FACTORS ASSOCIATED WITH ABNORMAL BIRTH WEIGHT IN NIGERIA

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ATTESTATION

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CERTIFICATION

I certify that this work was carried out in the Department of Epidemiology and Medical Statistics, Faculty of Public Health, University College Hospital, University of Ibadan under the supervision

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DEDICATION

This work is dedicated to Almighty God.

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ABSTRACT

Weight at birth plays a major role in the survival, physical growth and mental development of an infant. Birth weight can be classified into three categories. Low birth weight (defined by birth weight < 2.5 kg), normal birth weight (defined by birth weight ≥2.5 kg < 4.0 kg), and high birth weight (defined by birth weight > 4.0 kg). More than 15.5% (20 million) of all infants births worldwide were born with abnormal birth weight and 95.6% of these were in developing countries. About 14% of all births in Nigeria were born with abnormal birth weight. Most research on birth weight outcomes in Nigeria have focused mainly on identifying risk factors of clinical/medical importance and have largely ignored socio-demographic and economic factors which encompasses maternal characteristics such as genetic endowment, socio-cultural, demographic, and medical conditions. The objective of this study was to examine the factors associated with abnormal birth weight (low birth weight and macrosomia) in Nigeria.

This study used a secondary data set. The data set was obtained from the 2013 Nigeria Demographic and Health Survey (NDHS). This is a descriptive cross-sectional study conducted among 28,596 women of reproductive age in Nigeria. Bivariate Analysis was used to determine the association between various variables. A p-value of less than 0.001 and 0.05 were considered as statistically significant. Predictors of low birth weight and High birth weight were investigated using multinomial logistic regression model.

The mean age of the respondents was 29.45±6.92years. The mean birth weight of the baby was 3.24±0.76, with 3143 (11.1%) reporting having a low birth weight baby, 22134 (77.4%) having normal birth weight baby and 3319 (11.6%) having high birth weight baby respectively. Fourteen Thousand Three Hundred and Eighty Seven (50.3%) gave birth to male children while 14209 (49.7%) have female children. Majority (97.1%) gave birth to singleton babies while 2.9% have twin babies. Variables which remained statistically significant and associated with abnormal birth weight include maternal age, maternal educational level, marital status, wealth index, place of residence, Antenatal visits, and region for socio-demographic and economic factor. Maternal BMI, were also statistically significant while maternal smoking and parity were not significantly associated with abnormal birth weight for maternal socio-demographic and economic factors. Maternal BMI, Child's sex and Twin children were also statistical significant while preceding birth interval and parity were not significantly associated with abnormal birth weight for biophysical characteristics and foetal-related factors. Based on final multivariate multinomial model, Twin children were 4 times more likely to be low birth weight babies [AOR=4.07, 95%CI=3.46-4.80] while they were 0.5 times less likely to be high birth weight babies [AOR=0.50, 95%CI=0.36-0.68]. Married women were 0.6 less likely to have low birth weight babies [AOR=0.60, 95%CI=0.47-0.77] while Divorce women were 1.63 times more likely to have high birth weight babies [AOR=1.63, 95%CI=1.09-2.43].

The study identified a number of maternal socio-demographic and economic factors that significantly associated with abnormal birth weight. It also demonstrates that certain maternal biophysical characteristics and foetal-factors could play a role in the infant birth weight and are preventable through simple public health approaches. Therefore, in order to reduce this menace in Nigeria, holistic approaches such as health education, maternal nutrition, improvement in socio-economic indices, and increasing the quality and quantity of the antenatal care services are of paramount importance.

Keywords: Abnormal birth weight, maternal lifestyle, foetal-factors, biophysical characteristics.

Word counts: 543

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ABBREVIATIONS AND ACRONYMS

AIDS	-	Acquired Immunodeficiency Syndrome
ANC	-	Antenatal Care
BMI	-	Body Mass Index
HIV	-	Human Immunodeficiency Virus
NDHS	-	Nigeria Demographic Health Survey
NBS	-	National Bureau of Statistics
ABW	-	Abnormal Birth Weight
LNMP	-	Last Normal Menstrual Period
MDG	-	Millennium Development Goal
MUAC	-	Mid Upper Arm Circumference
NMR	-	Neonatal Mortality Rates
SGA	-	Small for Gestational Age
UNICEF	-	United Nations Children's Fund
VDRL	-	Venereal Diseases Research Laboratory
WHO	-	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Weight at birth is one of the significant predictors of mental development, future physical growth, and survival of a child. It is one of the important risk factors for infant morbidity and mortality. Birth weight plays a crucial role in adolescent metabolic diseases of a child. Birth weight can be classified into three categories, i.e. normal birth weight (birth weight ≥2.5 kg < 4.0 kg), Low birth weight (birth weight < 2.5 kg) and high birth weight (macrosomia) (birth weight > 4.0 kg). These birth weight conditions have adverse consequences on the life of the infant. Studies have shown that this is associated with short-term consequences such as high infant mortality and childhood growth failure among survivors. ABW has a long-term risk in the form of high prevalence of adult coronary heart disease and type 2 diabetes. According to Gluckman, this may be due to fetal or perinatal responses, which may include changes in metabolism, hormone production, and tissue sensitivity to hormones that may hinder the relative development of various organs, resulting in persistent changes in physiologic and metabolic homeostatic set points. Low Birth Weight was also shown to have debilitating long-term consequences on childhood development, school achievement and adult capital, including achievement in height, economic productivity and birth weight of offspring. Low Birth Weight is caused by either a short gestation period (<37 weeks) or retarded intrauterine growth (or a combination of both). Eleven percent (11%) of all newborns in developing countries like Nigeria are born at term with Low Birth Weight, a prevalence which is six times more than in developed countries. According to UNICEF, the prevalence of Low Birth Weight babies in Nigeria is 13.0 %. Pre-term birth, maternal age (<20 years and >35 years), stress during pregnancy, maternal under nutrition before pregnancy and first parity may lead to Low Birth Weight. Other evidence adduced by Bategeka shows that factors such as low socio-economic status and use of services such as antenatal care and tetanus vaccination could influence birth weight positively.

On the other hand, the term macrosomia is used to describe a newborn with an excessive birth weight. Macrosomia prevalence in the developed countries is between 5% and 20% but an increase of 15%-25% has been reported in the past decades. However, in developing countries data for the changing prevalence of macrosomia are scarce. In one study in China researchers observed an increase from 6.0 % in 1994 to 7.8 % in 2005. As the prevalence of diabetes and obesity in women of reproductive age increase in developing countries, a corresponding increase in macrosomic births

may be expected. High pre-pregnancy weight or body mass index (BMI), mother's age (20-34years) and height, excessive gestational weight gain, gestational and pre-gestational diabetes mellitus, post term pregnancy and male sex are found to be associated with macrosomia.

Abnormal birth weight (Low Birth Weight and macrosomia) may contribute to the current and future burden of chronic diseases. Complications during delivery as a result of macrosomia can lead to additional hazards to the mother and newborn in resource scarce settings as compared to resource rich settings because of the restricted availability of emergency obstetric and other essential care. Therefore, the present study was aimed at contributing to the understanding of the issues related to abnormal birth weight and to determine the related factors influencing it in Nigeria.

Maternal characteristics have been variously shown to impact on the progress and outcome of pregnancy, especially those related to birth weight and perinatal mortality. Such maternal factors like genetic endowment, socio-cultural, demographic, and medical conditions (e.g. hypertension, malaria, urinary tract infections, malnutrition and anaemia) are strongly associated with foetal complications especially Low Birth Weight, prematurity and birth asphyxia all of which act individually or in concert with each other to increase neonatal and infant mortality. In Nigeria, most births are unattended to by a trained birth attendant occurring at home or in settings outside the hospital. Even the few that come to the hospital book very late with little or no window for effective intervention.

However, not much is known about factors that affect infant weight gain in early infancy. Infant feeding is recognized as one of the most influential factors affecting weight gain. Reviews from various parts of the world have suggested a protective effect on cardiovascular diseases (CVD) risk profile from early initiation and prolonged breastfeeding. In addition, limited evidence has shown that maternal characteristics such as postnatal depression and maternal eating habits influence infant weight gain and may predispose infants to weight faltering. Infants who gain weight rapidly during early infancy especially the first 2 weeks of life are at increased risk of childhood obesity and adult metabolic disease. Stettler *et al.*, had demonstrated that excessive weight gain during the first week of life in healthy European American formula fed infants was associated with overweight 2-3 decades later. This observation they postulated may be related to obesity in women of reproductive age increase in developing countries, a corresponding increase in macrosomic births

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1.2 Problem Statement

More than 20 million (15.5%) of all infants births worldwide are born with abnormal birth weight and 95.6% of these were in developing countries (NPC & ORC Macro, 2009).

Low Birth Weight increases the morbidity and mortality in newborns and has largely contributed to the high Neonatal Mortality Rates (NMR) in the developing countries. The incidence of Low Birth Weight in developing countries ranges from 5% to 33% with an average of 16.5% which is more than double the rate of 7% noted in developed regions. The average incidence rate of Low Birth Weight in Nigeria is 12%. Eleven percent (11%) of all newborns in developing countries are born at term with Low Birth Weight, a prevalence which is six times more than in developed countries. On the other hand, Macrosomia prevalence in the developed countries is between 5 % and 20% but an increase of 15%-25% has been reported in the past decades, which is solely driven by an ascendance of maternal obesity and diabetes (Henriksen et al, 2008). However, in developing countries data for the changing prevalence of Macrosomia are scarce, in one study in China (Lu Y et al, 2005), researchers observed an increase from 6.0% in 1994 to 7.8% in 2005.

In Port Harcourt, Nigeria, study shows that Macrosomia prevalence is 14.65%. This is a clear manifestation of the double burden of malnutrition phenomenon, which is increasingly becoming a public health problem in developing countries where maternal under-nutrition coexists with maternal over-nutrition. Abnormal birth weight (low birth weight and macrosomia) may contribute to the current and future burden of chronic diseases. Complications during delivery as a result of macrosomia can lead to additional hazards to the mother and newborn in resource scarce settings as compared to resource rich settings because of the restricted availability of emergency obstetric and other essential care. Therefore, the present study was aimed at contributing to understanding of the issues related to abnormal birth weight. The aim of this study was to determine the prevalence of abnormal birth weight (low birth weight and macrosomia) and related factors such as socio-economic status and demographic characteristics of mothers in the developing countries like Nigeria and Ghana.

One of the salient slogans of the World Health Organization (WHO) is "Children's health is tomorrow's wealth." The concern for children's health and survival finds expression in the continuous monitor by WHO of abnormal birth weight worldwide as a public health indicator (UNICEF and WHO, 2004).

Approximately, thirty million children worldwide are born with abnormal birth weight every year, representing 23.8% of all births (WHO, 2009). Infants weighing 2000-2499 g at birth are 4 times more likely to die during their first 28 days of life than infants who weigh 2500-2999 g, and 10 times more likely to die than infants weighing 3000-3499 g Low birth weight infants are 5 times more likely than normal birth weight infants to die later in the first year and account for 20 percent of post neonatal deaths. (Judith & laura, 2000).

1.3 Justification of the Study

The justification for this study is that most research on birth weight outcomes in Nigeria have focused mainly on identifying risk factors of clinical/medical importance (Olubukola, 2011). The factors for abnormal birth weight are yet to be completely understood even though abundant research has been conducted to ascertain the underlying factors. Although abnormal birth weight is considered as a multifactorial disease, most of the risk factors are preventable before pregnancy.

Abnormal birth weight (Low Birth Weight and Macrosomia) may contribute to the current and future burden of chronic diseases. Complications during delivery as a result of Macrosomia can lead to additional hazards to the mother and newborn in resource scarce settings as compared to resource rich settings because of the restricted availability of emergency obstetric and other essential care. Macrosomia is seen as an important risk factor for prenatal asphyxia, death, and shoulder dystocia, and mothers of babies with Macrosomia are at an increased risk of caesarean section, prolonged labor, postpartum hemorrhage, and perinatal trauma. With the general improvement in the socioeconomic status of the Nigerian populace, the incidence of fetal Macrosomia and its attendant complications are expected to rise. There is a need for increased documentation of the determinants and outcome of pregnancies complicated by fetal Macrosomia in this environment, thus necessitating this study. To determine the prevalence of abnormal birth weight. Findings from the study will provide useful information to policy makers for the design of appropriate public health interventions.

Birth weight is a powerful predictor of infant growth and survival. An infant born with a low birth weight begins life immediately at a disadvantage and faces extremely poor survival rates. Approximately, every ten seconds an infant born in developing countries dies from diseases or infections that can be attributed to low birth weight.

Despite that, there is improvement in maternal and child health services in developing countries including Sudan, yet high prevalence of abnormal birth weight has been documented. This draws the researchers' attention to investigate about the risk factors associated with abnormal birth weight and to provide some recommendations to improve the situation.

Abnormal birth weight affects a large number of births annually and is one of the leading health problems of the world. The factors that causing abnormal birth weight are so many and vary from one community to another and they may be interdependent on each other. Therefore, the present study was aimed at contributing to understanding of the issues related to abnormal birth weight.

1.4 Objectives of the study

The broad objective of this study is to examine the factors associated with abnormal birth weight (low birth weight and macrosomia) in Nigeria.

The Specific objectives:

The specific objectives of this study are to:

i) Determine the prevalence of abnormal birth weight in Nigeria.

ii) Determine the maternal socio-demographic and economic factors associated with abnormal birth weight among newborn in Nigeria.

iii) Identify the maternal biophysical characteristics and foetal-related factors associated with abnormal birth weight in Nigeria using NDHS 2013.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

By going through the available literature on research relating to birth weight, it is observed that a vast majority of researchers have reported the relationship between a very wide spectrums of factors associated with child birth weight. These factors may be classified as demographical, physical, psychosocial, nutritional, behavioural, previous obstetric history, morbidity during pregnancy and antenatal care. Demographic factors pertain to the age, religion, place of residence, socio-economic status (income, education and occupation). The physical factors include the maternal height, pre-pregnancy weight, paternal height and weight. Nutritional factors consist of food intake as well as weight gain during pregnancy. Psychosocial factors comprise of the psychological make-up of the mother during pregnancy as well as the social factors having an effect on the mother. Health behaviours affecting birth weight include smoking as well as passive smoking and physical activity. Previous obstetric history encompasses the details of previous pregnancies as well as any previous adverse outcomes. Maternal morbidity during pregnancy checks for general morbidity or any episodic illness during pregnancy and any significant complication during pregnancy. Antenatal care focuses on the month of initiation as well as the number of visits and quality of the care.

2.2 Factors associated with Abnormal Birth Weight

The factors associated with abnormal birth weight are maternal age, place of residence, socio-economic status, hereditary factors, maternal psychosocial stress, health behaviours, maternal nutritional status, morbidity during pregnancy, antenatal care utilization and physical factors include the maternal height, pre-pregnancy weight, paternal height and weight. These factors can be reviewed as follows:

2.2.1 Maternal Age

Maternal age is considered to be a very important aspect in the area of birth weight studies. Leppert et al. (1986) in a study conducted among adolescents and older mothers in New York reported maternal age as a significant predictor of birth weight. Viegas et al. (1989), based on a study conducted in Singapore validated a quadratic relationship between birth weight and maternal age. Fraser et al. (1995) found that a younger maternal age conferred an increased risk for abnormal birth weight. Feleke and Enquoselassie (1999) reported that age of the mother had a significant impact on birth weight. A study by Abel et al. (2002) discovered a U-shaped relationship between age and abnormal birth weight. In India, Bisai et al. (2006) found maternal age group to be a significant factor in determining birth weight. Gage et al. (2009) reported that maternal age significantly influences the birth weight distribution in a study from 8 populations in New York State. Considering the effect of religion on birth weight, Ward (1987) reported, in a study conducted in Vienna, that religion did not influence birth weight whereas Dhall and Bagga (1995) revealed a significant effect of religion on birth weight among babies born in North India, even though both studies supported the effect of maternal age on birth weight.

2.2.2 Place of Residence

The impact of the place of residence on birth weight has been studied. For instance, Antonisami et al. (1994) compared 2 birth cohorts separated by a gap of 20 years in South India and found that even though the increase in mean birth weight and decrease in the percentage of abnormal birth weights over the years was greater in rural area compared to urban, yet rural newborns were lower in birth weight compared to their urban counterparts. Larson et al. (1997) in a study in United States showed that residence in a non-metropolitan county was not found to be associated with an increased risk of abnormal birth weight. Hillemeier et al. (2007) detailed rural areas further as large rural city-focused areas and more rural areas compared to urban areas and found that abnormal birth weight risk is associated with some but not all types of rural areas when compared to urban communities. Auger et al. (2009) concluded that rural relative to urban area as well as low socio-economic status (represented by maternal education) as having an association with abnormal birth weight.

2.2.3 Socio-Economic Status (SES)

Socio-economic status (SES) mainly comprises of factors relating to education, occupation and income. Parker et al. (1994) found that maternal and paternal education levels were the best overall predictors of reproductive outcomes like birth weight. Low SES was seen to be significantly related to abnormal birth weight in a study by Deshmukh et al. (1998) conducted in an urban area in India. A study in Thailand by Tuntiseranee et al. (1999) observed that among the SES indicators, only family income correlated with birth weight.

Radhakrishnan et al. (2000) stated that low maternal SES was the principal determinant of abnormal birth weight baby in a study done in Kerala, India. Nicolaidis et al. (2004) in a retrospective cohort study done in Washington State concluded that paternal education was associated with birth weight. Singhammer et al. (2005) revealed that the family's SES a decade prior to giving birth was not significantly associated with birth weight.

Zeka et al. (2008) suggested a greater likelihood of reduced birth weight among the socially disadvantaged group.

2.2.4 Hereditary Factors

Langhoff – Roos et al. (1987) studied the relation between hereditary factors with birth weight and concluded that maternal and paternal birth weights were poor predictors of infant birth weight. But, Alberman et al. (1992) in their study on the intergenerational effects on birth weight found a direct association between parental and offspring birth weight. Emanuel et al. (1992) supported the view of a multigenerational influence on birth weight, passed on through the maternal line. A study from India conducted by Mavalankar et al. (1994) showed that attributable risk for abnormal birth weight contributed by low maternal weight was much more than that by low maternal height. Karim and Mascie – Taylor (1997) in their study from Bangladesh confirmed that mother's weight at term was the best predictor of birth weight. Rao et al. (2001) in a study from Karnataka, India revealed that pre pregnancy weight and maternal height were independently associated with birth weight. Gourangie and Ahmed (2007) using a regression model stated that pre-pregnant weight had direct positive linear relationship with the birth weight. Agnihotri et al. (2008) studied 2 birth cohorts in India and suggested that both maternal and paternal birth weights are strong determinants of offspring birth weight. Maternal weight below 45 kgs was found to be a significant risk factor for abnormal birth weight by Sharma et al. (2009). Analysis of the II National Family Health Survey conducted in India in 1998-1999, by Dharmalingam et al. (2010) revealed that mother's body mass index is more pervasive across India than other factors on birth weight.

2.2.5 Maternal Psychosocial Stress

There is a growing area of studies concerned with maternal psychosocial stress and the effect on birth weight. Work related stress was seen to be an important factor in the determination of birth weight, especially for those women who did not want to remain in the work force, thus emphasizing the need for personal motivation and physical impact of work to be evaluated, as suggested by Homer et al (1990), while Hedegaard et al. (1993) stated that psychological distress does not influence fetal growth. Peacock et al. (1995) demonstrated the effect of adverse social circumstances having a negative effect on birth weight.

Hashim and Moawed (2000) in a study among Saudi women found that increasing amount of stress during pregnancy increased the risk of abnormal birth weight babies. Sable and Wilkinson (2000) suggested that interventions among pregnant women, assessing perceived stress and attitudes towards pregnancy, have the potential to improve pregnancy outcome. Walker and Kim (2002) studied the psychosocial thriving late in pregnancy and found that it was not related to birth weight. Patel and Prince (2006) revealed that maternal psychological morbidity was independently associated with abnormal birth weight.

2.2.6 Health Behaviours

Health behaviours affecting birth weight include habits like smoking, presence of passive smoking and also physical activity. Exposure to passive smoke has been seen to be significantly related to abnormal birth weight in an American study by Martin and Bracken (1986). In a study by Rubin et al. (1986), the effect of passive smoking on birth weight was found to be greatest in the lower social classes. The main environmental cause of variation in birth weight was found to be smoking by Brooke et al. (1989). Mathai et al. (1992) reported that passive smoking was associated with a decrease in birth weight, even after adjusting for other variables known to affect birth weight. Pivarnik (1998) stated that moderate to vigorous activity throughout pregnancy enhanced birth weight, except severe regimen which could result in decreased birth weight. Reduction in smoking frequency to less than eight cigarettes per day was suggested in a study by England et al. (2001). A specific finding in a study by Gupta and Sreevidya (2004) relates to an average reduction of 105 grams in birth weight with smokeless tobacco use. Regarding physical activity, Goel et al. (2004) studying the adverse health effects of exposure to environmental tobacco smoke, or passive smoking, suggested that there appeared to be a dose response relationship between the quantum of smoke inhaled and the magnitude of weight reduction in the reduction of birth weight. Again, Vahdaninia et al. (2008) reported, based on a retrospective study from Iran, that smoking during pregnancy was a significant determinant of abnormal birth weight.

2.2.7 Maternal Nutritional Status

Nutritional status as well as weight gain of the mother during pregnancy has been studied as an important component of prenatal health. Balanced protein energy supplement was also suggested by Merialdi et al. (2003) as a part of fetal weight improvement, especially in populations with high prevalence of under nutrition.

A study in Mexico by Ramakrishnan et al. (2003) found that multiple micronutrient supplementation during pregnancy did not lead to greater birth weight than does iron-only supplementation. Kramer (2003) stated that abnormal birth weight in developing countries was primarily caused by low gestational weight gain due to low energy intake. A regression model by Mathule et al. (2005) found that third trimester exposure to hungry season was an indicator of abnormal birth weight. Joshi et al. (2005) suggested improvement in maternal nutrition during pregnancy for reducing abnormal birth weight newborns. A study conducted by Rao et al. (2007) in Haryana, India revealed that low calorie intake in the third trimester of pregnancy was associated with abnormal birth weight.

Previous obstetric history encompasses the details of previous pregnancies as well as history of adverse outcomes. Seidman et al. (1988) observed that birth weight increased with increasing birth order. Hirve and Ganatra (1994), in an Indian based cohort study, reported that the odds associated with abnormal birth weight decreased with increasing parity. Miller (1994) also concluded that first born infants fared worse than infants of higher birth orders. Kapilashrami et al. (2000) noted a higher incidence of abnormal birth weight among infants born to primiparas. Rousham and Gracey (2002) in a study from Australia, concluded that the only significant predictor of abnormal birth weight was a previous history of having a abnormal birth weight baby. Boo et al. (2008) demonstrated that nulliparity and previous history of having a abnormal birth weight baby had a significant influence on birth weight. Brown et al. (2008) showed that previous abortion was a significant risk factor for abnormal birth weight and the risk increased with the increase in the number of previous abortions. Anitha et al. (2009) found that parity and a history of abnormal birth weight were predictors of birth weight.

2.2.8 Maternal Morbidity during Pregnancy

Morbidity or illness that affects the mother during pregnancy also has an effect on the fetal birth weight. Schieve et al. (1994) observed that exposure to urinary tract infection during pregnancy elevated the risk for abnormal birth weight baby. Sheehan (1998) used a structural equation model to demonstrate that the mother's history of medical risks shows an independent influence on birth weight. Stekettee et al. (2001) reviewed studies between 1985 & 2000 and stated that malaria during pregnancy led to a population attributable risk ranging from 8 –14% for abnormal birth weight. Badshah et al. (2008) stated that presence of anaemia in the mother was significantly associated with abnormal birth weight baby. Rulisa et al. (2009) in a study conducted in Rwanda, found that birth weight is not directly influenced by malaria.

2.2.9 Antenatal Care Utilization

Antenatal care is an essential component of prenatal health, having a significant influence on birth weight. Malik et al. (1997) noted that antenatal visits independently affected the birth weight of the newborn. Sinha (2006) in a study conducted in an urban slum in Delhi, India stated that the incidence of abnormal birth weight was lower in the area than the country, due to antenatal care utilization.

Raatikainen et al. (2007) concluded that non or under-attendance for antenatal care is associated with elevated risk of abnormal birth weight. Tayie and Lartey (2008) revealed that early antenatal care is crucial to favourable pregnancy outcomes including birth weight.

The review in the area of birth weight estimation also reveals a set of studies based on the ultrasound scan measurements of the foetus. The scanning parameters are considered for the inherent relations and the overall implication for birth weight. There are formulas proposed with different parameters as well as combination of the parameters. Majority of the studies resort to regression analysis for providing estimates to be used in the prediction of birth weight. A formula containing measurements of fetal head, abdomen and femur was proposed by Hadlock et al. (1984). It was shown by Wong et al. (1985) that the Campbell's equation based on abdominal circumference provides higher accuracy and precision in predicting fetal weight. Majority of the studies show femur length as playing a major role, like the studies conducted by Roberts et al. (1985), Hill et al.(1985), Warsof et al. (1986), Yarkoni et al. (1986), Vintzileos et al. (1987), during the later part of 80's. During the early 90's, there were few studies reported from different places on the use of femur length for the estimation of birth weight like those of Ferrero et al. (1994), Scott et al. (1996). Studies during the early 2000's relying on femur length were Honarvar et al. (2001) and Venkat et al (2001). However, a lot of studies have been reported centering on Hadlock's formula, some of them claim superiority over Hadlock's and some of try to evaluate Hadlock's in different situations. Hebbar (2003), Kurmanavicius et al. (2004), Donma et al. (2005) are some of the papers justifying the application of Hadlock's formula. From the evaluation side, there are studies in 90's that critically evaluate Hadlock's equation or use Hadlock's equation as the central point and provide some modifications to it like Shamley and Landon (1994), Mongelli and Gardosi (1995). Sato et al. (1985) used multiple regression for the estimation of birth weight by ultrasonic measurements from several growth parameters. Rose and McCallum (1987) proposed a simplified model with a comparison to Shepard-Warsof model. Secher et al. (1987) provide an exponential model with gestational age for the estimation of fetal weight in the third trimester. A comparison of various methods using ultrasonic scan measurements for estimating fetal weight is made by Jackson et al. (1990) and a new formula is presented. Stratton et al.(1996) provide an interesting study by actually conducting a verification of the different types of models, using infant's weight immediately after birth. Smith et al. (1997) corroborate the finding of Stratton J et al in the use of abdominal circumference for birth weight estimation. Studies like those of Chauhan et al. (1998), Chein et al. (2000), Pressman (2000) have compared the accuracy of predicted birth weight by the gestation adjusted projection method. There are studies comparing clinical and ultrasound estimation of fetal weight by Rogers et al. (1993), Mehdizadeh et al. (2000), Titapant et al. (2001), Baum et al. (2002), Nahum and Stanislaw (2003).Yoshida et al. (2001) stated that sonographic determination of fetal growth from 20 weeks of gestation onwards seemed to be correlated with birth weight deviation. A logistic model was proposed by Habib (2002) that predicts normal birth weight in terms of placental diameter and thickness. Gull et al. (2002) studied the variation among sonographers on the estimation of birth weight. A review paper by Dudley (2004) compares the ultrasound estimation of fetal weight methods. A linear regression model is given by Isobe (2004) for estimation of fetal body weight using ultrasound. A stepwise regression analysis based on fractional polynomials with the scan parameters was used to estimate sex specific fetal weight by Schild et al. (2004). A very important question was raised and answered by Romano-Zelekha et al. (2005) regarding the use of population specific methods for birth weight estimation without depending on a uniform method everywhere.

In a multi-level analysis study of the link between antenatal care and birth weight, the study documented that adequate use of antenatal care during pregnancy leads to higher birth weights among infants and by extension better health for infants (Awiti, 2014).

2.3.0 Influence of Maternal Height on Fetal Weight

Increasing maternal height influences fetal birth weight positively. Many studies vouch to it. In Arhus Municipal Hospital, Risskov, Denmark frequency for "light-for-date" was significantly higher in babies of short mothers than in control (15.4 % and 5.6 % respectively). In this study, relative risk of a "light-for-date" baby in short mother was 2.8.

In Nepalese women, an increase in the number of abnormal birth weight was found when mothers' height decreased. The incidence was 45.45 % among women less than 140cm height group, to 28.08 % in the 140-144cm group, 19.62 % in the 150-154cm group and 12.78 % in 155-160cm group. Desai, Hazra and Trivedi reported increased abnormal birth weight among short statured mothers of Baroda, India. Identical result was found among Maltese women.

In a study conducted to determine the prevalence of abnormal birth weight and its association with maternal factors, Desmukh et al. recognized an association between abnormal birth weight and mothers below 144cm in height. In another Indian study, less than 145cm height was significantly more common amongst the mothers of abnormal birth weight babies. Dhall and Bagga found that among Indian women birth weight of babies increased with increasing maternal height. It was observed that the birth weight in mothers < 145cm tall and between 145-150cm were 155g and 37g less than those of the reference category. In Tamil Nadu, India, Kamaladoss et al. found that the rate of abnormal birth weight was high for mothers with < 145cm (29.7 %) than mothers with ≥145cm (24.2 %). It was noticed that mothers with < 145cm height had 1.32 times risk of giving birth to abnormal birth weight in comparison to mothers > 145cm in height.

Among Tanzanian women 10.1 % abnormal birth weight babies belonged to the group of short statured mothers, whereas only 6.5 % belonged to tall women.

In Nigeria, Dawodu and Laditan observed a significant relationship ($p < 0.001$) between the mothers' height and the incidence of abnormal birth weight. The incidence was 9.1 % among short statured women and 4.0 % among tall mothers. Wright found that in the plateau region of Nigeria, short statured mothers had the largest number of abnormal birth weight babies.

Max Mongelli observed that though birth weight is determined by multiple interrelated factors, maternal height is an important and significant variable with a p value of < 0.005.

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The proportion of newborn with normal birth weight rises with the maternal height. About 70 % of babies of women 160cm or more in height were of normal birth weight according to a study. Nearly half of the babies of 150-159cm tall women were of normal birth weight, but two-third of the newborn were abnormal birth weight when maternal height was below 150cm.

The height of the mother is a well-known predictive index of perinatal mortality and morbidity. A high incidence of abnormal birth weight infants has been shown in mothers with height less than 140cm. Since there is a high perinatal mortality in abnormal birth weight infants, height has an indirect influence. However, WHO meta-analysis shows only an OR of 1.7 for abnormal birth weight, which is not very significant.

2.3.1 Maternal Weight and Fetal Weight

Maternal weight gain within recommended parameters reduce the risk of adverse outcome. According to Williams (1997), low weight gain is associated with preterm or otherwise abnormal birth weight infants. A significant increase in perinatal mortality was observed when the maternal weight gain was 5.0kg or less. In addition it was observed that the incidence of abnormal birth weight increased significantly in mothers with weight gain of 5kg or less when preterm birth was excluded.

According to WHO meta-analysis, weight attained at different lunar months has significant ORs for predicting fetal birth weight. Chadha et al. found an increase of 150g in fetal birth weight with every kg rise in maternal weight gain. Kamaladoss et al. demonstrated that the rate of abnormal birth weight was high for mothers whose gestational weight at third trimester was ≤ 50kg (68.6 %) than mothers whose gestational weight was > 50kg (31.4 %). This was significantly high ($p < 0.001$). Dhall and Bagga reported that babies of mothers weighing < 50kg were 87g lighter than those between 51-60kg. A similar observation was made by Desmukh et al.

In a study in Tanzania, maternal post-delivery weight less than 45kg had an OR of 2.03 for abnormal birth weight. To find out pregnancy hazards associated with low maternal body mass indices, a study was conducted by Cattanach et al. at Mater Misericordiae Mothers' Hospital, South Brisbane. The results showed significant evidence to support the view that underweight women are at greater risk of obstetric hazards. An OR of 2.26 and 2.16 was found for birth weight < 1500g and < 2500g respectively for underweight women.

A strong positive correlation exists between maternal health and reproductive performance, and weight gain during pregnancy. Higher incidence of prematurity or dismaturity and increased perinatal mortality show a close association with poor weight gain during pregnancy.

2.3.2 Multinomial Logistic Regression Model and Abnormal Birth Weight

In a multinomial logistic regression study, mothers who had not attended antenatal care were found to have more than a double likelihood of delivering low birth weights compared to those attended a minimum of four antenatal visits. In addition, mothers who had not had formal education, those of rural residence, those of low socio-economic status, those who gave birth to a male infant and multiple births were more likely to deliver a low birth weight baby (Omedi *et al*, 2015).

CHAPTER THREE

METHODOLOGY

3.1 Study Design

This study used a secondary data set. The data was obtained from the 2013 Nigeria Demographic and Health Survey (NDHS). This is a cross-sectional study with data on various subjects such as household population, fertility levels, family planning, infant mortality, maternal health etc.

3.2 Study Population

The 2013 Nigeria Demographic Health Survey (NDHS) consist of a nationally representative sample of 28,596 women between the ages of 15-49 years were individually interviewed. All women were from selected households or women who spent the night before the survey in the selected households were eligible for individual interviews.

3.3 Sample Design

The 2013 NDHS is the fifth Demographic and health survey in Nigeria. A national representative sample of 40, 320 households were selected. All women age 15-49 who were either permanent resident of the household or visitors present in the household at the night before the survey were eligible to be interviewed.

Nigeria is divided into 36 states and each state is further divided into local government areas (774 LGAs). Nigeria lies on the west coast of Africa between latitudes 4°16' and 13°53' north and longitudes 2°40' and 14°41' east. It occupies approximately 923,768 square kilometers of land stretching from the Gulf of Guinea in the Atlantic coast in the south to the fringes of the Sahara Desert in the north. The territorial boundaries are defined by the republics of Niger and Chad in the north, the Republic of Cameroon in the east, and the Republic of Benin in the west. Nigeria is the most populous country in Africa and the 14th largest in land mass. The country's 2006 Population and Housing Census placed the country's population at 140,431,790.

The 2013 Nigeria Demographic and Health Survey (NDHS) was implemented by the National Population Commission. It is the fifth in the series of Demographic and Health Surveys conducted so far in Nigeria; previous surveys were conducted in 1990, 1999, 2003, and 2008.

3.4 Inclusion criteria

The inclusion criteria include mothers who gave birth to a child 5 years before the interview and aged 15–49 years who were either permanent residents or visitors present in the household on the night before the survey conducted.

3.5 Exclusion criteria

Subjects with missing values for any of the studied variables were excluded from this study.

3.6 Dependent variables

The dependent variable Birth Weight was grouped into 3 categories:

Category 1: Low Birth Weight (Birth weight < 2.5kg)

Category 2: Normal Birth Weight (Birth weight > 2.5kg < 4.0kg)

Category 3: High Birth Weight (Birth weight > 4.0kg)

3.7 Independent variables

i) Socio-demographic factors: Maternal age, place of residence, maternal educational level, wealth index, region, Antenatal visits, maternal smoking, religious background, marital status.

ii) Socio-economic factors: Accessibility to health care facility, maternal occupation, maternal health status and environmental exposures.

iii) Maternal biophysical characteristics: Maternal Body Mass Index, Parity, age at first birth, number of previous births, number of pregnancies, preceding birth interval, family size, desired family size.

iv) Foetal - related factors: Twin children, child's sex, multiple gestation.

v) Maternal lifestyle: Antenatal care (timing of first ANC visit, number of ANC visits, tetanus injection), maternal smoking.

3.8 DATA MANAGEMENT

All data analysis was done using SPSS 20. Individual data was extracted from the NDHS 2013 dataset. The data was directly extracted from the children file, a subdivision of the data set dedicated to children's data and all that affects them. Frequency and percentages were used to describe various dependent and independent variables. Bivariate analysis was done to calculate the association and relationship between variables and abnormal birth weight.

3.9 Multinomial Logistic Regression

Multinomial logistic regression (often just called 'multinomial regression') is used to predict a nominal dependent variable given one or more independent variables. It is sometimes considered an extension of binomial logistic regression to allow for a dependent variable with more than two categories. As with other types of regression, multinomial logistic regression can have nominal and/or continuous independent variables and can have interactions between independent variables to predict the dependent variable. Multinomial logistic regression can also be used for ordinal variables, but you might consider running an ordinal logistic regression instead. It is a multi-equation model, similar to multiple linear regression. Multinomial regression analysis uses the concept of probabilities and k-1 log odds equations that assume a cut-off probability 0.5 for a category to happen. The practical difference is in the assumptions of both tests.

The assumptions are:

1. The dependent variable should be measured at the nominal level.
2. The ordinal independent variables must be treated as being either continuous or categorical.
3. The independence of observations and the dependent variable should have mutually exclusive and exhaustive categories.
4. There should be no multicollinearity. multicollinearity occurs when you have two or more independent variables that are highly correlated with each other. This leads to problems with understanding which variable contributes to the explanation of the dependent variable and technical issues in calculating a multinomial logistic regression. Determining whether there is multicollinearity is an important step in multinomial logistic regression.
5. There needs to be a linear relationship between any continuous independent variables and the logit transformation of the dependent variable.
6. There should be no outliers, high leverage values or highly influential points.

In Multinomial logistic regression, K possible outcomes, running $K-1$ independent binary logistic regression models, in which one outcome is chosen as a "pivot" and then the other $K-1$ outcomes are separately regressed against the pivot outcome.

$$\ln \frac{Pr(Yi=1)}{Pr(Yi=K)} = \beta_1.x_i \quad \text{------------------------------------ (i)}$$

$$\ln \frac{Pr(Yi=2)}{Pr(Yi=K)} = \beta_2.x_i \quad \text{---------------------------------- (ii)}$$

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$$\ln \frac{Pr(Yi=k-1)}{Pr(Yi=K)} = \beta_{k-1}.x_i \quad \text{-------------------------------- (iii)}$$

Exponentiate both sides and solve for the probabilities:

$$Pr\ (Yi = 1) = Pr\ (Yi = K)e^{\beta 1.xi} \quad \text{------------------- (iv)}$$

$$Pr\ (Yi = 2) = Pr\ (Yi = K)e^{\beta 2.xi} \quad \text{------------------- (v)}$$

....

....

$$Pr\ (Yi = K\text{-}1) = Pr\ (Yi = K)e^{\beta k-1.xi} \quad \text{------------------- (vi)}$$

Considering the fact that the sum of the probabilities of all K is one;

$$Pr(Yi = K) = \frac{1}{1 + \sum_{k=1}^{k-1} e^{\beta k.xi}} \quad \text{------------------- (vii)}$$

Therefore, for other probabilities;

$$Pr(Yi = 1) = \frac{e^{\beta 1.xi}}{1 + \sum_{k=1}^{k-1} e^{\beta k.xi}} \quad \text{-------------------------- (viii)}$$

$$Pr(Yi = K\text{-}1) = \frac{e^{\beta k-1.xi}}{1 + \sum_{k=1}^{k-1} e^{\beta k.xi}} \quad \text{--------------------------- (ix)}$$

For this study, this model will be used. For the dependent variables, Y, is in 3 categories, that is, Low Birth Weight category, Normal Birth Weight category and High Birth Weight category.

Y_1 = Low Birth Weight category (Birth weight < 2.5kg)

Y_2 = Normal Birth Weight category (Birth weight >2.5kg < 4.0kg)

Y_3 = High Birth Weight category. (Birth weight > 4.0kg)

β_i = the independent variables

The second category would be used as the reference.

3.10 Conceptual Framework of Abnormal Birth Weight

In order to determine the association between various factors and abnormal birth weight a conceptual framework similar to that described by Magadi was adopted (Magadi*et al*, 2004). Under this framework, we hypothesized that abnormal birth weight was likely to be contributed by the following categories of factors, namely; socio-demographic and economic factors, and service accessibility, maternal health care and general health care behavior, maternal health status including the mother's nutritional status, and newborn factors. Other factors that include woman's health behavior e.g. cigarette smoking and exposure to environmental contaminants were similarly examined on the basis of findings from previous studies.

These factors may influence abnormal birth weight either directly or indirectly. A number of factors which do not show direct associations with unfavourable birth outcomes contribute to these outcomes indirectly through intermediate factors. Socio-demographic, reproductive behaviour and service accessibility do not have direct association but are linked to unfavourable outcomes through antenatal care. Antenatal care is the central link between various socio-demographic and reproductive factors and birth outcomes.

The socio-demographic factors are also likely to influence pregnancy outcomes through maternal health care and maternal health status. Appropriate maternal health care has been found to prevent adverse pregnancy outcomes for the mother and the baby and the woman's health has a dramatic impact on the quality of life and productivity, and the life of the newborn, the most important being her nutritional status (Magadi*et al*, 2000a).

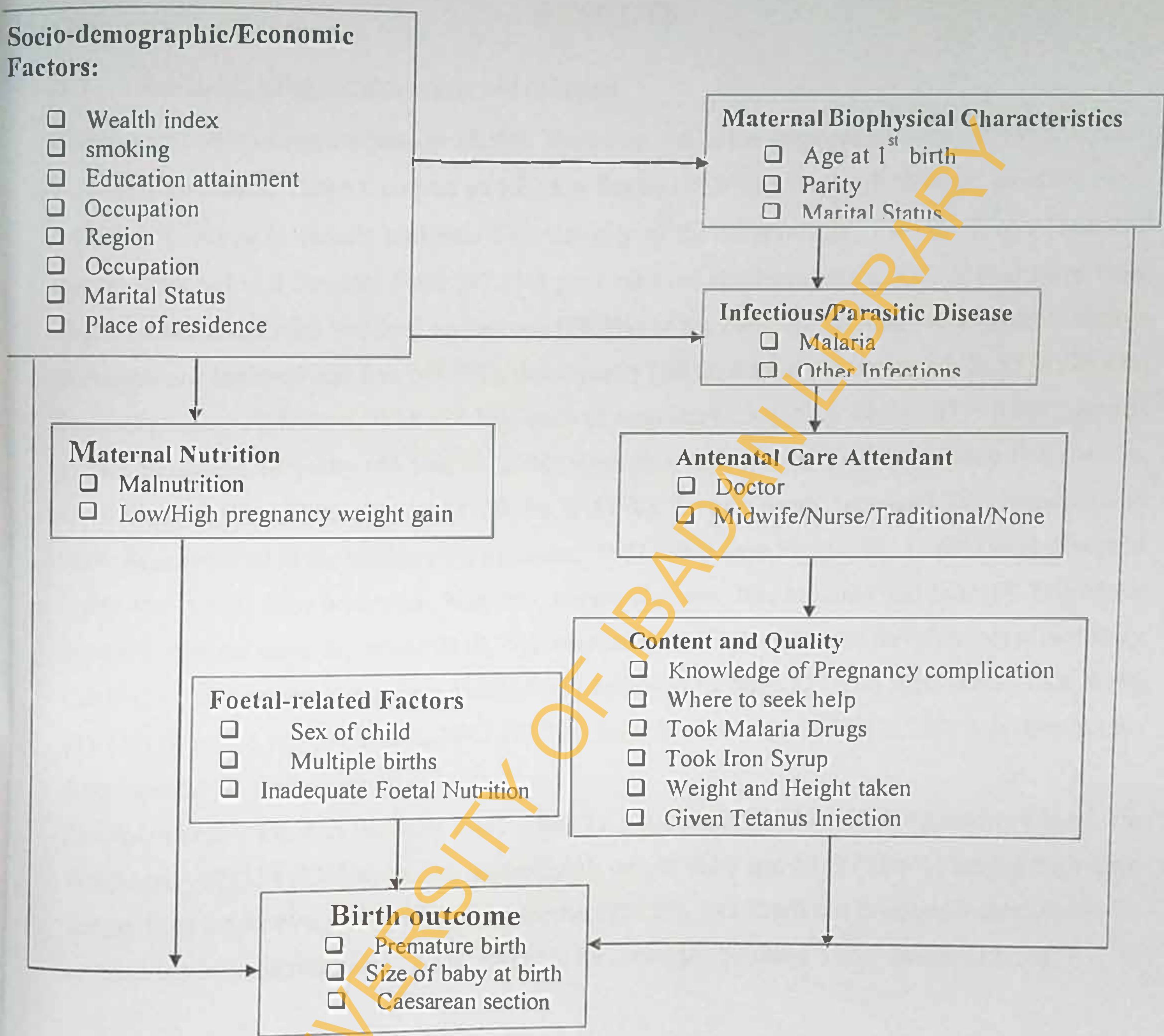

Fig 1: The inter-relationship among various variables is shown in the flow chart below.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics

The total number of respondents is 28,596. The mean age of the respondents was 29.45±6.92years. Fourteen Thousand Three Hundred and Eighty Seven (50.3%) gave birth to male children while 14209 (49.7%) have female children. The majority of the respondents, Twenty Seven Thousand Seven Hundred and Seventy Four (97.1%) gave birth to singleton while 822 (2.9%) have twin. Eighteen thousand nine hundred and eleven (66.1%) of the sampled women were urban. Thirteen thousand one hundred and five (45.8%), the majority had no formal education while 5836 (20.4%) were of primary education, 7818 (27.3%) were of secondary education, while 1837 (6.4%) were of higher education. Majority (44.6%, n=12740) were poor followed by those who were rich (34.1%, n=10086) and the middle class were (20.2%, n=5770). Twenty Seven thousand Two Hundred and Sixty Four (95.3%) of the mothers were married, 550 (1.9%) were Single, 331 (1.6%) were divorced while 451 (1.6%) were widowed. Majority, twenty thousand five hundred and four (99.7%) of the mothers were not smoking, while 92 (0.3%) were smokers. Eight thousand Seven hundred and sixty (30.6%) of the mothers were from North-West, followed by 5856 (20.5%) from North-East, 4286 (15.0%) from the North-Central, 3643 (12.7%) from South-West, 3498 (12.2%) from the South-South and 2553 (8.9%) from the South-East.

The mean birth weight of the baby was 3.24±0.76, with 3143 (11.1%) reporting having a low birth weight baby, 22134 (77.4%) having normal birth weight baby and 3319 (11.6%) having high birth weight baby respectively. Majority of the mothers (53.5%, n=15296) had attended 4 antenatal visits or more while some mothers (12.6%, n=3613) had attended between 1 to 3 antenatal visits.

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Table 4.1: Frequency distribution of categorical background characteristics of the respondents (N = 28596)

Characteristics	Frequency	Percentage
Child's sex		
Male	14387	50.3
Female	14209	49.7
Twin		
No	27774	97.1
Yes	822	2.9
Maternal age group (years)		
<20	1349	4.72
20-29	13549	47.38
30-39	10814	37.82
40-49	2884	10.09
Maternal education level		
No education	13105	45.8
Primary	5836	20.4
Secondary	7818	27.3
Higher	1837	6.4
Marital status		
Single	550	1.9
Married	27264	95.3
Widowed	331	1.2
Divorced	451	1.6
Maternal BMI (kg/m^2)		
Underweight	2453	8.6
Normal	18694	65.4
Over weight/Obese	7449	26.0
Maternal smoking		
No	28504	99.7
Yes	92	0.3
Preceding birth interval		
<18	1856	6.5
18-36	16382	57.3
>36	10358	36.2
	9687	33.9
Antenatal visits		
1-3	3613	12.6
>=4	15296	53.5
Parity		
1	3393	11.9
2-4	13731	48.0
≥5	11472	40.1
Wealth index		
Poor	12740	44.6

Middle	5770	20.2
Rich	10086	35.3
Place of residence		
Rural	9685	33.9
Urban	18911	66.1
Region		
North-Central	4286	15.0
North-East	5856	20.5
North-West	8760	30.6
South-East	2553	8.9
South-South	3498	12.2
South-West	3643	12.7
Birth Weight		
Low (<2.5kg)	3143	11.1
Normal (>= 2.5<4kg)	22134	77.4
High (>4kg)	3319	11.6

4.2 Association between the Maternal Socio-Demographic and Economic Factor, and Birth Weight.

Table 4.2 shows the association between the Maternal Socio-Demographic and Economic Factor, and the ABW. The following variables had significant simple associations with the Abnormal Birth Weight. These variables are maternal age ($p < 0.0001$), maternal educational level ($p < 0.0001$), marital status ($p < 0.0001$), wealth index ($p < 0.0001$), place of residence ($p < 0.0001$), region ($p < 0.0001$) and Antenatal visits ($p < 0.0001$), while maternal smoking ($p = 0.021$) had no significant association with Abnormal Birth Weight.

Table 4.2: Association of Maternal Socio-Demographic and Economic Factor with Abnormal Birth Weight.

Variable	Birth weight			χ^2	df	P-value
	Low, n (%)	Normal, n (%)	High, n (%)			
Maternal age group (years)				85.519	6	< 0.001
<20	212 (21.3)	1000 (64.8)	137 (13.9)			
20-29	1626 (13.7)	10368(75.4)	1537 (10.9)			
30-39	1063 (3.72)	8487 (29.68)	1264 (11.3)			
40-49	242 (9.5)	2261 (78.0)	381 (12.1)			
Maternal education level				193.90	6	< 0.001
No education	1773 (13.1)	9877 (75.8)	1455 (11.2)			
Primary	601 (10.8)	4597 (77.8)	638 (11.4)			
Secondary	651 (9.6)	6186 (78.7)	981 (11.7)			
Higher	118 (8.9)	1474 (78.4)	245 (12.7)			
Marital status				62.88	6	< 0.001
Single	92 (16.7)	411 (74.7)	47 (8.6)			
Married	3010 (11.1)	21108 (77.4)	3146 (11.5)			
Widowed	24 (7.3)	249 (75.2)	58 (17.5)			
Divorced	17 (3.8)	366 (81.2)	68 (15.1)			
Wealth index				210.55	4	< 0.001
Poor	1719 (13.5)	9628 (75.6)	1393 (10.9)			
Middle	649 (11.2)	4507 (78.1)	614 (10.6)			
Rich	775 (7.7)	7999 (79.3)	1312 (13.0)			
Place of residence				157.20	2	< 0.001
Rural	763 (7.9)	7670 (79.2)	1252 (12.9)			
Urban	2380 (12.6)	14464 (76.5)	2067 (10.9)			
Region				238.98	10	< 0.001
North Central	519 (12.1)	3303 (77.1)	464 (10.8)			
North East	751 (12.8)	4433 (75.7)	672 (11.5)			
North West	1156 (13.2)	6657 (76.0)	947 (10.8)			
South East	158 (6.2)	2029 (79.5)	366 (14.3)			
South South	334 (9.5)	2755 (78.8)	409 (11.7)			
South West	225 (6.2)	2957 (81.2)	461 (12.7)			
Maternal smoking				7.76	2	0.021
No	3126 (11.0)	22064 (77.4)	3314 (11.6)			
Yes	17 (18.5)	70 (76.1)	5 (5.4)			
Antenatal Visits				109.29	4	<0.001
None	1285 (13.3)	7305 (75.4)	1097 (11.3)			
1-3	450 (1.6)	2760 (9.7)	403 (11.2)			
≥4	1408 (9.2)	12069 (78.9)	1819 (6.4)			

4.3 Multinomial Logistic Regression model of Maternal Socio-Demographic and Economic Factor with related to Abnormal Birth Weight.

Table 4.3 shows the multinomial logistic regression models of Maternal Socio-Demographic and Economic Factor with related to Abnormal Birth Weight. The following factors were associated with low birth weight babies: women of age group 20-29 years were 1.49 times more likely to have low birth weight babies [AOR= 1.49, 95%CI=1.29-1.73]. Women with no educational level were 1.42 times more likely to have low birth weight babies [AOR=1.42, 95%CI=1.13-1.77]. Single mother were 1.82 times more likely to have low birth weight babies [AOR= 1.82, 95%CI= 1.42-2.32]. Women with middle wealth index were 1.15 times more likely to have low birth weight babies [AOR=1.15, 95%CI= 1.01-1.31].Women living in the rural area were 0.87 times less likely to have low birth weight babies [AOR=0.87, 95%CI= 0.78- 0.97]. Women in the North-Central Region were 1.70 times more likely to have low birth weight babies [AOR=1.70, 95%CI=1.43-2.02].

On the other hand, maternal age, maternal educational level, marital status, maternal smoking, region, place of residence, were not statistically significant to having high birth weight babies. However, women of age group 30-39 were 0.87 times less likely to have high birth weight babies [AOR=0.87, 95%CI= 0.77- 0.99]. Also, women with middle wealth index were 0.86 times less likely to having high birth weight babies [AOR=0.86, 95%CI=0.76- 0.96]. Mothers that do not attend Antenatal Care (ANC) were not statistically significant.

Table 4.3: Multinomial Logistic Regression of Maternal Socio-Demographic and Economic Factor with related to Abnormal Birth Weight.

Variable	Low BW vs. Normal BW		High BW vs. Normal BW	
	OR [95% CI]	AOR [95% CI]	OR [95% CI]	AOR [95% CI]
Maternal age group (years)				
< 20	1.98 [1.62, 2.42]**	1.73 [1.41, 2.12]*	0.81 [0.66, 1.00]	0.86 [0.70, 1.07]
20-29	1.46 [1.27, 1.69]**	1.49 [1.29, 1.73]**	0.88 [1.62, 2.42]*	0.88 [0.78, 1.00]
30-39	1.17 [1.01, 1.36]**	1.27 [1.09, 1.47]**	0.88 [0.78, 1.00]	0.87 [0.77, 0.99]*
40-49	1	1	1	1
Maternal education level				
No education	2.42 [1.85, 2.72]**	1.42 [1.13,1.77]*	0.89 [0.77, 1.03]	1.03 [0.86, 1.23]
Primary	1.63 [1.33, 2.01]**	1.25 [1.00,1.55]	1.63 [1.33, 2.01]*	0.91 [0.77, 1.08]
Secondary	1.32 [1.07, 1.61]**	1.08 [0.88,1.33]	0.95 [0.82, 1.17]	1.00 [0.85, 1.16]
Higher	1	1	1	1
Marital status				
Single	1.57 [1.25, 1.97]*	1.82 [1.42, 2.32]*	0.77 [0.57, 1.04]	0.76 [0.55, 1.04]
Widowed	0.68 [0.44, 1.03]	0.83 [0.54, 1.27]	1.56 [1.17, 2.08]**	1.50 [1.12, 2.01]*
Divorced	0.33 [0.20, 0.53]**	0.33 [0.20, 0.53]**	1.25 [0.96, 1.62]	1.27 [0.97, 1.65]*
Married	1	1	1	1
Wealth index				
Poor	1.84 [1.68, 2.02]*	1.21 [1.06, 1.38]*	0.88 [0.81, 0.96]*	0.91 [0.81, 1.04]
Middle	1.49 [1.33, 1.66]*	1.15 [1.01, 1.31]*	0.83 [0.75, 0.92]*	0.86 [0.76, 0.96]*
Rich	1	1	1	1
Place of residence				
Rural	0.60 [0.55, 0.66]*	0.87 [0.78, 0.97]*	1.14 [1.06, 1.23]*	1.07 [0.97, 1.17]
Urban	1	1	1	1
Region				
North Central	2.07 [1.75, 2.43]**	1.68 [1.42, 1.99]**	0.90 [0.78, 1.03]	0.96 [0.83, 1.11]
North East	2.23 [1.90, 2.60]**	1.57 [1.32, 1.87]**	0.97 [0.86, 1.10]	1.03 [0.89, 1.19]
North West	2.28 [1.97, 2.65]**	1.56 [1.32, 1.85]**	0.91 [0.81, 1.03]	0.96 [0.83, 1.11]
South East	1.02 [0.83, 1.26]	1.00 [0.81, 1.24]	1.16 [1.00, 1.34]	1.17 [1.01, 1.36]*
South South	1.59 [1.34, 1.90]**	1.41 [1.18, 1.70]**	0.95 [0.83, 1.10]	1.00 [0.87, 1.16]
South West	1	1	1	1
Maternal smoking				
Yes	1.71 [1.01, 2.92]*	1.91 [1.21, 3.26]*	0.48 [0.19, 1.18]	0.46 [0.19, 1.14]
No	1	1	1	1
Antenatal visits				
None	0.66 [0.61, 0.72]**	0.72 [0.66, 0.78]**	1.00 [0.93, 1.09]	0.96 [0.89, 1.04]
1-3	0.93 [0.83, 1.04]	0.95 [0.84, 1.06]	0.97 [0.86, 1.10]	0.96 [0.85, 1.09]
≥ 4	1	1	1	1

*P<0.05, **P<0.001

4.4 Association of Maternal biophysical characteristics and foetal-related factor with Abnormal Birth Weight.

Table 4.4 shows the association between the maternal biophysical characteristics and foetal related factor with abnormal birth weight. The following variables had significant simple associations with the Abnormal Birth Weight. These variables are maternal BMI ($p < 0.0001$), Child's sex ($p < 0.0001$) and Twin children ($p < 0.0001$). However, preceding birth interval ($p = 0.638$) and parity ($p = 0.375$) were not significantly associated with abnormal birth weight.

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Table 4.4 Association of Maternal biophysical characteristics and foetal related factor with Abnormal Birth Weight.

Variable	Birth weight			χ^2	df	P-value
	Low, n (%)	Normal, n(%)	High, n (%)			
Maternal BMI (kg/m^2)				197.08	4	< 0.001
Underweight	361 (14.7)	1845 (75.2)	247 (10.1)			
Normal	2246 (12.0)	14411 (77.1)	2037 (10.9)			
Over weight/Obese	536 (7.2)	5878 (78.6)	1035 (13.9)			
Child's sex				77.04	2	< 0.001
Male	1350 (9.4)	11317 (78.7)	1720 (12.0)			
Female	1793 (12.6)	10817 (76.1)	1599 (11.3)			
Twin				289.11	2	< 0.001
No	2906 (10.5)	21592 (77.7)	3276 (11.8)			
Yes	237 (28.8)	542 (65.9)	43 (5.2)			
Preceding birth interval				2.54	4	0.638
<18	194 (10.5)	1433 (77.2)	229 (12.3)			
18-36	1815 (11.1)	12650 (77.2)	1917 (11.7)			
Parity				4.24	4	0.375
1	403 (11.9)	2594 (76.5)	396 (11.7)			
2-4	1498 (10.9)	10666 (77.7)	1567 (11.4)			
≥5	1242 (10.8)	8874 (77.4)	1356 (11.8)			

4.5 Multinomial Logistic Regression of Maternal biophysical characteristics and foetal related factor with Abnormal Birth Weight.

Table 4.5 shows the multinomial logistic regression models of maternal lifestyle and biophysical characteristics with related to Abnormal Birth Weight. The table indicated that the following factors were associated with low birth weight babies. Maternal BMI (Obese) were 0.62 times less likely to have low birth weight babies [AOR=0.62, 95% CI=0.56-0.69]. Female children were 1.39 times more likely to be low birth weight babies [AOR= 1.39, 95% CI=1.29-1.50]. Twin children were 3.24 times more likely to be low birth weight babies [AOR=3.24, 95% CI=2.77-3.80].

On the other hand, Obese women were 1.26 times more likely to have high birth weight babies [AOR= 1.26, 95%CI=1.16-1.36]. Child's sex were of no statistical significant to high birth weight babies while twin children were 0.52 times less likely to be high birth weight babies [AOR=0.52, 95%CI=0.38-0.71].

Table 4.5 Multinomial Logistic Regression of biophysical characteristics and foetal related factor with Abnormal Birth Weight.

Variable	Low BW vs. Normal BW		High BW vs. Normal BW	
	OR [95% CI]	AOR [95% CI]	OR [95% CI]	AOR [95% CI]
Maternal BMI (kg/m^2)				
Underweight	1.26 [1.11, 1.42]**	1.22 [1.08, 1.38]**	0.95 [0.82, 1.09]	0.94 [0.82, 1.09]
Over weight/Obese	0.59 [0.53, 0.65]**	0.62 [0.56, 0.69]**	1.25 [1.15, 1.35]**	1.26 [1.16, 1.36]**
Normal	1	1	1	1
Child's sex				
Female	1.39 [1.29, 1.50]**	1.39 [1.29, 1.50]**	0.97 [0.90, 1.05]	0.97 [0.90, 1.05]
Male	1	1	1	1
Twin children				
Yes	3.25 [2.78, 3.80]**	3.24 [2.77, 3.80]**	0.52 [0.38, 0.71]**	0.52 [2.77, 3.80]**
No	1	1	1	1

*P<0.05, **P<0.001

4.6 Final Multinomial Logistic Regression investigating the determinant of Abnormal Birth Weight.

Table 4.6 shows the results of the final multinomial logistic model. Based on this model, the following factors were associated with low birth weight of babies: Child's sex (female) were 1.40 times more likely to be low birth weight babies than male children [AOR=1.40, 95%CI=1.30-1.52]. Twin children were 4.02 times more likely to be low birth weight babies [AOR=4.02, 95%CI=3.41-4.74]. Women of Age group 20-29 were 1.36 times more likely to have low birth weight babies [AOR=1.36, 95%CI=1.18-1.58]. Mother with no level of education were statistically significant to having low birth weight babies. Single mothers were 1.77 times more likely to have low birth weight babies [AOR=1.77, 95%CI=1.38-2.26]. Women that were smoking were 2.42 times more likely to have low birth weight babies [OR=2.42, 95%CI=1.41-4.18]. Women living in the rural place of residence were 0.88 times less likely to have low birth weight babies [AOR=0.88, 95%CI=0.79-0.98]. Women in the North-Central region were 1.70 times more .likely to have low birth weight babies [AOR=1.70, 95%CI=1.43-2.02].

However, this model also indicates that the following factors were associated with High Birth Weight babies: Twin children were 0.50 times less likely to be high birth weight babies [AOR=0.50, 95%CI=0.36-0.68]. Widow women were 1.50 times more likely to have high birth weight babies [AOR=1.50, 95%CI=1.12-2.00]. Middle wealth index women were 0.87 times less likely to have High Birth Weight babies [AOR=0.87, 95%CI=0.78-0.98]. Women living in the South East were 1.18 times more likely to have High Birth Weight babies [AOR=1.18, 95%CI=1.01-1.37].

4.6 Final Multinomial Logistic Regression investigating the determinant of Abnormal Birth Weight.

Table 4.6 shows the results of the final multinomial logistic model. Based on this model, the following factors were associated with low birth weight of babies: Child's sex (female) were 1.40 times more likely to be low birth weight babies than male children [AOR=1.40, 95%CI=1.30-1.52]. Twin children were 4.02 times more likely to be low birth weight babies [AOR=4.02, 95%CI=3.41-4.74]. Women of Age group 20-29 were 1.36 times more likely to have low birth weight babies [AOR=1.36, 95%CI=1.18-1.58]. Mother with no level of education were statistically significant to having low birth weight babies. Single mothers were 1.77 times more likely to have low birth weight babies [AOR=1.77, 95%CI=1.38-2.26]. Women that were smoking were 2.42 times more likely to have low birth weight babies [OR=2.42, 95%CI=1.41-4.18]. Women living in the rural place of residence were 0.88 times less likely to have low birth weight babies [AOR=0.88, 95%CI=0.79-0.98]. Women in the North-Central region were 1.70 times more .likely to have low birth weight babies [AOR=1.70, 95%CI=1.43-2.02].

However, this model also indicates that the following factors were associated with High Birth Weight babies: Twin children were 0.50 times less likely to be high birth weight babies [AOR=0.50, 95%CI=0.36-0.68]. Widow women were 1.50 times more likely to have high birth weight babies [AOR=1.50, 95%CI=1.12-2.00]. Middle wealth index women were 0.87 times less likely to have High Birth Weight babies [AOR=0.87, 95%CI=0.78-0.98]. Women living in the South East were 1.18 times more likely to have High Birth Weight babies [AOR=1.18, 95%CI=1.01-1.37].

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However, this model also indicates that the following factors were associated with High Birth Weight babies: Twin children were 0.50 times less likely to be high birth weight babies [AOR=0.50, 95%CI=0.36-0.68]. Widow women were 1.50 times more likely to have high birth weight babies [AOR=1.50, 95%CI=1.12-2.00]. Middle wealth index women were 0.87 times less likely to have High Birth Weight babies [AOR=0.87, 95%CI=0.78-0.98]. Women living in the South East were 1.18 times more likely to have High Birth Weight babies [AOR=1.18, 95%CI=1.01-1.37].

Table 4.6: Final Multinomial Logistic Regression Models investigating the determinants of abnormal birth weight

Variable	Low BW vs. Normal BW		High BW vs. Normal BW	
	OR [95% CI]	AOR [95% CI]	OR [95% CI]	AOR [95% CI]
Child's sex				
Female	1.39 [1.29, 1.50]**	1.41 [1.30, 1.52]**	0.97 [0.90, 1.05]	0.97 [0.90, 1.04]
Male	1	1	1	1
Twin				
Yes	3.25 [2.78, 3.80]**	4.07 [3.46, 4.80]**	0.52 [0.38, 0.71]**	0.50 [0.36, 0.68]**
No	1	1	1	1
Maternal age group (years)				
< 20	1.98 [1.62, 2.42]*	1.73 [1.41,2.12]*	0.81 [0.66, 1.00]	0.86 [0.70, 1.07]
20-29	1.46 [1.27, 1.69]*	1.49 [1.29,1.73]*	0.88 [1.62, 2.42]*	0.88 [0.78, 1.00]
30-39	1.17 [1.01, 1.36]*	1.27 [1.09,1.47]*	0.88 [0.78, 1.00]	0.87 [0.77, 0.99]*
40-49	1	1	1	1
Maternal education level				
No education	2.42 [1.85, 2.72]*	1.42 [1.13,1.77]*	0.89 [0.77, 1.03]	1.03 [0.86, 1.23]
Primary	1.63 [1.33, 2.01]*	1.25 [1.00,1.55]	1.63 [1.33, 2.01]*	0.91 [0.77, 1.08]
Secondary	1.32 [1.07, 1.61]*	1.08 [0.88,1.33]	0.95 [0.82, 1.17]	1.00 [0.85, 1.16]
Higher	1	1	1	1
Marital status				
Single	1.57 [1.25, 1.97]*	1.82 [1.42, 2.32]*	0.77 [0.57, 1.04]	0.76 [0.55, 1.04]
Widowed	0.68 [0.44, 1.03]	0.83 [0.54, 1.27]	1.56 [1.17, 2.08]*	1.50 [1.12, 2.01]*
Divorced	0.33 [0.20, 0.53]*	0.33 [0.20, 0.53]*	1.25 [0.96, 1.62]	1.27 [0.97, 1.65]*
Married	1	1	1	
Maternal BMI (kg/m^2)				
Underweight	1.26 [1.11, 1.42]**	1.22 [1.08, 1.38]**	0.95 [0.82, 1.09]	0.94 [0.82, 1.09]
Over weight/Obese	0.59 [0.53, 0.65]**	0.62 [0.56, 0.69]**	1.25 [1.15, 1.35]**	1.26 [1.16, 1.36]**
Normal	1	1	1	1
Maternal smoking				
Yes	1.71 [1.01, 2.92]*	2.45 [1.42, 4.22]*	0.48 [0.19, 1.18]	0.45 [0.18, 1.11]
No	1	1	1	1
Antenatal visits				
None	0.66 [0.61, 0.72]**	0.95 [0.87, 1.05]	1.00 [0.93, 1.09]	0.91 [0.82, 1.00]
1-3	0.93 [0.83, 1.04]	1.01 [0.90, 1.14]	0.97 [0.86, 1.10]	0.95 [0.84, 1.08]
≥4	1	1	1	1
Wealth index				
Poor	1.84 [1.68, 2.02]*	1.21 [1.06, 1.38]*	0.88 [0.81, 0.96]*	0.91 [0.81, 1.04]
Middle	1.49 [1.33, 1.66]*	1.15 [1.01, 1.31]*	0.83 [0.75, 0.92]*	0.86 [0.76, 0.96]*
Rich	1	1	1	1
Place of residence				
Rural	0.60 [0.55, 0.66]*	0.87 [0.78, 0.97]*	1.14 [1.06, 1.23]*	1.07 [0.97, 1.17]
Urban	1	1	1	1

Region				
North Central	2.07 [1.75, 2.43]**	1.68 [1.42, 1.99]**	0.90 [0.78, 1.03]	0.96 [0.83, 1.11]
North East	2.23 [1.90, 2.60]**	1.57 [1.32, 1.87]**	0.97 [0.86, 1.10]	1.03 [0.89, 1.19]
North West	2.28 [1.97, 2.65]**	1.56 [1.32, 1.85]**	0.91 [0.81, 1.03]	0.96 [0.83, 1.11]
South East	1.02 [0.83, 1.26]	1.00 [0.81, 1.24]	1.16 [1.00, 1.34]	1.17 [1.01, 1.36]*
South South	1.59 [1.34, 1.90]**	1.41 [1.18, 1.70]**	0.95 [0.83, 1.10]	1.00 [0.87, 1.16]
South West	1	1	1	1
Maternal height (cm)	0.97 [0.96, 0.98]**	0.99 [0.98, 0.99]**	1.00 [1.00, 1.01]	1.00 [0.99, 1.01]
Maternal weight (kg)	0.97 [0.97, 0.97]**	0.98 [0.98, 0.99]**	1.01 [1.01, 1.01]**	1.01 [1.00, 1.01]*

***P < 0.05, **p < 0.001**

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

Infants' birth weight and size at birth's Information is crucial to prevent the complications resulting from ABW. The prevalence of LBW and Macrosomia in Nigeria in this study were 11.1% and 11.6% respectively. The significant predictors of ABW were identified. Maternal age, maternal education level, marital status, Maternal BMI, ANC visit, Geopolitical zone, and maternal weight were significant predictors of ABW in Nigeria. The study was aimed at contributing to understanding of the issues related to abnormal birth weight. It was also to detennine the prevalence of ABW (low birth weight and macrosomia) and related factors such as maternal socio-demographic and economic characteristics, maternal biophysical and foetal-related factors in the developing countries like Nigeria.

This study has shown that maternal age, child sex, marital status, maternal smoking status, wealth index, place of residence, and geopolitical zone were significantly associated with the birth weights of the infants. All the categories of maternal age, female child sex, twin children, smoker women and mothers who reside in rural areas were significantly associated with a higher percentage of infants with ABW. It is noted that higher level of education could improve the socio-economic status of the family and subsequently the odds for delivering ABW infants could be reduced. Education will guide the pregnant mothers to make decisions about their reproductive health and improve their interactions with the healthcare system. This study also have shown that the educational level that is low were predictors of adverse birth outcomes, such as preterm birth and ABW.

The proportion of ABW children in the rural areas was higher than that of the urban areas in this study. It could be due to the fact that rural women are more susceptible to poor diet, infections during pregnancy, and inadequate ANC facilities. The proportion of ABW was higher among younger mothers compared to other age groups. Pregnancy at a young age is detrimental to the health of both mother and the unborn child. Among teenage mothers, the physical development of the girl is still not complete. Indeed, most of the younger mothers were unprepared, unaware or inexperienced.

With regards to maternal lifestyle and biophysical characteristics, our study found that maternal height, maternal weight, BMI, and the frequency of ANC visits were significantly associated with the birth weights of the infants. The majority of the ABW infants were born to mothers who were late for their ANC registration. Inadequate ANC increases the risk of delivering ABW infants. Access to high-quality ANC should be highlighted since it is not only enhances the maternal health, but also creates opportunities for counseling and risk detection. Risk factors for ABW should be identified during ANC visits. Through this initiative, numerous opportunities exist during pregnancy to minimize the risk of ABW.

Pregnant mothers with twin pregnancies were more prone to having ABW babies. Twin pregnancy has been well-recognized as a risk factor for ABW, possibly because all the aspects related to fetal growth are shared between two fetuses. Pregnant women exposed to tobacco products were at high risk of delivering ABW babies. However, in the present study, smoking status was not found to be a significant risk factor for ABW. The number of smoking pregnant mothers in this study were very low.

5.2 Conclusion

Information on birth weight or size at birth is important for the design and implementation of programs aimed at reducing neonatal and infant mortality. The result of the current study had provided valuable information on the prevalence of ABW, the maternal socio-demographic and economic factors associated with ABW, the maternal biophysical and foetal-related factors related to ABW and the significant risk factors associated with ABW infants, based on the recent national survey in Nigeria. The findings from this study will provide insight for public health professionals and policy makers to implement strategies or intervention programs to reduce the prevalence of ABW in the future.

However, ABW is influenced by a multiplicity of factors, the incidence of ABW could be reversed if maternal risk factors are detected earlier and appropriate prevention strategies are delivered to the high-risk group. From a public health perspective, it is an advantage that most of these factors can be modified.

5.3 Recommendation

Based on the outcome of this study, it is recommended as follows:

i) There are still a number of factors for ABW not studied in NDHS 2013 survey that should be assessed in the future. Factors like poor maternal nutritional status during the antenatal period, history of abortion, pregnancy-induced hypertension, gestational age, and anemia should be investigated in the future.

ii) Emphasis should be placed on counseling and suggested actions that would help reduce the risk factors of ABW.

iii) Promotion of care-seeking at all stages of pregnancy is crucial because the early detection of at-risk pregnancies, together with intensive ANC will not only prevent the maternal morbidity and mortality but also give better foetal birth outcome.

5.4 Limitations and strength of this Study

i) This study is based on nationally representative household surveys that reflect every locality in Nigeria.

ii) Data were pooled together to create large sample sizes of deaths reported within 5 years preceding the surveys.

iii) Analyses were restricted to births within 5 years of each of the surveys to reduce recall bias by mothers interviewed and to minimise bias that may have arisen from changes in household characteristics.

iv) Newborns' dates of birth and death given by mothers may have been misreported-particularly those that had occurred a few months or years before the survey. Causes of death and medical conditions of children were unknown at the time of survey.

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