, prevention and treatment strategies may not only optimize management of problems related to high blood pressure during pregnancy but also have long term impact on women’s cardiovascular events and outcomes years after the pregnancies. The fetal syndrome includes fetal growth restriction, small-size-for-gestational-age, reduced amniotic fluid, and placental insufficiency leading to fetal hypoxia and hypoperfusion. Preeclampsia can occur near or before term, with or without fetal complications (Srinivas etal., 2009). Such problems fall into four categories: chronic (preexisting), gestational (transient), pre-eclampsia, eclampsia and pre-eclampsia superimposed on chronic hypertension.

While the exact prevalence of each condition is difficult to determine, almost 10% of all pregnancies are thought to be complicated by high blood pressure (**Haram et al., 2009).** Hypertension in pregnancy stand alone or with proteinuria is one of the leading causes of maternal morbidity and mortality in the world. Epidemiological and clinical studies have shown that an inverse relationship exists between calcium intake and development of hypertension in pregnancy though the effect varies based on baseline calcium intake and pre-existing risk factors (**Imdad et al., 2011).**

**Urine Protein – Pre-Ecclampsia**

With the target of the MDGs in sight, preeclampsia/eclampsia needs to be recognized as priority areas in reducing prenatal morbidity and mortality in developing countries (Osungbade and Ige, 2011). Urine protein as part of preeclampsia has remained a significant public health threat in both developed and developing countries contributing to maternal and perinatal complications globally (McClure et al., 2009).However, the impact of the disease is felt more severely in developing countries.

The prevalence of preeclampsia in developing countries ranges from 1.8% to 16.7%. Many challenges exist in the prediction, prevention, and management of preeclampsia. Promising prophylactic measures like low-dose aspirin and calcium supplementation need further evidence before recommendation for use in developing countries. Treatment remains with prenatal care, timely diagnosis, proper management, and timely delivery (Osungbade & Ige, 2011).

Prematurity is a critical public health problem. It is the greatest cause of morbidity and mortality in obstetrics (Reedy, 2007). However, circumstances leading to preterm birth are still unclear, but its aetiology is believed to be multi-factorial (Beck et al., 2010). It has been implicated as one of the main predisposing factors for intrauterine foetal growth restriction and prematurity (Roudbari et al., 2007).

Consistent with findings from studies conducted elsewhere a hypertensive pregnancy disorder and urine protein (pre-eclampsia) was also observed to significantly increase the risk of LBW (AORs 2.71; 95% CI 1.18 - 6.23) (Awoleke, 2011).Pre-eclampsia affects approximately 7% of all pregnancies. Along with intrauterine growth restriction and premature rupture of the membranes, they represent the most common reasons for indicated preterm delivery (Goldenberg et al., 2008, Plunket, 2008).

Pre-eclampsia is a significant, multifactorial, multiorgan disease affecting 5%-8% of all pregnancies. A clinical diagnosis of pre-eclampsia is usually made when hypertension occurs with one or more of proteinuria or fetal growth restriction. Elevated blood pressure is one of the first signs of preeclampsia. In preeclampsia, hypertension and proteinuria are present, and when convulsions occur in addition to these signs, the condition is referred to as eclampsia ([Kim et al. 2007](http://www.ncbi.nlm.nih.gov/pubmed/17982238)). The cardinal clinical features of the condition are hypertension and proteinuria occurring after 20 weeks gestation in women who were not previously known to be hypertensive. The current International Society for the Study of Hypertension in Pregnancy (ISSHP)research definition of pre-eclampsia is systolic blood pressure ≥140mmHg or diastolic blood pressure ≥90mmHg with proteinuria of at least 1+ on urine dipstick occurring on 2 occasions after 20 weeks gestation, whereas that for gestational hypertension is the same criteria for high blood pressure but without co-occurrence of proteinuria. Furthermore proteinuria may be made more severe by high blood pressure, due to increased pressure on the glomerular endothelium (Lindheimer & Kanda, 2010).The clinical literature assessing disease progression from isolated proteinuria to pre-eclampsia is limited, however. A case study of 37 women reported progression from isolated gestational proteinuria to full pre-eclampsia in 19 (51%) women (Morikawa et al., 2009) and in two retrospective clinical cohort studies of women with eclampsia, 9.8 and 7.5% respectively had proteinuria alone in the week prior to the first convulsion (Knight, 2007).

Established pre-eclampsia risk factors include maternal pre-pregnancy body mass index, age, nulliparity and multiple pregnancy would all be associated with the occurrence of isolated proteinuria and conversely smoking would be protective (England & Zhang, 2007). Higher maternal pre-pregnancy body mass index (BMI), younger age, nulliparity and twin pregnancy were independently associated with increased odds of any proteinuria in pregnancy. Women who experienced proteinuria showed five patterns: proteinuria in early pregnancy only (≤20 weeks gestation), and onset at 21–28 weeks, 29–32 weeks, 33–36 weeks and ≥37 weeks gestation. In women with proteinuria onset after 33 weeks blood pressure was higher in early pregnancy and at the end of pregnancy (Macdonald-Wallis et al., 2011). Other signs and symptoms include edema and headache, and in severe cases, the condition is associated with seizures (eclampsia) and fetal growth restriction ([Davison et al., 2004](http://www.ncbi.nlm.nih.gov/pubmed/15339993)).

Maternal plasma levels have been shown to be significantly reduced in the second trimester in women who went on to develop preeclampsia compared to controls ([Kim et al. 2007](http://www.ncbi.nlm.nih.gov/pubmed/17982238)).Despite improvements in the diagnosis and management of pre-eclampsia, severe complications can occur in both the mother and the fetus, and there is no effective method of prevention. Early detection and identification of pregnant women most at risk of developing the disease have proven challenging, but recent efforts combining biochemical and biophysical markers are promising (Turner, 2010).Pregnant women should be assessed at their first antenatal clinic for risk factors of preeclampsia such as young age, nulliparity, first pregnancy after age of 35 years, obesity prior to the current pregnancy, multiple gestation, prior history of preeclampsia, diabetes mellitus, and hypertension. Detecting and quantifying proteinuria is an integral part for both the diagnosis and assessment of severity of these disorders. The presence of significant proteinuria is associated with higher maternal and fetal risks among hypertensive pregnancy. Hypertensive disorders of pregnancy are one of the most common medical complications of pregnancy globally accounting for much of maternal and perinatal morbidity and mortality (Wolde et al., 2011). Predictors of poor pregnancy outcome include low gestational age and high levels of proteinuria.

Urine protein to creatinine ratio has been used increasingly as a measure of proteinuria. Proteinuria assessment in hypertensive pregnant women is usually done through 24-hour urine protein measurement. This is a routine simple visual dipstick urinalysis of a voided midstream sample (Valerio et al., 2005). In the evaluation of the value of random urinary protein-creatinine and calcium-creatinine ratios to predict 24-hour proteinuria in hypertensive pregnancies Rizk et al (2007),fifty-one patients had significant proteinuria. The conclusion was that spot urinary protein-creatinine predicts total urinary protein excretion in hypertensive pregnancies (Rizk et al., 2007).To assess the diagnostic accuracy of random urine protein-creatinine ratio for the prediction of proteinuria in patients with preeclampsia, Aggarwal, (2008)reported that the predictive value of the random urinary protein-creatinine ratio for the diagnosis of significant proteinuria was estimated by using a 300-mg protein level within the collected 24-hour urine as the gold standard.

The random urine protein-creatinine ratio was not a good predictor of significant proteinuria in patients with preeclampsia(Aggarwal, 2008).Random protein/creatinine ratio determinations are helpful primarily when they are below 130-150 mg/g, in that 300 mg or more proteinuria is unlikely below this threshold. Midrange protein/creatinine ratio has poor sensitivity and specificity, requiring a full 24-hour urine for accurate results. Higher thresholds have not been adequately studied (Papanna, 2008).Statistical analysis demonstrated no significant difference in the mean protein excretion when comparing the 2-hour values with the 24-hour and further comparing 4-hour values with the 24-hour value (Soni et al., 2009).Amount of the protein excretion in 2-hour and 4-hour samples predicted mild preeclampsia with predictive value of 100% and negative predictive value of 80%.

Both 2-hour and 4-hour proteinuria can be used for initial assessment of preeclampsia thereby

avoiding the inconvenience and delay in treatment(Soni et al., 2009). To compare the urine

protein-creatinine ratio with urinalysis to predict significant proteinuria, urine protein-creatinine

ratio and urinalysis were compared to the 24-h urine collection. The urine protein-creatinine ratio

is a better screening test. It provides early information for more patients (Dwyer, 2008).

The tendency to develop preeclampsia appears to run in families. The daughters and sisters of

women who have had preeclampsia are more likely to develop the condition in pregnancy. It is

most common among women who are first time mothers. About 7% of all new mothers

(nulliparas) develop preeclampsia. The disease is most common in mothers under the age of 20,

or over the age of 35 (Chhabra & Kakani, 2007).

Untreated, it can adversely affect both baby and mother. It also leads to reduced placental blood

flow and fetal distress. The same damaging effects to the blood vessels in the pregnant mother

can also damage the blood supply involved with the placental exchange of oxygen and nutrients

from mother to baby and result in intrauterine growth retardation –small for gestational babies.

Pre-eclampsia, if not well controlled eventually leads to strokes in brain, heart attacks and kidney

damage.

In India, Chhabra & Kakani, (2007) studied trends of maternal deaths due to eclamptic

and non-eclamptic hypertensive disorders by analysis of case records of women who died

secondary to these disorders over a period of 20 years. Women who died due to eclampsia who

were below age 20 was 32%.

**Pre-eclampsia & Antioxidants**

There is increasing evidence that shows that anti-oxidants help prevent preeclampsia; serum and

placental concentration of vitamins C and E and carotenoids were greatly reduced in women with

preeclampsia.The most recent development is in using antioxidants such as vitamin C and

vitamin E to prevent pre-eclampsia is at an early stage, although early results seem promising.

However, a recently published review stated that there was no difference in pre-eclampsia

between vitamin and placebo groups (Polyzos et al., 2007).

Circulating levels of oxidative stress markers have been found to be elevated and that of

antioxidants depressed women with pre-eclampsia compared to women without the disorder.

These observations on the effects of oxidative stress in pre-eclampsia have given rise to increase

interest in the potential benefits of antioxidant therapy given for the prevention of hypertensive

disorders of pregnancy (Mistry and Williams, 2011).

The findings of a Vietnamese study suggested that providing preeeclamptic women with regular

weekly iron-folic acid supplements before and during pregnancy was associated with a reduced

prevalence of low birth weight (Passerini et al, 2012). To determine if vitamin C and E

supplementation in high-risk pregnant women with low nutritional status reduces pre-eclampsia

a multi-centred, randomised trial was carried out with antenatal care clinics and hospitals in four

countries (Villar et al., 2009).

Six hundred and eighty-seven women were randomised to the vitamin group and 678 to the placebo group. Vitamins C and E at the doses used did not prevent pre-eclampsia in these high-risk women (Villar et al., 2009). Roberts and colleagues conducted a carefully monitored trial of daily supplementation with 1000 mg of vitamin C plus 400 IU of vitamin E orplacebo to 10,000 women with uncomplicated first pregnancies starting between 9 and 16 weeks of gestation.

The results showed that supplementation did not affect either maternal or perinatal outcomes (Roberts et al., 2010). Again, some studies on antioxidants such as vitamins C and E and magnesium and zinc supplements have been less promising ([Poston et al. 2006](http://www.ncbi.nlm.nih.gov/pubmed/16616557)). Furthermore, a large follow-up study of vitamin E combined with vitamin C failed to find any benefit, Rumbold et al, (2006) and in a review of 10 studies involving a total of 6,533 subjects, antioxidant supplementation (of mostly vitamins E and C) during pregnancy did not reduce the risk of pre-eclampsia or any of its complications (Rumbold et al., 2008).

In addition, a high-quality randomized trial of 1,365 high-risk pregnant women found that daily supplementation with combination vitamin E and vitamin C was not associated with reduced risk of pre-eclampsia or other serious outcomes (Villar et al., 2009). To perform a systematic review and meta-analysis of the effectiveness of combined vitamin C and E (vitCE) supplementation for the prevention and treatment of preeclampsia, it was concluded that combined VitCE supplementation does not decrease the risk of preeclampsia and should not be offered to gravidas for the prevention of preeclampsia or other pregnancy induced hypertensive disorders (Basaran et al., 2010). Pregnancy places increased demands on the mother to provide adequate nutrition to the growing fetus. A number of micronutrients function as essential cofactors for or themselves acting as antioxidants. Larger intervention trials are required to reinforce or refute a beneficial role of micronutrient supplementation in disorders of pregnancies (Mistry and Williams, 2011).

**Urine Sugar –Gestational Diabetes**

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance, first time detected in pregnancy. Early diagnosis of the disease may reduce fetal exposure to maternal hyperglycemia and decrease the risk of large-for gestational age newborn (Szymańska et al., 2008). Almost all women have some degree of impaired glucose tolerance as a result of hormonal changes that occur during pregnancy. That means that the blood sugar may be higher than normal, but not high enough to have [diabetes](http://www.medicinenet.com/script/main/art.asp?articlekey=343). Up to fifty percent of women will have glucose in the urine at some point during pregnancy. During the later part of pregnancy (the third trimester), these hormonal changes place pregnant women at risk for gestational diabetes. Gestational diabetes is a condition in which high blood glucose develops at any time during pregnancy in a woman who does not have diabetes.

It is similar to type 2 diabetes in that it involves insulin resistance and affects 3-10% of pregnancies, depending on the population studied (Taylor et al., 2005). Fetal growth and development is primarily dependent upon the nutritional, hormonal and metabolic environment provided by the mother. A wartime famine study in Holland first showed that a low food intake reduces the glucose offered to the fetus and thus produces smaller size infants at birth. Maternal glucose regulation is however affected by numerous factors including physiological changes of pregnancy -. insulin resistance, pathological conditions -gestational diabetes mellitus and maternal nutrition. Maternal glucose is substantially influenced by the type of carbohydrates in the diet through its direct effect on glycemia. The rate at which each carbohydrate raises blood glucose levels after ingestion, can be measured via the dietary glycemic index ([Tzanetakou](http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=search&db=PubMed&term=%20Tzanetakou%2BIP%5bauth%5d) et al., 2011). Carbohydrate type and the glycemic index of the diet enhance or inhibit abnormal hyperglycemia during pregnancy caused by either pathological conditions or the inability of the mother to cope with the physiological insulin resistance of pregnancy.

In turn, maternal gestational hyperglycemia may be involved in the pathogenesis of insulin resistance, impaired glucose tolerance, type 2 diabetes mellitus, the metabolic syndrome and subsequent cardiovascular diseases in adult offspring. A low glycemic index maternal diet has been associated with measurable benefits to the offspring. These include a positive effect on altering maternal blood glucose production, insulinemia and reduced adiposity as well as fetal and placental insulin and glucose regulation, fetal growth, birth weight and offspring adiposity ([Tzanetakou](http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=search&db=PubMed&term=%20Tzanetakou%2BIP%5bauth%5d) et al., 2011). No specific cause has been identified, but it is believed that the hormones produced during pregnancy reduce a woman's sensitivity to insulin, resulting in high blood sugar levels.The hormones of pregnancy can cause insulin resistance in women predisposed to developing this condition. In an attempt to establish whether blood glucose profile differed in women with high glucose levels such as gestational diabetics, Leinonen et al, (2004) concluded that 43% of gestational diabetics had hypertensive complications.

Glucose levels which are higher during early morning hours may reflect insulin resistance (Leinonen et al., 2004). The best method of screening for gestational diabetes remains unsettled. The World Health Organization diagnostic criteria, which are used in many countries are based on a 2-hour 75-g OGTT. Gestational diabetes is diagnosed by WHO criteria if either the fasting glucose is > 126 mg/dl or the 2-hour glucose is > 140 mg/dl. The incidence of diabetes in pregnancy using the WHO criteria was 7.2% (6.5-7.9) according to a study conducted among pregnant women around the world (Tracy et al., 2005). The newly proposed criteria for diagnosing gestational diabetes will result in a gestational diabetes prevalence of 17.8%, doubling the numbers of pregnant women currently diagnosed. These new diagnostic criteria are based primarily on the levels of glucose associated with a 1.75-fold increased risk of giving birth to large-for-gestational age infants in the Hyperglycemia Adverse Pregnancy Outcome (HAPO) study; they use a single OGTT (Ryan, 2011).

Abnormal glucose metabolism during pregnancy can result in significant adverse outcomes for newborns. Women are screened between the 24th and 28th week of pregnancy. Currently, management of women with gestational diabetes mellitus (GDM) consists of medical nutrition therapy with adjunctive exercise for at least 30 minutes per day, and in emergency case administration of insulin (Mottola, 2007). A cohort study on gestational diabetes mellitus using predictive factors for maternal and fetal outcomes concluded that fasting glucose on the oral glucose tolerance test correlated closely with birth weight and is also an independent risk factor for macrosomia (Lin et al., 2009).However, another study concluded that there was no correlations between the results of the diagnostic tests, the time of the diagnosis or the mode of treatment -diet alone or with insulin and birth weight (Szymańska et al., 2008). In exploring the relationship between maternal glycemia and birth weight in women from different ethnic groups in New Zealand, birth weight increased significantly with increasing glucose among Pacific women (P<0.001) even after adjusting for maternal weight and other confounders (Simmons, 2007).

Again, in an investigation on the relationship between amniotic fluid glucose concentration, amniotic fluid volume and neonatal birth weight in a cohort of gestational diabetics it was concluded that there were correlations between amniotic fluid glucose concentration, amniotic fluid volume and neonatal birth weight (Xu &Wu, 2006). To determine associations of gestational diabetes mellitus (GDM) and obesity with adverse pregnancy outcomes in the Hyperglycemia and Adverse Pregnancy Outcome Study (Owens et al., 2010).

In pregnancy, the blood sugar levels are increased due to the presence of hyperglycemic hormones such as human placental lactogen (Crowther et al, 2005). This hormone limits the effectiveness of insulin, preventing it from "unlocking" cells so glucose can enter and be transformed into energy. Usually, the pancreas overrides this resistance by pumping out more insulin; but sometimes the pancreas can't keep up, and blood glucose levels rise as gestational diabetes sets in.

This leads to a high delivery of sugar to the kidneys and results sometimes in the presence of sugar in the urine (Crowther et al., 2005). To investigate the effect of impaired glucose tolerance during pregnancy on newborns, Wang et al, (2009) found that different degrees of maternal impaired glucose tolerance have different effects on newborns. As maternal GDM increases the risk of macrosomia, large for gestational age, small for gestational age, neonatal hypoglycemia and premature birth (Wang et al., 2009). A sample of urine often is stored in the bladder for several hours before it is tested. Also, because sugar does not show up in urine until it is much higher than normal in the bloodstream, urine cannot be used to check for slightly high or low blood sugar levels

(Szymańskaet al. 2008). Clinically, urine sugar is not used to diagnose diabetes in pregnancy. This is done with the oral glucose tolerance test. This test involves quickly drinking a sweetened liquid, which contains 50g of sugar. The body absorbs this sugar rapidly, causing blood sugar levels to rise within 30-60 minutes. A blood sample will be taken from a vein in an arm one hour after taking the solution. The test measures how the sugar solution is metabolized or processed by the body. Research suggests a possible benefit of breastfeeding to reduce the risk of diabetes and related risks for both mother and child (Taylor et al.,2005).

Glucose Tolerance Test (GTT) is part of a normal routine service provided by hospitals in pregnancy and thus the hospitals take care of the expenses involved. During the three previous days the mother must have an unrestricted diet and unlimited physical activity. If this second test was found to be abnormal, gestational diabetes was diagnosed. Women who develop gestational diabetes have no previous diabetes before pregnancy.

Patients who fail to maintain glycemic goals through diet and exercise therapy are given insulin injections to stabilize them (Mottola, 2007). Pregnancy may accelerate the development of type 2 diabetes in susceptible women.

**Hemoglobin**

Low hemoglobin concentration is a cause of iron deficiency anemia, which is one of the most common pregnancy complications. If maternal stores are depleted, transfer of iron to the developing fetus is compromised and may result in low birth weight. Maternal anemia is a pregnancy complication in developing countries ( Zhang et al., 2009). Anemia is regarded as a major risk factor for unfavorable pregnancy outcomes ([Xing et al, 2009](http://www.ncbi.nlm.nih.gov/pubmed/19754927)). For the purposes of this study, the World Health Organization standard (Hb <11g/dl) was used to determine anemia status in pregnancy based on hemoglobin levels ([WHO, 2006](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2995917/#R23)). Studies carried out in developing countries, where the prevalence of anemia is high, have also shown a positive impact of iron supplementation during pregnancy on fetal growth (Rioux & LeBlanc, 2007). Anemia is a major health problem among women of reproductive age group, however, its epidemiology remains largely unexplored particularly in Ghana.

In Ghana, anemia for three continuous years of 2004 through 2006 at registration had always been higher than at 36 weeks gestation. Results of hemoglobin status had fluctuated for 2004-12% to 9% in 2005 and almost 25% in 2006 (MOH, 2006). Iron deficiency and anemia during pregnancy, two nutritional disorders of public health importance, are common in developing countries (de Benoist *et al*., 2008). Anemia during pregnancy is associated with negative maternal and neonatal outcomes. However, there is limited data regarding prevalence and effects of anemia during pregnancy. Despite being a major public health issue, anemia in pregnancy is still not well understood in terms of its definition, prevalence, incidence, causes and treatment. In Africa, fifty seven percent of pregnant women are anemic, which corresponds to about 17 million affected women, with severe consequence on health,social, and economic development (de Benoist et al., 2008). Studies in Africa have shown a high prevalence of anemia in pregnancy ranging from 41-83% in different settings (Haggaz et al., 2010). There is however significant variation in prevalence of anemia, both within and between countries, necessitating a need for local data to help inform preventive programmes (Kidanto et al., 2009).

Recent statistics indicate that anemia affects 41.8% of pregnant women globally, with the highest prevalence in Africa (WHO, 2006). Anaemia would be classified according to the World Health Organization (WHO) standards: normal – Hb ≥11.0 g/dl. Low hemoglobin concentration is a decrease in normal number of [red blood cells](http://en.wikipedia.org/wiki/Red_blood_cell). It is the world’s most common nutritional deficiency disease. It is the most common form of anaemia.

It is defined as a condition with less than normal haemoglobin (Hb) level in the body and this reduces the oxygen-carrying capacity of the blood to tissues where they are required (Pena-Rosas & Viteri, 2009). Anemia refers to a condition in which the hemoglobin content of the blood is lower than normal as a result of a deficiency of one or more essential nutrients heavy blood loss, parasitic infections such as hookworm infestations, acute and chronic (**WHO, 2005 )****.**

Screening for iron deficiency anemia is recommended at the first prenatal visit and thereafter. In pregnancy, additional iron is needed to expand maternal red blood cell mass. Another dose is needed to supply fetal and placental tissues. Hemoglobin concentrations are known to decline from week 10–12 through week 32–34 of gestation due to increases in plasma volume, which can result in anemia. The fetus requires a large supply of iron from maternal blood. If maternal stores are depleted, transfer of iron to the developing fetus is compromised (Mathews et al., 2004). At least half of anemia worldwide is due to iron deficiency. Iron deficiency is due primarily to a lack of bio-available dietary iron or increased requirements such as during childhood and pregnancy (FAO/WHO, 2002 & Cusick et al, 2008).

WHO’s threshold is 11g/dl for pregnant women. A study was conducted to investigate the possible contribution and impact of anemia and iron status on pregnancy and its outcomes in a Nigerian population. Three hundred and forty nine (349) pregnant women aged 15-40 years were followed weekly till delivery. An inverse relationship was observed between anemia and iron deficiency with lower prevalence of iron deficiency found among groups with high prevalence of anemia. Parity and antenatal attendance had significant (p < 0.05) effect on maternal haemoglobin with multiparous women having higher prevalence of anemia and more than 10 antenatal attendance being associated with lower anemia prevalence. On the pregnancy outcomes, neither maternal iron status nor anemia was related to birth weight. However, higher foetal head circumferences and more preterm deliveries (< 37wk) were found in anaemic than non-anemic women (19 vs. 3, p = 0.001) (Ugwuja et al., 2010).

Although no significant difference in maternal illnesses during pregnancy was found either in the iron or the anemia groups, surgically delivered babies were significantly (p < 0.05) more in iron deficient than in the iron adequate group (16 vs. 1, p = 0.021). In conclusion, maternal anemia was associated with premature delivery, delivery through caesarean section, and infants with lower head circumference. Thus, there is indication that apart from iron deficiency, other factors that predispose pregnant women to the development of anemia may play important role in determining pregnancy outcomes (Ugwuja et al., 2010). Shah and Ohlsson (2009) observed a significant reduction in the risk of low birth weight among infants born to women who received multi-micronutrients during pregnancy compared with placebo or iron-folic acid supplementation. Birth weight was significantly higher among infants whose mothers were in the multimicronutrient group than among those whose mothers received iron-folic acid supplementation (Shah & Ohlsson, 2009).

Out of 1224 deliveries with 12.6% LBW incidence, maternal anaemia was a main risk factor for LBW (Elhassan, 2010). Iron is normally obtained in the diet and through supplementation. Symptoms of iron deficiency may include pale skin, fatigue, weakness, brittle nails, reduced appetite, shortness of breath. According to the MOH, there was almost 30% anemia rate at registration and about 25% at 36 weeks gestation (MOH, 2006). In a retrospective case-control study conducted in Sudan, it was concluded that compared with women with no anaemia, the risk of LBW was 2.5 times higher in women with anaemia and 8.0 times in women with severe anaemia **(**[Ali et al.,](http://www.springerlink.com/content/?Author=AbdelAziem+A+Ali) 2011). An in-hospital data were analysed and 2.15% of women were found to have severe anaemia. The study was undertaken to determine the maternal and perinatal outcome in patients with severe anaemia in pregnancy, with a haemoglobin concentration of <7 g/dl ( [Rohilla](http://informahealthcare.com/action/doSearch?action=runSearch&type=advanced&result=true&prevSearch=%2Bauthorsfield%3A%28Rohilla%2C+M.%29) et al., 2011). Another study examined the maternal risk factors associated with increased prevalence of anemia among antenatal and postnatal women. Of the 1,077 antenatal women studied, 540 were anaemic. Among the 1,000 postnatal women, the prevalence was 53.7%. The high prevalence was strongly associated with low socioeconomic status (OR 1.409 ([1.048–1.899]; *p*< 0.023) which affected their knowledge and health seeking behavior in both groups (Noronha et al., 2010). A research was undertaken to determine the prevalence of anemia in pregnancy at a booking in Nigeria. A cross-sectional study of 461 women attending the antenatal clinic was carried out. Of the 461 pregnant women studied, 239 were anemic, a prevalence of anaemia at booking of 51.8%. The majority of these patients, 67.4%, were mildly anaemic, 30.5% were moderately anaemic while only 2.1% had severe anaemia (Bukar et al., 2008).

Although maternal socio-demographic characteristics and anthropometric measurements were not associated with LBW, maternal anaemia was the main risk factor for LBW ([Haggaz](http://www.tropicalmedandhygienejrnl.net/article/S0035-9203%2809%2900245-4/abstract" \o "Search for all articles by this author) et al., 2010). In a case–control study conducted in Kassala hospital in Eastern Sudan, maternal anaemia was the main risk factor for stillbirth (Ali and Adam, 2010). To evaluate the efficacy of prenatal multiple micronutrient supplementation for improving birth size, pregnancy outcome, and maternal micronutrient status incomparison with iron-folic acid supplementation, UNICEF/United Nations University/World Health Organization jointly proposed a formulation for a multiple micronutrient supplement for pregnant women, and several effectiveness trials were conducted to assess its impact (Sunawang et al., 2009).Although there were no significant differences between the groups in the percentage of infants with LBW, there was a trend toward a lower incidence of LBW in the group receiving multiple micronutrients (6.3% vs. 7.3%), and the mean birthweight was 40 g higher in the group receiving multiple micronutrients than in the iron-folic acid group, although the difference was not significant.

The anemia rates in the two groups were similar after supplementation, even though the amount of iron in the multiple micronutrient supplement was half that in the iron-folic acid supplement (Sunawang et al., 2009). To estimate the effect of the severity of maternal anaemia on various perinatal outcomes, a cross-sectional study in a major hospital in Tanzania was carried out. The risk of preterm delivery and LBW increased in proportion to the severity of maternal anemia. The prevalence of anaemia and severe anaemia was high. The risks of preterm delivery and LBW were significantly and independently increased relative to the severity of maternal anaemia found on admission for delivery (Kidanto et al., 2009).

The objective of the study was to determine the prevalence and possible risk factors for anemia and its effect on perinatal outcomes among pregnant women attending antenatal care in Moshi municipality in northern Tanzania. A cohort of pregnant women aged 14-43 with anaemia were more likely to have low birth weight (LBW) infants. Compared with non-anaemic women, the risk of LBW was 4.8 times higher for neonates born to women with moderate and severe anaemia, respectively (Kidanto et al., 2009). The prevalence and risk factors of women with anemia during pregnancy in Iran was explored in a retrospective cross-sectional study. This was performed based on 2,213 pregnancies. The conclusion showed that the prevalence of anemia was not high in the study. Factors associated with anemia during pregnancy were parity, smoking, opium use and not using iron supplement (Mirzaie et al., 2010).

**2.4 SOCIO-DEMOGRAPHY**

Predictors such as socio-economic status, lifestyle behaviors, stress and neighborhood of residence, pose a major challenge to pregnancy outcome. With the increasing number of mothers who continue to work late into their pregnancy, occupational stress is hypothesized to be an important contributor to adverse reproductive outcomes, both for mother and baby (Mutambudzi et al., 2011). Maternal socio-demographic characteristics such as age, parity, maternal education and anthropometric measurements were not associated with LBW (Elhassan, 2010). Maternal socio-demographic characteristics and maternal weight were not found to be risk factors for LBW in western Sudan (Haggaz et al., 2010). In India, a recent study revealed that pre- pregnancy maternal weight (< 45 kgs), anaemia in pregnancy and maternal age less than 20 years were the significant risk factors of low birth weight of term babies (Ganesh et al., 2010). In Bangladesh, maternal age, educational level, antenatal care and economic status play an important role in the incidence of low birth weight (Khatun & Rahman, 2008). Research findings during the last decades on the links between antenatal depression and preterm birth, low birth weight and intra-uterine growth restriction have revealed a relatively inconsistent and inconclusive picture (Yonkers et al., 2009). The overall pattern of findings in a meta-analysis highlighted the salient public health risk of preterm birth (PTB) and low birth weight (LBW) posed by antenatal depression, particularly for socioeconomically disadvantaged women in developing countries and in the United States (Grote et al., 2010). Furthermore, mounting evidence from this meta-analysis and other sources Wisner et al., (2009) suggested that untreated major depression during pregnancy was as likely to lead to poor birth outcomes.

It was recently found that infants who were continuously exposed to major depression throughout the three trimesters of pregnancy were more likely to be born preterm than were infants with partial or no exposure (Wisner et al., 2009). Depression also has been linked to known risk factors for adverse pregnancy outcomes such as smoking, substance abuse, hypertension, preeclampsia and gestational diabetes (Kozhimannil et al., 2009). In recent times, studies that attempt to provide rationale for how social factors influence this problem have indicated that populations with greater inequities in health or wealth have a much higher proportion of LBW rates. Socio-economic differences were observed in stillbirth, preterm birth, birth weight, congenital anomalies and infant death (Mortesen et al., 2011). Neighbourhood of residence, employment, income and other social characteristics have been found to influence health to a large extent. Locality is independently associated with elevated blood pressure (Agyemang et al., 2005). Access to quality health care for the expanding urban poor is always a challenge.

A study in Mexico City found that low socio-economic level was the most important risk factor for LBW and was independent of other factors, including those related to reproduction and nutrition, smoking, morbidity during pregnancy, accessibility to health services and prenatal care (Torres-Arreola et al, 2005). While some factors such as age and gender differences are much easier to deal with, many of the most important factors that influence health, particularly for pregnant women are much harder to take into account.

This is especially so with the interaction between risks linked to income, unemployment, poor quality housing, low educational attainment and severe life’s events (Khashan et al, 2009). A study was conducted in western Sudan to investigate the prevalence of and risk factors for low birthweight. Among 430 singleton births, 64 (14.9%) of the neonates had LBW. Maternal sociodemographic measurements were not associated with low birth weight (Haggaz et al., 2010). On the other hand, a study in Bosnia examined the association between incidence rate of low birth weight in liveborn infants and maternal socio-demographic status. The study reported a statistically significant association between low-birth-weight and maternal socio-demographic status. Among the liveborn infants, 1373 (7.5%) had birth weight of <2500 g, which is significantly more in comparison with 851 (3.6%) infants in this birth weight group born before and 1864 (2.8%) after the war (Skokić et al., 2010).

In a cohort study to investigate whether racial disparities in the prevalence of diabetes exist beyond what may be attributable to differences in socio-economic status (SES) and other modifiable risk factors. The findings indicated that major differences in diabetes incidence and prevalence between African Americans and whites may simply reflect differences in established risk factors for the disease, such as socio-economic status, that typically vary according to race (Signorello et al.**,** 2006).

LBW is associated with many socio-economic factors such as residence (urban-rural difference), birth order, the family’s income and many maternal conditions such as nutritional status, tobacco use, mother’s age, education, occupation and health status (Viengsakhone, 2010). Behavioral stressors such as lack of social support systems, poor food choices and feeding practices, lack of physical activity, smoking, alcohol are of great importance as modifiable risk factors. These behaviours pose specific challenges in establishing a cause and effect relationship as far as birth weight is concerned because of their inherent complexity (Behrman & Butler, 2007). The negative role of an impoverished living environment and feelings of helplessness, as well as the positive role of having a stable form of social support as seen in marriage suggest new directions for research on the causes of low birth weight and other deviances.

**Maternal Age**

Higher risks of preterm birth and small for gestational age babies have been reported in teenagers. Pregnancy in adolescence is a major health challenge because it is associated with high risk. The association between teenage pregnancy and adverse birth outcomes could be explained by deleterious social environment, inadequate prenatal care, or biological immaturity will continue to remain controversial. The risk of preterm birth was increased in first and second time mothers aged 14-17 yrs compared to the reference group (Kashan et al., 2010). Birth weight was reduced in the first time mothers aged 14-17 years compared to the reference group. Teenage mothers were at increased risk of preterm birth compared to adult mothers and this risk is further increased in second time teen pregnancies (Kashan et al., 2010). The importance of maternal age, which has been widely reported to influence pregnancy outcomes and therefore duration is escalating (Shrim, 2011).This is due to the increasing frequency in the last few decades of mothers bearing children at advancing ages. Women under 19 and those above 35 have a 2 to 4 percent higher rate of preterm birth compared with those between 21 and 24 years of age (Shrim, 2011).

Low maternal age as seen in teenage mothers carry an increased risk of adverse pregnancy outcomes. This includes delivering earlier than mothers twenty years and above, but above thirty five years. They are also more likely to have higher rates of extreme prematurity (Shrim, 2011). Adolescents are still growing and are likely to have a lower body mass index (Hossain et al., 2006). They are also more reluctant or late to seek health care such as ante-natal services, for the fact that most of the pregnancies are unplanned and unwanted (Shin et al., 2005).In an investigation to explore the impact of maternal growth on birthweight in pregnant teenagers, concluded that maternal growth was not associated with small -for -gestational –age birth: growing mothers delivered more large-for-gestational-age infants (Jones et al., 2010). Advanced maternal age is associated with certain pregnancy-related risks. Pregnancy outcome among women in the age group of 35 years and more are considered to be less favorable than those of younger women. A study conducted concluded a reduced fetal oxygenation with maternal age and also a rise in the frequency of preexisting hypertension with age. Maternal age is an important and independent risk factor in pregnancy outcome (Jahan et al., 2009).

**Increasing maternal age is associated with significantly elevated risks for pregnancy complications and adverse outcomes, which vary by parity according to an investigation carried out in 2007 (Luke and Brown, 2007).** Research on the effect of maternal age and parity on the birth weight of the neonate has resulted in inconclusive and conflicting findings (Usta & Nassar, 2008). More women are postponing pregnancy into the fourth and fifth decades of life for a variety of reasons. Advanced maternal age, traditionally defined as age more than 35 years, has been associated with increased obstetric morbidity. In addition, perinatal complications are reported to be higher in this patient population, although recent data point to a more favorable outcome (Usta & Nassar, 2008).

Shin et al, (2005) concluded that maternal age and birth weight were strongly related and infants born to older mothers were heavier. On the analysis of mothers age, parity and birth weight, it was found that birth weight increase with age and parity (Shin et al., (2005). The results of a research to assess the health conditions pertaining to newborns according to maternal age groups, supported the notion that for young mothers, giving birth is a social rather than a medical problem, whereas the reverse is true for older mothers.

In the attempt to determine the relationship between low birth weight (LBW) and maternal age, it was concluded that there was no significant association between age of mother and LBW ([Adamson](http://ajol.info/index.php/dmsj/article/view/51201/0), [2007)](http://ajol.info/index.php/dmsj/issue/view/6939). Weight gain adequacy may be a particular problem among adolescent pregnant mothers because of their tendency to poor pre-pregnant nutritional status, poor diets during pregnancy and body image concerns.

To examine the effects of maternal age on low birth weight, it was concluded that the seemingly poorer birth outcomes of teenage mothers appear to result largely from their adverse socio-economic circumstances, not from young maternal age per se. It was observed that 32% who died due to preeclampsia were less than 20 years of age (Chhabra & Kakani, 2007).

A study concluded that women less than 18 years old were more likely to deliver preterm babies than older women. In most other respects they have less maternal and perinatal morbidity and were more likely to have normal deliveries **(**[Adamson](http://ajol.info/index.php/dmsj/article/view/51201/0), [2007)](http://ajol.info/index.php/dmsj/issue/view/6939). In a retrospective cohort of singleton pregnancies studied on obstetric outcomes in women aged 40 years or older versus women younger were compared for both nulliparous and multiparous women.

Advanced age was independently associated with spontaneous preterm labor and low birth weight neonates **(**Chan and Lao, 2008). A case-control study was performed to compare the pregnancy outcomes of women aged 40 years and older with those of 20- to 30-year-old women. The incidences of preeclampsia, gestational hypertension, cesarean delivery, abruptio placenta, preterm delivery, and 5-minute Apgar scores < 7 were significantly higher in the older group (p <0.05) ( Jahromi and [Husseini,](http://www.ncbi.nlm.nih.gov/pubmed?term=Husseini%20Z%5BAuthor%5D&cauthor=true&cauthor_uid=18935996) 2008).

Some complications such as diabetes, chronic hypertension and perinatal mortality were more

common in the older mothers, but the differences were not statistically significant. Maternal and

neonatal complications increased in women aged 40 years and above, but neonatal outcomes

were similar to those in the younger age group (Jahromi and [Husseini,](http://www.ncbi.nlm.nih.gov/pubmed?term=Husseini%20Z%5BAuthor%5D&cauthor=true&cauthor_uid=18935996) 2008).

**Parity**

Although associations between maternal parity and pregnancy outcome have been observed previously, few studies have focused on the possibility that parity is an independent risk factor for low birth weight as this study did. Women with up to four children accounted for 7.9% of low birth weight babies as compared to 4.7% of those with five or more children. At both bivariate and multivariate levels, parity was not found to be statistically significant. In comparison, **the highest risks among women aged ≥45 versus 30–34 by parity (primiparas and multiparas, respectively) were for chronic hypertension, diabetes, primary caesarean, excessive labour bleeding, pregnancy hypertension and birth <32 weeks (Luke and Brown, 2007).**Previous studies indicate that nulliparous women (i.e., women having no previous births) are at higher risk for adverse birth outcomes than multiparous women. The observed differences in rates of adverse outcomes between nulliparous and multiparous women are partly attributable to higher-risk women not having a subsequent live birth, either by choice or due to fecundity differences (Miranda and Williams, 2011).

In a retrospective cohort study, the authors compared the risks for adverse reproductive outcomes of adolescent nulliparae to teenagers who either have had an induced abortion or a previous birth. The results suggested that teenagers who give birth twice as adolescents have worse outcomes in their second pregnancy compared to those teenagers who are giving birth for the first time (Reime et al., 2008). Preeclampsia (p = 0.002) and abruptio placenta (p = 0.012) were more common in multiparous older women **(Luke and Brown, 2007).**Meta-analyses were performed with forty-one studies. Nulliparity was associated with increased risk of LBW but not preterm births (Shah, 2010). In a Nigerian study of more than three hundred pregnant women, the effect on maternal haemoglobin with multiparous women had higher prevalence of anaemia (Ugwuja et al., 2010). To assess factors that may be associated with LBW, Muula et al, (2011) used secondary data on the Malawi Multiple Indicator Cluster Survey (MICS). Logistic regression analyses were conducted. Women who previously had a child were less likely to deliver a LBW baby (Muula et al., 2011).

**Sex of Baby**

Birth weight unlike gender is a significant predictor of neonatal outcome. Published literature on sex of baby and its influence on newborn weight is scanty. Gender-specific infant mortality varies across nations (Kane & Edward, 2006). Studies linking the sex of a baby to birth weight have been limited and inconclusive. A retrospective descriptive study to evaluate the effect of birth weight and gender on neonatal mortality in over a 2 year period revealed that birth weight unlike gender is a significant predictor of neonatal outcome (Kane & Edward, 2006).

Gender also plays a role in determining perinatal outcomes. Male fetuses are more likely to be delivered prematurely than females and show worse morbidity and mortality rates. Male sex itself is considered an independent risk factor for poor pregnancy outcome (Di Renzo et al., 2007). Previous studies have pointed male sex as an independent risk factor for adverse pregnancy outcome, such as premature rupture of membranes, preterm, neonatal morbidity, fetal and neonatal death (Di Renzo et al., 2007). Contrary to that evidence in this cohort LBW was associated with female sex. This might be due to the greater weight at lower gestational age of male newborns compared to females and to the fact that women expecting males have higher rates of gestational diabetes and fetal macrosomia (Di Renzo et al., 2007). A regression model further showed the percentage contribution of sex of baby (r2 = 0.43), maternal age (r2 = 0.27) and parity (r2 = 0.09) to observed LBW incidence in a study conducted in Nigeria (Amosu et al., 2011).

The birth of a female infant among low birth weight deliveries were significantly higher than infants with birth weight of >2500g (Akin et al., 2010). In Korea, Shin et al (2005) showed that LBW was statistically higher for females. At birth, boys tend to be longer than girls (Eriksson et al., 2009). A recent study to investigate the average birth weight of male newborns and their female counterparts came to a conclusion that - a higher percentage of LBW was observed in female newborns (Restrepo-Mesa et al., 2010).

**2.5 HEALTH BEHAVIOURS AND KNOWLEDGE**

Knowledge about LBW and its risk factors is an important pre-requisite for a pregnant woman to implement behavioral changes leading towards healthy pregnancy outcome. There is scanty data on the status of knowledge. Policy makers and health advocates have called attention to the problem by encouraging preventive strategies as one of the alternative ways to improve health for individuals and communities. Despite these efforts, the studies that have examined behaviors and knowledge have proposed psycho-behavioural models to help in this effort.

Health behavior theories suggest that policies providing information may be particularly useful for individuals who are not yet considering or have only recently begun to consider changing or modifying their behaviours and knowledge ([Dunton](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Dunton%20GF%22%5BAuthor%5D) et al., 2010). Improving the design and implementation of evidence-based practice depends on successful behaviour change interventions and appropriate methods for characterising interventions and linking them to the targeted behaviours (Michie et al., 2011). Policies that provide opportunities may be less effective for individuals who do not deem healthy food selection or antenatal visits important and interesting. Policies that offer incentives or require the behavior may not be particularly useful at promoting long-term changes ([Dunton](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Dunton%20GF%22%5BAuthor%5D) et al., 2010). The health of individuals and aggregate populations within communities are dependent on their ability to identify their risk for specific health problems ie. birth weight.

Recent study corroborated that an individual is more likely to change if a threat is perceived (Riley et al., 2011). In addition, these individuals and vulnerable groups must be willing to adhere to lifestyle changes for health and wellness. People who are more efficacious try new behaviors, spend more time on those behaviors and persevere longer when they encounter challenges (Bandura, 2007). Possible solutions to increasing the participation rate include organizing mass media campaigns, adapting preventive interventions to the needs of specific subpopulations, positioning the services in primary care including antenatal services, integrating the interventions in community-wide interventions (**Cuijpers** et al., 2010). The act of making health decisions and choices over activities such as medical check-ups, antenatal visits, physical activity, food selection, stress management, is complex and involves numerous steps.

Although these decisions may vary in how much people think about them for each event, the decisions are effectively made by the time of the event. According to the Health Belief Model, behavior changes depend on perceived threat (low birth weight), perceived benefit (normal birth weight), cues to action barriers (preparedness), self efficacy (ability to control one’s health). It is one of the approaches for the promotion and maintenance of lifestyle changes that encourage health promotion, to decrease complications associated pregnancy. Self efficacy – confidence in one’s ability to take action is deemed to be ideal for behavior modification. In general, efficacy is strengthened when a person successfully performs the behavior, receives positive reinforcements from a competent and significant other, and interprets signals as indicators of achievement. People’s intention to participate in an active behavior (i.e. healthy food selection, mild walking) by their self efficacy and outcome expectancy (Blanchard et al., 2007). An example to illustrate the Health Belief Model (HBM) is – anthropometric analysis or a visit to antenatal service reveals low hemoglobin concentration or inadequate gestational weight gain (perceived threat). She knows that her friend’s baby born low birth weight present health challenges and frequent hospitalizations. Her doctor tells her that regular mild exercise would be the best way to make delivery easier (perceived benefit). The doctor prescribes multi-vitamin supplement and an exercise program for her.

The pregnant woman knows that with tight schedule and family obligations, it will be hard to find time to walk (perceived barriers). On her way to work, she sees a notice board promoting daily walks as one’s morning and evening routine. She tries to get up earlier each day to walk and realizes success with this lifestyle (self efficacy).This model fits well with most health promotion programmes including antenatal services. Traditional theory testing commonly applies cross-sectional and occasionally longitudinal survey research to test health behavior theory. Since such research cannot demonstrate causality, a number of researchers have called for the increased use of other methods for theory testing. Alternative approaches to theory testing can demonstrate causality in a much more robust way than is possible currently ([Noar](http://www.ncbi.nlm.nih.gov/pubmed?term=Noar%20SM%5BAuthor%5D&cauthor=true&cauthor_uid=21185144) & [Mehrotra](http://www.ncbi.nlm.nih.gov/pubmed?term=Mehrotra%20P%5BAuthor%5D&cauthor=true&cauthor_uid=21185144), 2011). The development and testing of new theories will guide future researchers and ultimately lead to reducing the incidence and prevalence of low birth weight. Health behaviours, attitudes, environments and knowledge are relevant to healthy pregnancy outcome. There is a lack of valid and reliable tools to measure these parameters.

**Ante-natal Services (ANC)**

Antenatal care (ANC) is one of the “four pillars” of Safe Motherhood and is practiced all over the world. It provides a critical platform for influencing a woman to select a skilled provider for birth, and to establish a plan for normal birth as well as emergency plan (WHO, UNICEF, 2003). In Ghana, four visits and above of antenatal care declined from 62% in 2005 to 58.5% a year later in 2006 (MOH, 2006). Women who did not seek ANC and who delivered at home without skilled attendants had perinatal mortality three times higher, and maternal mortality 100 times higher than those who did. Observational studies (Dowswell et al., 2010) also tend to show that women who receive antenatal care have lower maternal and perinatal mortality and better pregnancy outcomes. However, in recent years, apart from frequency of ANC visits and interval between the visits, attention has been directed to the essential elements of ANC package, so that quality is not neglected in favour of quantity.

It has thus been debated that probably, more effective care could be provided with fewer but “goal oriented” visits, especially focused on the elements of ANC that have been proven to be effective and have an impact on substantive outcome (Dowswell et al., 2010). Ugwuja et al.,(2010) concluded in a study of more than three hundred pregnant women that 10 antenatal attendance was associated with lower anaemia prevalence ( Ugwuja et al., 2010). Antenatal care is much more effective in preventing adverse pregnancy outcomes when sought

early and continued throughout the pregnancy and delivery. Obstetricians generally recommend that mothers begin antenatal visits as early as possible in the first trimester (GDHS, 2008). Monthly antenatal visits are recommended up to the seventh month of pregnancy, after which visits every two weeks recommended up to the eighth month, when the visits should be weekly until delivery.

Urban Ghanaians accounted for eighty eight percent whereas rural women made up seventy two percent reported visiting antenatal clinics at least four times during their pregnancy (GDHS, 2008). According to the Ghana Demographic and Health Survey (2008) women have problems accessing healthcare services and in particular antenatal care. Some of the reasons women have given for lack of or delayed ante-natal service and care include lack of money and transportation. More than nine in ten mothers reported seeing a health professional at least once for· antenatal care for the most recent birth in the five-year period before the survey (GDHS, 2008). Although ANC is high, coverage is slightly lower among mothers whose age at delivery is 35 or

older and in rural areas (94 %). Across regions, the proportion of mothers who reported receiving antenatal care with the lowest percentage among mothers residing in the Volta Region (91%) and the highest percentage among mothers in the Upper West and Ashanti regions (98% and 97%, respectively) (GDHS, 2008). As mother's educational level rises, so does the likelihood that she will see a health professional for care during pregnancy; the percentage rises from 94 percent among mothers who have never been to school to 99 percent among mothers with secondary or higher education (GDHS, 2008).

**Antenatal and The National Health Insurance Scheme**

The National Health Insurance Scheme (NHIS) which is an integral part of socio-economic status for recipients and participants of this study covers six antenatal visits; additional medically necessary visits, delivery, including all emergencies arising from the delivery, two post-natal visits within 6 weeks. In addition, care of the baby up to 3 months on the mother’s registration and other NHIS covered benefits. Registration occurs at the scheme offices or NHIS desks at healthcare facilities.

There is no payment of premium or processing fee and no waiting period. Approximately 290,361 pregnant women are registered nationally (NHIS, 2008). The newborn is covered under a parent’s/guardian’s membership for a period of up to 90 days after birth and parents/guardians are advised to register newborns within the 90-day period allowed. In the current study, there was no statistically significant association between health insurance and birth weight (p=0.411).

**Physical Activity**

According to the present guidelines, all pregnant women are encouraged to be physically active for at least 30 minutes on most days of the week, in the absence of medical or obstetrical contraindications (Olson et al., 2009). It is recommended that sedentary women start moderate exercise for a minimum of 15 minutes, 3 to 4 times a week and increase to 30 minutes 5 times a week. The optimal dose for recreational physical activity during pregnancy remains to be determined, and the impact of prolonged and repeated aerobic exercise on clinical outcomes for mother and infant are still unknown (Chasan-Taber et al., 2007). A systematic review associated physically demanding work with increased risk of premature birth, whereas a recent large cohort study showed increased risk of early spontaneous abortion with > 7 h/wk of high impact exercise (Bonzini et al., 2007).

Another concern is the increasing prevalence of newborns with high birth weight or fetal macrosomia (Bell, 2008). To examine the effect of aerobic dance exercise twice a week, in addition to 30 minutes of moderate self-imposed physical activity on the remaining week-days, on birth weight, including the proportion of small (< 2500 g) and large (≥ 4000 g) newborns in nulliparous previously inactive pregnant women newborns birth weight was grouped according to low birth weight (LBW) (< 2,500 g), normal birth weight (2,500-3,999 g) and macrosomia (≥ 4,000 g) (**Haakstad, 2011).** No statistically significant differences between the two groups in mean birth weight, length of gestation. Analysis showed a statistical significant difference between the two groups, with newborns of the exercise group scoring higher than the control group. No newborn in the exercise group had a score < 7, compared with two newborns in the control group **(Haakstad, 2011**). A comparative study reported opposite results and concluded that regular exercise (five sessions of 40 minutes per week) was associated with lower birth weight (3426 g vs. 3569 g) (Hopkins et al., 2010). In a research, the most frequently reported barriers for low adherence to exercise groups were children and household duties, job-imposed limitations, lack of transportation and distance between the woman's home and the fitness club (Cavalcante et al., 2009).

**Smoking**

Smoking is strongly related to placental abruption, reduced birth weight and infant mortality, however, the relationship of cigarette smoking to preterm birth is somewhat modest and not completely replicable (Behrman & Butler, 2007). Its influence on pregnancy outcomes, like preterm birth or low weight birth, is most notable in the third trimester and there is no increased risk detected in mothers who smoke prior to the onset, or in the early stages of pregnancy (Behrman & Butler, 2007). Maternal smoking is associated with low birthweight. Kabir et al., (2009) observed a decline in prenatal maternal smoking prevalence, but an increase in moderately LBW prevalence did offset the potential gains apparently achieved due to reductions in maternal smoking prevalence (Kabir et al., 2009). Smoking during pregnancy is associated with a reduction in birth size but very few studies have collated changes in neonatal anthropometry. Findings of an investigation reported that skinfold thicknesses were significantly lower in new-borns from smoking mothers but these differences were less evident than those from body size. Subcutaneous fat distribution did not show statistical differences between the two groups. After gestational age, to smoke during gestation is the second main determinant of birth weight

(Samper et al., 2011).

To clarify the relationship of maternal smoking with both small-for-gestational-age and preterm LBW infants, 1,329 pregnant women responded to questionnaires, and infant data were collected from 1,100 mothers. The findings reported an incidence of LBW 7.4%. In this cohort, maternal smoking during early pregnancy was associated with LBW and the small- for- gestational age (SGA) outcome. However, it was not a risk factor for LBW with appropriate weight for gestational age and LBW with preterm birth (Suzuki et al., 2008).

Performing multivariate analyses using multiple logistic regression models to clarify the relationship of maternal smoking during pregnancy with the SGA outcome and preterm birth in LBW infants, the results suggested that full term LBW and preterm LBW were associated with other risk factors that were not considered in the study, such as periodontal disease (Suzuki et al., 2008).

Also birth weight decreased 1g for every nanogram per milliliter of nicotine increase. Studies have shown that lower or stressful socioeconomic status contributes significantly to persisting to smoke during pregnancy (Weaver, 2007). Smoking in pregnancy was found to be the strongest behavioral predictor of LBW in a rural sample, an indication that ante-natal education should include smoking cessation information ( Bailey & Byrom, 2007).In examining the association between maternal exposure to smoking and low birth weight and preterm delivery, a cross-sectional study was carried out in four governmental hospitals in Jordan. Overall, 13.8% of women gave birth to a preterm babies and 10.0% gave birth full term low birth weight babies. About 12.6% of women who were exposed to smoking delivered low birth weight babies compared to 7.7% for non exposed women (Kader et al., 2011). The rate of preterm delivery among the exposed group was significantly higher than that of the non-exposed group (17.2 vs. 10.6%). In the multivariate analysis, exposure to smoking during

pregnancy was significantly associated with increased odds of low birth weight (OR = 1.56 (95% CI 1.31, 1.89)) and preterm delivery (Kader et al., 2011).

**Alcohol Use**

Descriptions of the effects of moderate alcohol consumption during pregnancy on adverse pregnancy outcomes have been inconsistent. High levels of alcohol use during pregnancy have detrimental effects on fetal development and subsequent neonatal survival. Women who have more than one drink a day are at an increased risk of preterm labour. According to a study, the relative risk of preterm delivery and very preterm birth, completed weeks, among women who had seven or more drinks a week during pregnancy was 1.77 and 3.26 respectively, compared to non-drinkers (Albertsen et al., 2004).Drinking alcoholic beverages can raise blood pressure, cause heart failure and lead to stroke. It can contribute to high triglycerides, cancer and other diseases, and produce irregular heartbeats (Strandberg-Larsen et al., 2008). A reduction of weight is associated with alcohol consumption in pregnancy. Intake of alcohol in pregnancy may cause physical and mental defects.

Consumption of alcohol during pregnancy may cause premature and miscarriage birth. Studies also indicate that alcoholism in pregnancy contributes to stillbirths. A Danish study found that pregnant women who took alcohol increased their risk for stillbirth by as much as 56% (Strandberg-Larsen et al., 2008).A systematic review and performance of meta-analyses on the effect of maternal alcohol exposure on the risk of low birthweight, preterm birth and small for gestational age indicated a dose–response relationship. Compared with abstainers, the overall dose–response relationships for low birth weight showed no effect up to 10 g pure alcohol/day (an average of about 1 drink/day) and preterm birth showed no effect up to 18 g pure alcohol/day (Patra et al., 2011). The results showed that heavy alcohol consumption during pregnancy increases the risks of all three outcomes whereas light to moderate alcohol consumption shows no effect (Patra et al., 2011). Moderate consumption during pre-pregnancy was associated with reduced risks for all outcomes.

## 2.6 CONCEPTUAL FRAMEWORK

A number of factors affect the nutritional and health status of women at various physiological stages, including pregnancy. Socio-demographic factors such as education, income, environment, obstetric history and lifestyle attributes intertwine with numerous variables such as nutrition, weight gain or loss, nutritional deficiencies, lack of physical activity, high blood pressure, diabetes and lipid levels to influence birth weight. Birth weight is an increasingly common complex phenomenon with multiple factors and has substantial medical, psychological, economic and social impacts (Allen, 2008). These factors play crucial role in influencing birth weight.These background factors, as shown in the framework below predetermine adopted norms and behaviours, which in turn are reinforced or discouraged through the social and health environment in which one lives. The interplay of these outlined factors in the framework has influence on women’s health - healthy or unhealthy women.

Personal characteristics such as cognition affects lifestyle and the environment, for instance, if the value a woman places on maintaining good health is high, the behavior and knowledge modification that will produce the change is more likely to occur. The availability of household food security which is predicated on income, which depends on education / employment and household size may influence quality and quantity of food consumed. This in turn affects frequency of meals, cumulative weight progression, vitamin and mineral adequacy and eventually improved birth weight.

**CONCEPTUAL FRAMEWORK**

Figure 1 Conceptual Framework

* Maternal age
* Parity
* Employment
* Marital status
* Education

**Behaviours &**

**Knowledge**

* Risks
* Prevention
* Antenatal
* Meal Freq.

**Disease**

**Indices**

* BP, Precclamp
* Urine protein
* Hb Anemia
* Urine glucose

**Birth Weight**

CHAPTER THREE

**Other Conditions**

* Stress
* Physical Activity
* Nutrients

Nutrient supplements

**Gestational Age**

<37wks

>37wks

# 

# 

# MATERIALS AND METHODS

## 

## The study area

**Accra Metropolis**

The study was conducted in Accra, the capital of the Greater Accra region and Ghana. It is located along the Greenwich meridian and the Gulf of Guinea to the south. The Greater Accra region is the smallest of the 10 administrative regions of Ghana, occupying a land surface area of 3,245 square kilometres (1.4%) of the surface area of Ghana. It is one of the fastest growing urban areas in African and has a coastline of approximately 225 kilometres. The study was conducted in two settings in Accra namely the Korle-Bu Teaching Hospital and Ridge Hospital.

It to have 40% of food insecurity households and this illustrates the extent of urban poverty. Average household size is 5.1 and child malnutrition is 17.3%. According to the Accra Urban Foods and Nutrition Study (2000) the poor in the city spend almost 40% of income on street foods. Major traditional livelihoods have been fishing, small size farming and petty trading. Accra is located within the Greater Accra Region which is located in the south-central part of the country. It shares common borders with the Central Region on the west, Volta Region on the east, Eastern Region on the north and the.

**Korle-Bu Teaching Hospital**

Korle-Bu Teaching Hospital is a flagship urban teaching hospital that serves Accra and other nearby towns and villages. It is the biggest hospital in Ghana with obstetric care at all levels. It registers approximately 10,000 pregnancies annually. It receives referrals from polyclinics and other maternity centers within Accra and surrounding towns and villages, and throughout the country. It is a 2000 bed capacity hospital and second largest (only to Soweto) in Africa. It runs on 10 million dollar annual budget (Korle-Bu Teaching Hospital Records, 2010).

**Ridge Hospital**

Ridge Hospital serves as a regional medical centre. Catchment area extends to Winneba, Kasoa, Nsawam, including neighbourhood polyclinics in Accra. There is an open door policy, no cases are turned away. The annual average figure for pregnancies for 2010 was 9360 with bed capacity of 191 (Ridge Hospital Records, Ghana 2010). These hospitals represent all socio-economic classes and communities. For instance, in 2008 Ridge recorded 350 cases of hypertensive-related disorders with 7 cases of mortality and a case-fatality of 2.0% (Ridge Hospital Records, Ghana 2010).

## 

**Inclusion Criteria**

A woman with singleton pregnancy and of gestational age 28 weeks and above at delivery who attended antenatal services at the Korle-Bu Teaching Hospital and Ridge Hospital in Accra were eligible for inclusion in the study.

**Exclusion Criteria:** Twin / multiple births and potential eligible women who were seriously sick or physically incapacitated were excluded.

## Sample calculation

The sample size was estimated using the following formula:

****

where,

*z =* the z value (i.e. 1.96 for 95% confidence interval)

*m* = margin of error (i.e. 0.025 or 2.5%), and



*p* = estimated proportion of a sample expected to have low birth weight deliveries. With no or limited empirical documented local data on this, findings from WHO and UNICEF of other developing countries were used as the basis for the sample size calculation (UNICEF, WHO 2004).

Using the reported proportion of approximately 16%, the formula estimates that a sample size of 826 women was required to detect differences statistically. Adjusting for non-response and attrition rate of 15% showed that the inclusion of 972 pregnant women was adequate for the study.

Advanced notification announcing the impending research was sent to heads of department and directors of hospitals. The researcher paid preliminary visits for the purpose of clarifying the goals, objectives and relevance of the study to staff. The variable of interest was birth weight. Aiming for the largest sample, all women that met the inclusion criteria were included in the study. The total number of mothers finally covered during data collection period was 946, which is well within the required sample size.

Systematic random sampling was used based on average attendance at each site. Since Korle-Bu Teaching Hospital (KBTH) does twice as many deliveries as Ridge, twice as many participants from KBTH were selected compared to Ridge. At Ridge, an average of 740 persons were attended to in a day, and given that a third of the total sample size was assigned purposely to Ridge, this gave a sampling interval of 3. Hence, having selected the first participant at random every other third person was selected. Since Korle Bu Teaching Hospital handled about twice the number of persons taken care of by Ridge, and KBTH handled almost 1,500 a day, a sampling fraction of 3 was again arrived at. Hence after the random selection of the first participant, every third participant was selected until the total required sample size was obtained.

## 3.5 DATA COLLECTION PROCEDURE

The methods for achieving the objectives of the research are stated below. Various data collection tools were developed to gather information on predictor variables. Data collection started soon after the training and pre-testing of survey instrument. The sample consisted of 946 women and their babies who were receiving maternal services in two major hospitals in Accra, the largest city in Ghana. Questionnaires were developed to gather information for the study. Weights (mother and baby), height, blood pressure, urine sample for protein, glucose and hemoglobin weretaken according to standard procedures of the hospitals. Data collection was done at both study sites at the same time, so that any chance event that might have occurred would be reflected in the data of each site. Relevant hospital records which included maternal health book, birth registry, hospital data were used to obtain additional information. The structured questionnaire was aimed at gathering data on specific variables and was made up of seven sections. The first section sought information on socio-economic and demographic attributes such as occupation, marital status, education, religious affiliation, health insurance, parity and age. The second section was about lifestyle risks as related to frequency of ante-natal visits and awareness of diseases.

Section three covered information on perception of health status such as current/ previous diagnosis. Knowledge on lifestyle diseases covered section four. Maternal nutrition –protein, calories, vitamin, mineral intake with general food selection and other health habits were emphasized. The last section examined self-risks. These ranged from personal responsibilities to experience in dealing with pregnancy related ailments.

A portion of the questionnaire was developed by the researcher whilst part was adapted from standard instruments.

**Pretesting**

Pre-testing was done on a sample of respondent population to assess the face validity in wording and interpretation. Content validity was done with public health and nutrition experts who reviewed the questions for appropriateness and comprehensiveness. The pretesting was limited to a facility that offered antenatal and postnatal services. Questionnaires were pretested. Lessons learned from the exercise were considered in the final survey instruments and for logistics purposes; and for better formulation relating to existing body of knowledge. Questions were finally modified to reflect language simplicity, clarity and ease in comprehension. Estimated time for each interview was adjusted, for instance, some of the questions were shortened. In order to reduce the number of non-responses, sensitive questions that had the tendency for reluctance to respond were restructured. There were neither drop outs nor refusals and no disabilities. Six sets of twins were excluded. The procedures were tested on a total of 946 antenatal women.

**Maternal Anthropometry**

This involved body measurements of the participant’s weight and height. Weight was taken to the nearest 0.1kg and height to the nearest 0.1cm. Initial measurement was taken at first antenatal visit and repeated at subsequent follow-up visits till delivery.

**Weight Measurement**

Weight was taken with the Seca scale. The scale was calibrated each time it was moved. This was done by sliding the main and fractional weights to their respective zero positions and adjusting the zeroing weight until it balanced at zero. The Seca scale is recommended by the Ministry of Health. Scales were placed on a flat, hard surface and where adequate privacy was provided. A participant stood still in the middle of the scale’s platform without touching anything and with the body weight equally distributed on both feet. The weight was read to the

nearest 100 g (0.1 kg) and recorded immediately (two measurements taken in immediate succession should agree to within 0.1 kg). As a good practice, the time the weight was measured was also recorded.

Study participants were in minimum clothing with no footwear (sandals/shoes). Heavy items such as keys, mobile (cell) phones, hair barrettes, necklaces etc. were removed before the weight was taken. This process was repeated at each clinic visit. Staff were trained on the importance of following proper and recommended procedures and especially on inadvertently transposing digits when writing them down and getting interrupted before writing down the result other weight. This was repeated at subsequent visits to collect participants weights which were recorded in the maternal health book.

**Height Measurement**

Each participant was bare footed with heels together, arms to the sides, legs straight, shoulders relaxed. The head of each woman was positioned and instructed to “look straight ahead”. Heels, buttocks, scapulae (shoulder blades), and back of the head were against the vertical board of the stadiometer. Just before the measurement was taken, the participant inhaled deeply, held the breath, and maintained an erect posture, while the headboard was lowered upon the highest point of the head with enough pressure to compress the hair. The measurement was read to the nearest 0.1 cm and the eye level with the headboard to avoid errors. This was done at the initial visit and was not repeated at subsequent contacts.

**Birth Weight Measurement of Newborns**

After delivery, infants received routine care. Neonatal measurements were obtained within 72 hours of delivery. Birth weight was obtained using a calibrated electronic scale. Length was measured using a standardized plastic length board. The newborns were weighed on a paediatric Seca scale that was accurate to within 10g by research nurses. Adjustments were made to zero for any cushion, a towel or diaper that was in place. The weight of the cushion was subtracted from the newborn’s weight. Infants were weighed nude or with minimum clothing. The average of two weighing was recorded in the infant’s record to the nearest 10 g (0.01kg). Weight at delivery was used to determine birth weight >90th percentile. Weight at the anthropometric assessment was used to determine total and percent body fat.Sex of the neonate was also established.

**Blood Pressure Measurement**

At the initial antenatal visit, a mother’s blood pressure was obtained. At subsequent visits, similar procedures for checking the blood pressure was followed and recorded in both the hospital record and the maternal health book. High blood pressure was based on the diagnosis by World Health Organization - International Society of Hypertension Guidelines for the Management of Hypertension. Hypertension was diagnosed if systolic or diastolic blood pressure was 140/90 mmHg. After at least 10 minutes rest, after a woman walked in, blood pressure was measured on two occasions with a mercury sphygmomanometer with an interval of 5 minutes between measurements with a pressure monitor. Two readings were taken -- the "systolic"' pressure was recorded as the heart beats, and the second "diastolic" reading was taken during the "rest" between beats.

The mean of the last two measurements was used. If BP was above 140/90 on at least two occasions within a week, a diagnosis of elevated blood pressure was made. This was followed by a referral to a competent professional for further evaluation.

**Hemoglobin Test**

Hemoglobin testing was used to measure the level of hemoglobin concentration. It is the primary method of anemia diagnosis. A consent statement was read to the eligible participants. This statement explained the purpose of the test and requested permission for the test to be carried out. It required just a small sample of easily obtained blood. Before the blood was taken, the finger was wiped with an alcohol prep swab and allowed to air-dry. Then the palm side of the end of a finger was pricked with a sterile, non-reusable, self-retractable lancet and a drop of blood collected. It measured the concentration of hemoglobin in the blood. The results were recorded in the maternal health book, and the book was returned to each mother as per hospital policy. For each participant whose hemoglobin level was lower than the cut-off point of 11g/dl a referral was made for further evaluation. It is normal for hemoglobin levels to go down somewhat in the second half of pregnancy, when

the amount of blood in the body is expanding dramatically. Follow-up hemoglobin (Hb) tests were given in late second trimester or early third trimester for monitoring.

**Urine Protein Test**

Detection of proteinuria in mothers was done through a 24-h urine protein measurement. This is a routine simple visual dipstick urinalysis of a voided midstream sample. A small sample of clean, midstream urine was collected and a chemically prepared strip was dipped in to assess protein levels in the body. The test was repeated periodically for monitoring throughout the pregnancy. If protein was found in the urine in late pregnancy and with elevated blood pressure, this was a sign of preeclampsia. If preeclampsia was suspected or diagnosed, a referral was made for the necessary evaluation and therapeutic procedures.

**Urine Sugar Test**

Pregnant women were screened for urine sugar. Participants were requested to provide a mid-stream to end urine to be tested for sugar. A plastic strip was dipped into a urine sample. The strip changed color to indicate the concentration of sugar in the sample. The resulting color was compared to a reference chart of colours; each colour indicated a level of glucose. This procedure was done at the first visit of antenatal care and repeated as necessary. The test involved only normal urination and there was no discomfort.

A positive glucose urine test of two visits in a row required the need to take a oral [glucose-tolerance test](http://www.whattoexpect.com/pregnancy/pregnancy-health/prenatal-testing/glucose-tolerance.aspx). If there was a concern about a high level of urine sugar and a potential for hyperglycemia and the risk of developing gestational diabetes, the test was given earlier. If the blood glucose was found to be above the cut-off point, another screening test that required fasting was done. The oral glucose tolerance test (OGTT) might be used to diagnose gestational diabetes. The presence of glucose may indicate the beginning of gestational diabetes. If gestational diabetes was diagnosed, a referral was made for further evaluation and the required therapy initiated.

**Health Behaviour & Knowledge**

A standard questionnaire was used to gather self-reported information on mothers knowledge and behaviours on a wide variety of health issues related to the current and previous pregnancies. The questionnaire was divided into sections with sub-headings for easier administration and analysis. These ranged from antenatal care visits, obstetric /delivery history, nourishment, micro-nutrient supplementation, meal frequency to mild physical activity and stress management. Other areas included willingness for behavior modification as and when necessary and self-efficacy on health seeking and interest in information. Dietary information was collected with an interviewed-administered meal frequency questionnaire adapted from standard questionnaire and modified. Women were tested on meals taken per day and feeding practices to support the pregnancy. Interpreters were on hand to assist when necessary. Participants had the option to decline responding to any question they found uncomfortable answering. Certain questions required further probing to get responses.

## 3.6 DATA MONITORING AND QUALITY CONTROL MEASURES

On quality control, measures were put in place to protect the quality and validity of the data. Personnel with the requisite background and training were recruited and oriented/trained. Equipment such as weighing scales, stadiometer were calibrated before use, even though challenges such as breaking of equipment and recording problems might affect the quality of the readings. Spot checks were conducted at study sites to ensure that acceptable procedures were followed. The questionnaire was reviewed for completeness and consistency before data was entered. To ensure that sample selection procedures were complied with, the author worked closely with the field supervisors and interviewers throughout the data collection period. Effective management of fieldwork was emphasized. Participants were screened based on inclusion criteria and sampling procedures were adhered to. Study questionnaire were pretested to provide face validity in wording and interpretation.

Staff ensured that interviewees fell within the specified sample criteria. Field editing of all completed questionnaires were done to ensure high quality of data. Prior to analysis, office editing and data cleaning was done. Data were entered two times to ensure a good data quality assurance**.** Content validity was established from a panel in public health research who for days read through the questionnaires thoroughly and made the needed recommendations. Another limitation was the relative simplicity of questions used to estimate meal frequency and daily intake. Health benefits or nutrients within food groups are not similar and comparable. Method of preparation can alter the original nutrient composition; for example, fruit eaten immediately after slicing will contain more vitamin C than the one left open on a counter top for five minutes.

**Variables**

The explanatory variables or determinants that may impact on maternal health, pregnancy and neonatal health of which the research attempted to examine included the following:

Independent (explanatory) Variables

Socio-Demography

* Age
* Education
* Marital Status
* Parity
* Household Size
* Employment
* Income
* Occupation
* Religious Affiliation

**Health Behaviours & Knowledge**

* Antenatal Care Utilization
* Self Evaluation of Health Status
* Previous Maternal History
* Health Knowledge, Attitudes and Practices

**Clinical**

* Blood Pressure
* Maternal anthropometry
* Newborn weight
* **Laboratory**
* Hemoglobin
* Urine protein
* Urine sugar

**Dependent (outcome / response) Variable**- Birth weight of newborns.

## 3.7 DEFINITION OF TERMS

**Anaemia** in pregnancywas defined according to the World Health Organization

(WHO) standards as: normal – Hb =11.0g/dl (de Benoist *et al*., 2008).

**Gestational age** in weeks was calculated from the first day of the last menstrual period.

**Gestational Hypertension** –repeated blood pressure of 140/90 mm Hg after 20 weeks of pregnancy.

**Gestational diabetes** is high blood sugar that starts or is first diagnosed during pregnancy.

**Proteinuria** - the presence of protein in the urine that exceed normal levels.

**Preterm delivery (low gestation)** was defined using the international definition endorsed by the World Health Organization as labour before 37 completed weeks of gestation and as recorded in the patient’s antenatal record.

**Intra-Uterine Growth Restardation (IUGR) –** deviation and reduction in expected fetal growth as a result of multiple adverse conditions that inhibit normal development.

**Fetal growth restriction** is variously defined as an estimated fetal weight of less than the 10th, 5th or 3rd percentile Figueras & Gardosa, 2011).

**Low birth weight** was defined as birth weight < 2500 grams.

## 3.8 ETHICAL CONSIDERATION

Ethical approval was given by the Ethical and Protocol Review Committee of the University of Ghana Medical School, the Noguchi Memorial Institute for Medical Research. Approval was also sought and given by the Health Research Unit of the Ghana Health Services. Informed verbal or written consent was requested from study participants. The participation by any person in the study was voluntary. The author has undergone training and completed Tutorials in Human Subjects Research by the Institutional Review Board of the Columbia University.

Participants were assured of optimum confidentiality and anonymity. Any eventualities that might occur would be taken care of by the hospitals or referred to an affiliate centre for follow-up and further evaluation. A brief statement spelling out the rationale for the study was written and interviewers were required to read it out in a language/ dialect that the participant understood to enhance comprehension and informed response.