

Association between Maternal Anthropometry and Neonatal Birth Weight among Women Who Came for Delivery in a Tertiary Health Facility, South East Nigeria

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Abstract

Background: Birth weight has been identified as one of the most significant predictors of a child's physical growth, development, and survival in later life. A quest to provide an answer on the impact of maternal anthropometry on neonatal birth weight necessitated this study. **Materials and methods:** It is a cross-sectional descriptive hospital based study that involved 130 participants selected using a systematic sampling method, utilizing a semi-structured, pre-tested interviewer administered questionnaire. Data were collected using a standard procedure and were summarized using proportions, and the Chi square test was used to explore the association between categorical variables. Predictors of birth weight were determined using logistic regression. The level of statistical significance was set at $p < 0.05$. **Results:** Participants had a mean age of 28.6 ± 5.1 years, mean weight of 72.2 ± 11.2 kg and mean height of 1.63 ± 0.07 m while the mean fetal birth weight was 3.10 ± 0.56 kg. There was a significant association between maternal delivery body mass index and neonatal birth weight ($p < 0.001$). The maternal delivery weight had a significant moderate correlation with neonatal birth weight ($r = 0.45, p < 0.005$) while maternal height had a significantly weak correlation with neonatal birth weight ($r = 0.36, p < 0.002$). The maternal age ≥ 35 years ($p < 0.01$), parity ($p < 0.02$) and body mass index ($p = 0.01$) were

predictors of neonatal extreme birth weight. **Conclusion:** The prevalence of low birth weight and macrosomia in this study population was high. The focus should be geared towards balanced nutrition support for all mothers at booking so as to mitigate the risks associated with these extremes of birth weight.

Keywords

Maternal, Anthropometry, Neonatal, Birth Weight, Delivery

1. Introduction

Birth weight has been identified as one of the most significant predictors of a child's physical growth, development, and survival in later life [1]. It provides useful information with regard to the possibility of intra-uterine growth restriction or excessive fetal growth, hence serving as an important health parameter especially to those involved in obstetrics and newborn care [2].

There are several factors that exert influence on fetal birth weight, although maternal factors such as maternal height, malnutrition, maternal obesity, maternal pregnancy weight gain and parity among others make bigger contributions [3]. It has been found that maternal height can independently influence fetal birth weight, but maternal age, weight and body mass index do not independently influence birth weight [2]. A study in the Netherlands and West Sumatra documented that pre-pregnancy body mass index and gestational weight gain are positively related [4]. In Benin City, Nigeria, a study found that maternal low weight has a negative effect on fetal development while higher maternal weight increases the chance of caesarean delivery [5]. Globally, the maternal obesity rate is increasing very rapidly, and it is considered a serious challenge in women of childbearing age because obesity is a main factor for the caesarean section and a risk factor for high fetal birth weights [6]. Maternal weight and weight gain patterns during pregnancy depend on diverse factors, including maternal dietary intake, pre-pregnancy weight and height, gestational period, and fetal size [7]. A study in Kenya demonstrated that even in the presence of other confounding factors such as socio-demographic factors, maternal weight and weight gain patterns had an independent influence on the birth weight of the infant [8].

In Nigeria, a study attributed a high incidence of low birth weight to poor maternal nutrition which was positively associated with the restrictions placed on some foods [9].

A cross-sectional prospective study done in the North-West Nigeria, demonstrated a positive correlation between maternal weight and birth weight with a statistically significant association [10]. Another cross-sectional study in Jos, Nigeria showed a positive correlation between maternal weight at delivery and birth weight of the infant [11]. In contrast, another study demonstrated that low pre-pregnancy body mass index is a strong predictor of adverse pregnancy outcomes such as preterm birth and fetal growth restriction [12]. Birth weight is also widely

used as an indicator of the health status of individuals and populations as it has strong associations with both childhood and adult health. It is also documented as the most important determinant of children's chance of survival, healthy growth and development in the future [13]. Nevertheless, maternal weight at birth and pregnancy weight gain have been demonstrated as indirect measures of neonatal birth weight. It was shown in another study that maternal weight showed a strong positive correlation with neonatal birth weight and this was statistically significant in keeping with other research findings [14].

The effect of maternal height on birth weight is conflicting. A study in India and Bangladesh, associated maternal height with low birth weight in large univariate studies. However, the effect of maternal height on low birth weight disappeared when adjusted for other important covariates, such as maternal age, weight, parity and education [15].

2. Materials and Methods

2.1. Study Population

This was a hospital-based descriptive cross-sectional study which involved 130 pregnant women who met the inclusion criteria.

2.2. Inclusion and Exclusion Criteria

Included in this study were pregnant women aged 18 years and above who had term singleton neonates at 37 completed weeks in the latent phase of labour that progressed to spontaneous vertex delivery, and mothers who consented to the study. Participants with chronic medical conditions and neonates with congenital malformations were excluded from this study as these conditions can affect maternal and fetal measurements.

2.3. Sample Size Determination

The sample size was determined by applying: [16]

$$n = Z^2 pq/d^2$$

where:

n = minimum sample size when the population is more than 10,000, Z = standard normal deviate corresponding to the level of significance taken as 95% confidence interval (CI), d = desired level of precision taken as 5%, p = the estimated proportion of population with the attribute, taken as 8.4% from a previous study [17]. At 95% confidence level and a precision level of 5%, $z = 1.96$ and $d = 0.05$; applying this in the formula, $n = 118$. In order to allow for non-responders during recruitment, an attrition value of 10% was added to the minimum sample size. This gave a sample size of 130 participants.

2.4. Sampling Technique

A systematic random sampling technique was utilized to select respondents over

2 months.

Research assistants were trained on how to take informed consent, administer the pre-tested questionnaire and anthropometric measurements, as well as on how to identify eligible women in the latent phase of labour.

Pre-testing was done by administering the questionnaire to 10 pregnant women who attended antenatal clinic at St Vincent Hospital Ndubia by the researcher. Modifications of the questionnaire were made where necessary. The feedback received was discussed with the supervisors and appropriate revisions were made accordingly.

2.5. Data Collection Instrument

Data was collected using a questionnaire and anthropometric measurements were obtained using standard procedures. The questionnaire was developed by the researcher following a review of WHO guideline recommendations for the control of non-communicable diseases and modified WHO stepwise approach to non-communicable disease risk factor surveillance (STEPS) questionnaire, as well as other relevant literatures on prenatal care. Face -validation of the questionnaire was done by expert panel of 2 consultants. The questionnaire was administered by the researcher and the research assistants.

The maternal weight in kilogram was measured using a standardized protocol and weighing scale (Seca 704) to the nearest 100 g. The height was measured using a graduated SECA stadiometer with a movable head board using standardized protocol to the nearest 0.1m. The maternal body mass index was calculated as weight (kg)/height (m²). Neonatal measurements were obtained immediately after delivery. Birth weight (kg) was obtained using a calibrated electronic scale® with or without pan that was within 10kg weight. The average of two measurements was recorded.

2.6. Data Analysis

The data was analyzed using Statistical Package for Social Sciences (version 20, IBM SPSS). Descriptive statistics were used to summarize data and was presented in tables. Association between the categorical variables was tested using the Chi-square. Pearson's correlation coefficient was used to correlate various maternal anthropometric parameters with the neonatal birth weight. The p-value <0.05 was considered significant for test of association. Multivariate logistic regression was done to identify maternal predictors of low birth weight and macrosomia.

3. Results

3.1. Socio-Demographic Characteristics of the Mothers

The study recorded a response rate of 100%. Participants had a mean age of 28.6 ± 5.1 years. Majority of respondents were married, predominantly had tertiary education and multiparous, as shown in **Table 1**.

Table 1. Frequency distribution of the socio-demography of the mothers.

Characteristic	Frequency (N = 130)	Percentage (%)
Age (in Years)		
≤24	25	19.2
25-34	90	69.3
≥35	15	11.5
Marital Status		
Single	3	2.3
Married	125	96.1
Separated	1	0.8
Widowed	1	0.8
Educational Status		
Primary	23	17.7
Secondary	52	40.0
Tertiary	55	42.3
Parity		
Primipara	46	35.4
Multipara	64	49.2
Grandmultipara	20	15.4

3.2. Anthropometric Characteristics of the Respondents/Association between Maternal Body Mass Index and Neonatal Birth Weight

The mean weight of the respondents at labour was 72.2 ± 11.2 kg, while their mean height was 1.63 ± 0.07 m. Significant association was found between maternal body mass index at delivery and neonatal birth weight. See **Table 2**.

Table 2. Anthropometric characteristics of respondents/association between maternal BMI categories at delivery and neonatal birth weight categories.

BMI N = 130	Birth Weight			χ^2	p value
	LBW N = 15 (%)	Normal N = 108 (%)	Macrosomia N = 7 (%)		
Normal (36)	9 (25.0)	25 (69.4)	2 (5.6)		
Overweight (67)	4 (6.1)	63 (93.9)	0 (0.0)	22.15	<0.001*
Obese (27)	2 (7.4)	20 (74.1)	5 (18.5)		

*Fischer exact.

3.3. Correlation between Selected Maternal Characteristics and Neonatal Birth Weight

There was statistically significant moderate positive correlation between weight at labour and neonatal birth weight ($r = 0.45$), as well as poor positive correlation between the neonatal birth weight and height ($r = 0.36$), BMI at labour ($r = 0.29$) and gestational age ($r = 0.24$). See **Table 3**.

Table 3. Correlation between selected maternal characteristics and neonatal birth weight.

	Birth Weight	Weight @delivery	Height	BMI @delivery	GA	Age	Total PA
Birth Weight	1.00	0.45*	0.36*	0.29*	0.24*	0.07	-0.10
Weight @delivery	0.45*	1.00					
Height	0.36*		1.00				
BMI @delivery	0.29*			1.00			
GA	0.24*				1.00		
Age	0.07					1.00	

*moderate positive correlation between maternal characteristics and neonatal birth weight.

3.4. Association between Maternal Socio-Demographics and Neonatal Birth Weight

Maternal age and parity were found to be significantly associated with neonatal birth weight ($p < 0.01$). Primiparity were most likely associated with low birth weight babies while grandmultiparity were associated with macrosomia ($p = 0.02$). See **Table 4**.

Table 4. Association between socio-demographic characteristics and neonatal birth weight.

Characteristic	Birth Weight			χ^2	P value
	LBW N = 15 (%)	Normal N = 108 (%)	Macrosomia N = 7 (%)		
Age in Years					
≤24	4 (16.0)	20 (80.0)	1 (4.0)		
25 - 34	8 (8.9)	80 (88.9)	2 (2.2)	18.72	<0.01*
≥35	3 (20.0)	8 (53.3)	4 (26.7)		
Parity					
Primipara	10 (21.7)	34 (73.9)	2 (4.3)		
Multipara	4 (6.3)	58 (90.6)	2 (3.1)	11.50	0.02*
Grandmultipara	1 (5.0)	16 (80.0)	3 (15.0)		

Continued

Marital Status					
Married	13 (10.4)	105 (84.0)	7 (5.6)	0.63	0.43*
Others	2 (40.0)	3 (60.0)	0 (0.0)		
Educational Status					
Primary	5 (21.7)	16 (69.6)	2 (8.7)		
Secondary	2 (3.8)	46 (88.5)	4 (7.7)	8.14	0.09*
Tertiary	8 (14.5)	46 (83.6)	1 (1.8)		

*Fischer exact.

3.5. Association between Maternal Characteristics and Low Birth Weight/Macrosomia

Only parity ($p = 0.02$) and BMI ($p = 0.01$) were found to be significantly associated with neonatal low birth weight. Age ($p = 0.001$) and BMI ($p < 0.01$) were found to be significantly associated with neonatal macrosomia. See **Table 5**.

Table 5. Association between maternal characteristics and low birth weight/macrosomia.

Maternal Characteristics	Low Birth Weight				Macrosomia			
	Yes	No	χ^2	p-value	Yes	No	χ^2	p-value
Age (Years)								
≤24	4 (16.0)	2184.0)			1 (40.0)	24 (96.0)		
24 - 34	8 (8.9)	8 (8.9)	2.16	0.34	2 (2.2)	88 (97.8)	15.99	0.001*
≥35	3 (20.0)	12 (80.0)			4 (26.7)	11 (73.3)		
Educational Status								
Primary	8 (14.5)	47 (85.5)			1 (1.8)	54 (98.2)		
Secondary	2 (3.8)	50 (96.2)	5.85	0.05*	4 (7.1)	48 (92.9)	24.1	0.30*
Tertiary	5 (21.7)	18 (78.3)			2 (8.7)	21 (92.3)		
Marital Status								
Currently married	13 (10.4)	112 (89.6)	1.74	0.18*	7 (5.6)	118 (94.4)	0.22	0.64*
Not currently married	2 (40.0)	3 (60.0)			0 (0.0)	5 (100.0)		
Parity								
Primipara	10 (21.7)	36 (78.3)			2 (4.3)	44 (95.7)		
Multipara	4 (6.3)	60 (93.7)	7.28	0.02*	2 (3.1)	62 (96.9)	4.37	0.11*
Grandmultipara	1 (5.0)	19 (95.0)			3 (15.0)	17 (85.0)		

Continued

Body Mass Index								
Normal weight	9 (25.0)	27 (75.0)			2 (5.6)	34 (94.4)		
Overweight	4 (6.0)	63 (94.0)	8.88	0.01*	0 (0.0)	67 (100.0)	8.55	0.01*
Obese	2 (7.4)	25 (92.6)			5 (18.5)	22 (81.5)		

*Fischer exact.

3.6. Logistic Regression Analysis of Significant Maternal Characteristics Associated with Low Birth Weight/Macrosomia

None of the factors analyzed was found to be significantly associated with low birth weight or fetal macrosomia. See **Table 6**.

Table 6. Logistic regression analysis of maternal characteristics associated of neonatal low birth weight/macrosomia.

Maternal Characteristics	Low Birth Weight		Macrosomia	
	p-value	OR (95%CI)	p-value	OR (95%CI)
Age	0.23	2.11 (0.67 - 7.19)	0.07	8.41 (0.85 - 83.23)
Parity	0.09	0.30 (0.07 - 1.21)	0.82	1.24 (0.20 - 7.67)
Marital Status	0.33	1.96 (0.32 - 8.22)	0.89	1.89 (0.32 - 9.77)
Body Mass Index	0.07	0.36 (0.12 - 1.07)	0.07	3.74 (0.88 - 15.80)

4. Discussion

4.1. Socio-Demographics of the Mothers

The findings in this study showed that most respondents were between age of 20-34 years, with a mean age of 28.6 ± 5.1 years. This is not surprising as it is the most reproductive age range. This finding is comparable with mean maternal age of 28 years reported by Isaiah *et al.* However, this finding is not in line with mean maternal age of 25.6 ± 1.3 years reported by Yilgwan *et al.* and mean maternal age of 25.6 ± 6.2 years reported by Muchemi *et al.* in similar studies [18] [19]. The mean maternal age reported in this study is much lower than the one reported in some similar studies. Nooro *et al.* reported mean maternal age of 30.5 ± 4.9 years and Affusin *et al.* reported maternal mean age of 30.12 ± 5.52 years [20] [21].

Majority of the mothers were married. This is in keeping with findings of other authors in similar studies [22] [23]. However, our finding is at variance with a similar study by Jennifer *et al.* who reported that only 59% of the mothers were married [24]. This difference may be because our study was done in Africa where most of the mothers were married, unlike theirs which studied single mothers in Europe. Significant proportion of the mothers had tertiary education. This is supported by a similar study by Ugwa *et al.* who reported that 49.5% of respondents

had tertiary education [10]. Half of the mothers in this study were multiparous women. Yilgwan *et al.* had similar report [11]. Similarly, Ugwa *et al.* documented the same finding [10]. Pressure from husbands and other family members, non-acceptance of family planning due to cultural and religious belief could be reasons most the mothers in this study were multiparous.

Low birth weight of 11.5% in this study could be as a result of intrauterine growth restriction. This finding is keeping with prevalence report of 11.4% and 12.1% by Maznah *et al.*, and Yilgwan *et al.*, respectively [18] [25]. Contrary to this finding, Ugboma *et al.* in a similar study reported much lower prevalence of low birth weight [26]. Afusim *et al.*, in similar study reported a very high prevalence of 17% [27]. The difference in the prevalence could be as result of number of participant recruited and the methodologies used in their studies. Conversely, a similar study in United States of America reported much lower prevalence of 4.8% among black women [28]. The reason for this wide disparity in the incidence of low birth weight in both studies may be related to the study design and the patient characteristics. The high prevalence of low birth weight observed in the present study could also be attributed to poor access to health services due to socio economic barriers which are found to be strongly related to access to adequate prenatal services [29].

The prevalence of fetal macrosomia in this study was 5.4%. This result is consistent with finding by Oghenefegor *et al.* [30]. However, this finding is at variance with the findings of similar studies that reported higher incidence of macrosomia [31] [32]. This difference may be as a result of methodologies used. Akindele *et al.* had a case control study with larger sample size. The low incidence reported in this study and other similar studies in Nigeria could be due to study design as most of the studies were hospital-based.

4.2. Association between Maternal Anthropometry at Delivery and Birth Weight

There was a significant correlation between maternal weight at delivery and birth weight. This is comparable to significant positive correlation observed between maternal weight and birth weight by other authors in similar studies. Ugwa *et al.* reported ($r = 0.48$) [10] and Yilgwan *et al.* reported ($r = 0.357$) [11]. The mean maternal height in this study was 1.63 ± 0.07 m with a positive correlation with birth weight and the mean maternal body mass index (BMI) at delivery was 27.3 ± 3.8 kg/m². A significant positive correlation was found between maternal BMI at delivery and neonatal birth weight with fetal macrosomia associated with obesity. This finding is in agreement with a similar study by Dahlui *et al.* who reported significant correlation between maternal BMI and birth weight at delivery [25]. Contrary to the finding in this study, Swati *et al.* did not find any correlation between maternal BMI and neonatal birth weight [33]. It is likely that in developed countries, mothers regulate their weight in pregnancy compared to developing nations.

4.3. Maternal Demographics and Birth Weight

There was a significant relationship between maternal age and neonatal birth

weight. Mothers who were 35 years and above were found to be more likely to deliver low birth weight babies and macrosomia. This is comparable with the finding of Ozaltin *et al.* and Mahmood *et al.* in similar studies that reported significant correlation between maternal age and birth weight [33] [34]. This may be related to the increased risk of medical disorders which is commoner among pregnant women with advanced maternal age. A significant relationship between advanced maternal age and neonatal macrosomia in this study is similar to study by Usta *et al.* who reported significant correlation between maternal age and fetal macrosomia [35]. However, a study by Atuahene *et al.* did not demonstrate any significant relationship between maternal age and neonatal birth weight [32]. Similarly, maternal parity was found to be significantly associated with birth weight, with primiparous mothers more likely to deliver low birth weight babies while the grandmultiparous were more likely to deliver macrosomic babies. A similar study by Elishiby *et al.*, showed that primiparity was associated with an increased relative risk for low birth weight and this was distinctly higher when compared to the relative risk for low birth weight of other maternal characteristics [36].

5. Conclusion

This study has shown that there is an increasing prevalence of both low birth weight babies and neonatal macrosomia in our environment. Maternal characteristics had a significant association with neonatal birth weight, hence are good predictors of neonatal birth weight. These maternal factors therefore can be recommended for use as screening tests in poor resource settings by Family Physicians in order to reduce the burden of low birth weight and fetal macrosomia with its attendant consequences

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Availability of Data and Materials

The sets of data generated and analyzed in this study are available from the corresponding author on reasonable request through the e-mail address of ogahstanly90@yahoo.com or ogahstanly90@gmail.com.

Ethical Consideration/Consent to Participate

Ethical approval was obtained from the hospital ethical review and research committee (FETHA/REC/VOL.1/2016/380). This research work complied with the Helsinki declaration 2013 on human research with verbal and written consent obtained from the participants and permission to carry out the study was obtained from the Head of the Department, Family Medicine, AEFUTHA. In the consent letter, participants were assured of confidentiality.

Conflicts of Interest

There was no conflict of interest recorded in the study.

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