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CONTRIBUTION OF GESTATIONAL WEIGHT GAIN TO FETAL BIRTH WEIGHT AMONG PREGNANT WOMEN IN A PUBLIC TERTIARY HOSPITAL, BENIN CITY, NIGERIA.

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ABSTRACT

Background: The ideal gestational weight gain (GWG) to ensure a favorable neonatal birth weight remains arguable but the desired birth weight for optimal early life adaptation and subsequent seamless childhood navigation is no longer in doubt.
Objective: We sought to document the role of GWG on birth weight and to examine the influence of some materno-fetal variables.
Method: The case records of patients who initiated antenatal care in the first trimester and delivered in University of Benin Teaching Hospital, Benin City from January 2014 to December 2017 were retrospectively studied. Data on sociodemographic characteristics, clinical management and outcome were extracted and analyzed.
Results: The frequency of early booking was 14.5%. Mean GWG was 7.7±5.8kg and the mean birth weight was 3.1±0.4kg. GWG did not significantly influence birth weight. Social class was significantly associated with birth weight ($P<0.001$). Weight gain less than 5kg with OR of 1.52 (CI=1.02 to 2.04; $P=0.042$) and lower social class with OR of 1.81 (CI=1.23 to 2.57; $P=0.02$) predicted birth weight lower than 2.5kg. Maternal age, parity and fetal sex did not significantly impact on birth weight.
Conclusion: Overall GWG in our study was poor but this did not significantly influence birth weight. GWG in the third trimester impacts on fetal growth, and low birth weight can be predicted by GWG lower than 5kg. A focus on improved GWG in the prenatal period to optimize birth weight appears necessary. We recommend nutritional counselling and support especially in the second half of gestation.

Key words: Pre-pregnancy weight, maternal weight, gestational weight gain, birth weight, Benin City

INTRODUCTION

The trend in weight changes in pregnancy is of interest to the obstetrician and mothers largely because adverse maternal and fetal outcomes have often been linked to extremes of weight changes in the mother.[1-3] Maternal weight gain in pregnancy is from a combination of factors including the weight of the developing foetus, placenta, amniotic fluid, breast and uterine enlargement, interstitial fluid and blood volume. Birth weight is directly linked to maternal height, pre-pregnancy weight, paternal height, parity, and maternal weight gain;[4,5] and this is usually modified by factors such as cigarette smoking, ambient altitude and glucose intolerance.

Weight changes in pregnancy and the impact on fetal weight have been studied extensively with guidance coordinated by recommendations such as the revised guidelines adopted by the Institute of Medicine (IOM)/ National Research Council (NRC) in 2009, which have given attention to achieving a balance between short and long term maternal and infant interests regarding favorable outcomes.[6]

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The IOM/NRC recommendation for GWG is based on maternal weight at the start of pregnancy. Underweight women are expected to gain more than overweight and obese women, while normal weight woman should attain GWG lying between the other categories. These recommendations have clearly highlighted that extremes of weight in pregnancy impact negatively on fetal outcome viz. increased risk of intrauterine growth restriction and preterm delivery in those with inadequate weight gain, while excessive weight gain in pregnancy has been correlated with larger birth weights and the attendant consequences.[1-3]

Maternal weight assessment is a cheap and reliable means of assessing fetal growth, thus providing a surrogate fetal surveillance modality for predicting low birth weight neonates and subsequent adverse perinatal outcome. The role of maternal anthropometric variables in predicting pregnancy outcome has been extensively studied elsewhere,[1-5] but there is need to direct more attention to this very important area of research in developing countries, considering the significant conflict in previous reports on the effect of maternal weight on birth weight. Costa et al[7] working in Brazil demonstrated an association between maternal obesity and fetal macrosomia, similar to the reports by Ezeanochie et al[8] and Iyoke et al[9] in Nigeria, who both noted obstetric complications traceable to obesity. Ugwa[10] in Nigeria also found maternal weight to be significantly correlated with birth weight. In contrast, Aisien and Olarewaju[11] in their study did not document any significant effect of maternal weight on birth weight.

Ultrasound scan examination coupled with astute clinical observation remains the basic modality for determining fetal growth and wellbeing. Yet this useful tool is not always at our disposal in resource-constrained settings. Hence, many clinicians now consider routine weight gain monitoring to predict fetal growth and wellbeing as a useful inexpensive intervention, considering its potential for widespread utilization. Previous studies have shown the determinants of birth weight to include maternal prepregnancy weight, GWG, fetal sex, length of the pregnancy in addition to inherent fetal programming for growth, and intercurrent feto-maternal clinical conditions.[12,13] Other investigators have in recent time paid particular attention to the role of GWG as a stand-alone determinant of the rate of growth in the fetus.[14] However, the interaction of GWG with the other established and potential contributors to neonatal birth weight, and the pattern of GWG that appears significant for the observed fetal weight at birth, continue to attract research interest. Therefore, the current study seeks to document the trend in weight changes among pregnant women attending the University of Benin Teaching Hospital (UBTH) and to determine the role of poor GWG in adverse fetal outcome like low birth weight.

MATERIALS AND METHODS

This was a retrospective study of all women who had antenatal care and delivery at the Department of Obstetrics and Gynaecology, UBTH, Benin City, from January 2014 to December 2017 (both inclusive). The study was carried out with the approval of the hospital's Research and Ethics Committee. All patients included had routine antenatal care until term, presented in spontaneous labour or were induced not later than 40 weeks gestational age. Antenatal booking after first trimester, teenage pregnancy, multiple pregnancy, and pre-existing medical disorders were exclusion criteria. Others with hypertensive diseases of pregnancy, gestational diabetes, polyhydramnios, preterm delivery, intrauterine fetal death, and delivery beyond 40 weeks were also excluded.

The required sample size was calculated based on the proportion of women expected to gain the recommended weight for their starting BMI according to the IOM/NRC guidelines, previously reported by Onwuka et al[14] to be 53.5%. We estimated that a sample size of 226 women would be required if we found a 25% increase in those with GWG appropriate for their BMI, taking alpha to be 0.05, and with a power of 80%. We decided to include all 420 eligible cases to further improve the power and to reduce the margin of error.

For all women included, sociodemographic data including age, parity, occupation and level of education of the patient and her spouse were entered into a pro forma. The social classes of the women were determined using the classification by Olusanya et al.[15] Other parameters of interest were estimated gestational age at booking, maternal weight at initiation of antenatal care, pattern of

GWG through the trimesters of pregnancy, gestational age at delivery, neonatal birth weight as well as neonatal sex.

Our primary outcome measure was the overall GWG. Secondary outcome measures included the trend in maternal weight changes, fetal outcome, mode of delivery and birth weight. Factors considered as confounders included maternal age, parity, social class, gestation at delivery and fetal sex.

The information used to generate a database for analysis was retrieved from our departmental electronic data records, patients' case notes as well as records of the theatre and labour ward. The socio-demographic and clinical information was subjected to statistical analysis with a personal computer using SPSS version 20.0 (SPSS IBM Corp, Armonk, NY) and GraphPad InStat 3 (GraphPad Software Inc., San Diego, CA). Univariate analysis was conducted using Chi-square test or Fisher's Exact Test as appropriate. Cross tabulations and Pearson correlation were used to determine associations while binary logistic regression was conducted to determine contributions of confounders. P value < 0.05 was considered significant.

RESULTS

Of the 8,926 women who delivered during the period covered by the study, 14.5% (1,294/8,926) of them had initiated antenatal care in the first trimester. The records of a total of 420 women were included in the study, giving an inclusion rate of 32.5%.

The mean age was 29.6± 4.35 years with over 61% of them in age group 21 to 30 years. Women less than 20 years or more than 39 years contributed 1.4% each. Almost 80% of the women had parity of 0 or 1, with para 5 making up 2.9%. Majority (89.9%) of the women were in upper social class while 2.3% were in lower social class. (Table 1)

With respect to prepregnancy BMI, 27.9% of the women were underweight, 38.1% had normal BMI, and 25.0% were overweight while 9.0% fell into the category of obesity. The maternal weight change (MWC) during pregnancy was more likely to reflect gain than loss (85% vs 5%, respectively), with the

TABLE 1: DEMOGRAPHIC AND CLINICAL PARAMETERS AT ENROLLMENT

Parameter	Frequency (n=420)	Percentage (%)
Age (year)		
≤19	6	1.4
20-29	258	61.4
30-39	150	35.8
≥40	6	1.4
Parity		
0	270	64.3
1	62	14.8
2	52	12.4
≥3	36	8.6
Social class		
Upper	377	89.9
Middle	33	7.8
Lower	10	2.3
Maternal BMI (Kg/m^2)		
Underweight	117	27.9
Normal weight	160	38.1
Overweight	105	25.0
Obese	38	9.0

BMI body mass index

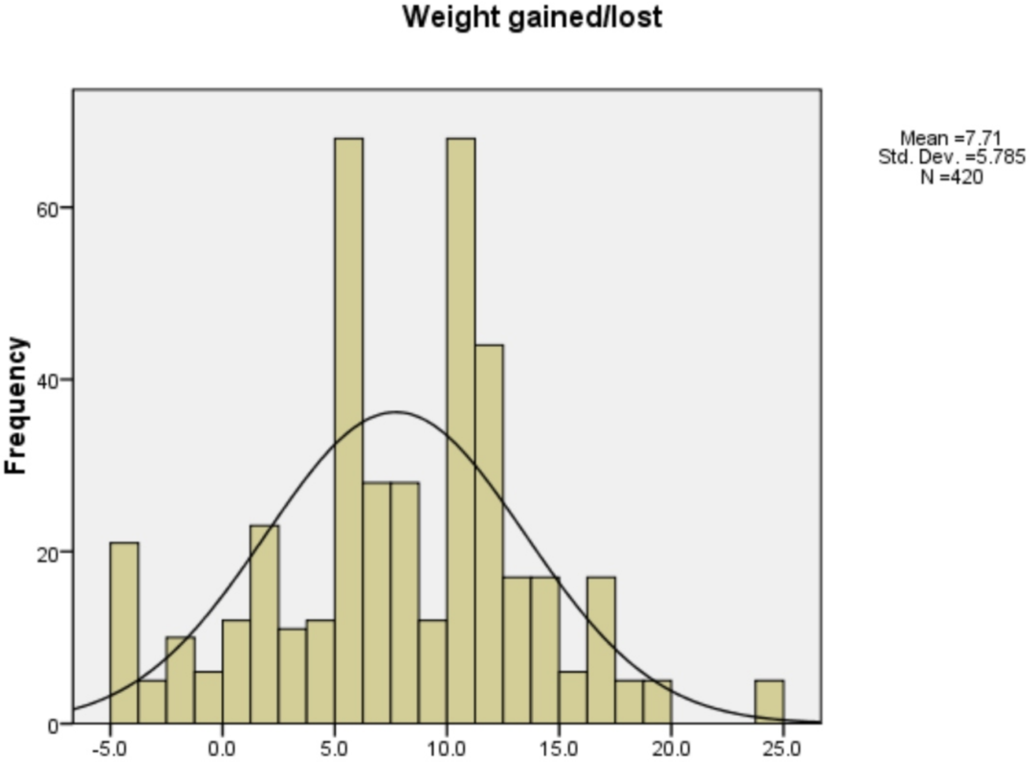

FIGURE I: DISTRIBUTION OF MATERNAL WEIGHT CHANGE IN PREGNANCY

TABLE 2: MATERNAL AND FETAL OUTCOME VARIABLES

Parameter	Number (n=420)	Percentage (%)
Weight gain (Kg)		
<5	194	46.2
5-9	85	20.2
10-14	76	18.1
15-19	40	9.5
20-24	25	6.0
Mode of delivery		
SVD	320	76.2
Elective CS	50	11.9
Emergency CS	50	11.9
Birth weight (Kg)		
<2.5	38	9.1
2.5-3.9	360	85.7
≥4.0	22	5.2
Neonatal sex		
Male	225	53.6
Female	195	46.4

SVD spontaneous vaginal delivery, CS Caesarean section

TABLE 3: DETERMINANTS OF MATERNAL WEIGHT CHANGE, MODE OF DELIVERY AND BIRTH WEIGHT

Predictor	Outcome		
	Weight change	Mode of delivery	Birth weight
	P value		
Age	0.34	0.45	0.28
Parity	0.18	0.23	0.10
Social class	0.20	0.17	0.04
Weight change	-	0.13	0.03
Gestational age	0.12	0.15	0.09
Neonatal sex	0.08	0.19	0.07
Birth weight	0.12	0.09	-

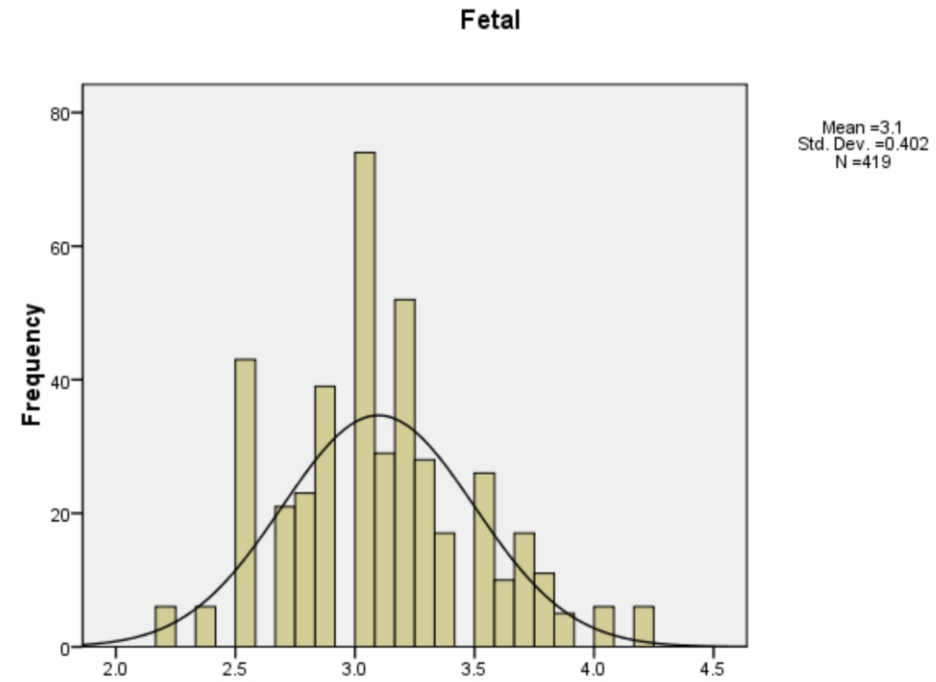

FIGURE II: DISTRIBUTION OF NEONATAL BIRTH WEIGHTS

largest weight gain being 24kg, and biggest weight loss by any woman was 5kg. MWC was not demonstrable in 10% of the women. The mean GWG was 7.7±5.8kg. (Table 1; Fig I)

More of the weight gain was observed in the third trimester than second trimester (1.84kg per week for GWG of 4.8kg vs 0.55kg per week for GWG of 2.9kg, respectively). Women with normal BMI gained the largest weight (9.2±4.5kg) followed by those who were underweight (7.5±4.1kg), and next were the category of obese women (7.2±3.5kg) before the overweight women (7.1±3.8kg). The overweight and obese women had GWG within the recommended range for their categories, giving a 34% rate of adequate GWG.

There were 420 babies born to the women studied, out of which 53.6% (225/420) were males, 76.2 (320/420) were delivered vaginally, with a mean birth weight of 3.1±0.4kg. The lowest weight at birth was 2.2kg and the largest babies weighed

4.2kg. Low birth weight babies constituted 9.1% (38/420) while macrosomia was seen in 5.2% (22/420) of the neonates (Table 2; Fig II). The mean GWG in the second trimester did not significantly influence the birth weight (P=0.07), similar to the effect of the GWG across the second and third trimesters (P=0.58). In contrast, GWG in the third trimester was significantly associated with neonatal birth weight (P=0.042).

Pearson correlation showed a positive but non-significant correlation between overall GWG and birth weight (r=0.18, P=0.59). Birth weight was also not significantly associated with maternal age (r=0.27, P=0.54), parity(r=0.16, P=0.43), gestational age at delivery (r=-0.02, P=0.32), or fetal sex (r=-0.6, P=0.24). However, social class was a strong predictor of birth weight (r=0.7, P=0.001).

Further logistic regression showed that none of the variables viz. maternal age, parity, social class, gestation at delivery, birth weight or fetal sex independently predicted GWG or mode of delivery. However, GWG less than 5kg and lower social class were the only predictors for low birth weight with odds ratio (OR) of 1.52 (CI=1.02 to 2.04; P=0.042) and 1.81 (CI=1.23 to 2.57; P=0.02) respectively. (Table 3)

DISCUSSION

In this study, we found that 14.5% of our antenatal women booked in the first trimester. Early booking was unlikely in young and older women as well as women of lower social class, but more likely in nulliparous and primiparous women. The mean GWG of 7.7±5.8kg was poor but the mean birth weight of 3.1±0.4kg was normal.

Though many researchers have previously reported a low prevalence of first trimester booking among pregnant women in Nigeria, 14.5% is similar to the 14.1% found by Okunola et al[16] in Ibadan and 15.4% by Addah et al[17] working in Bayelsa. A probable reason for the low rates across these studies is the previously observed behavior of multiple facilities booking by antenatal women,[18] so that late registration in one facility might indeed follow an earlier booking in another health facility.

The proportion of obese women in early pregnancy among antenatal clients in our study was 9.0%. This figure is similar to the 9.63% previously reported by Ezeanochie et al[8] from the same hospital and the 10.7% found by Chigbu et al[19] in Enugu. In contrast, it is much lower than the 33.1% prevalence documented by Anzaku et al[20] from Jos and 28% found by Onwuka et al[14] also working in Enugu. The characteristics of the population studied by the various researchers probably played a role in these observations. Ezeanochie et al[8] reported on a similar patient population as the women we studied but from an earlier period. While Anzaku et al[20] studied women attending a private teaching hospital in the North Central part of Nigeria, Chigbu et al[19] worked in a public health facility in the South-East. It is likely that the sociodemographic and cultural variations between patient groups studied gave rise to the marked difference in the reported prevalence of obesity.

Maternal obesity is reported more frequently in the affluent populations mainly because many women are delaying pregnancy or are getting pregnant at advanced ages. In our environment, maternal obesity has also been shown to be on the increase. Maternal characteristics which appear to contribute to obesity include excessive weight gain in pregnancy and short inter-pregnancy interval.[21] GWG recommended by the IOM/NRC is based on the starting weight in early pregnancy. In line with this, many researchers have continued to document MWC across pregnancy for the different pre-pregnancy BMI categories. In our series, the mean GWG was 7.7±5.8kg. Onwuka et al[14] reported 10.7±3.4kg while Lawoyin[22] found an average GWG of 13.3±4.7kg. The normal BMI category is expected to gain between 11kg and 16kg throughout pregnancy according to the IOM/NRC. The mean GWG in the present study was lower than the recommendation for normal BMI women, but this observation is certainly skewed by the women we found lost weight during pregnancy. Furthermore, only 34% of the women we studied achieved adequate GWG. This is much lower than the 53.5% reported by Onwuka et al[14] in Enugu. Perhaps the marked difference in the structure of the BMI of the two obstetric populations reflected in this observation, considering that obesity was reported by Onwuka et al[14] to be 28% compared to 9% in the present study, while they found underweight to be

3.5% compared to our 28%.

The mean birth weight in the present study of 3.1kg is similar to the reports of previous researchers in Nigeria who found 3.18kg,[23] and 3.3kg in term babies.[14] Onankpa et al[24] reported a lower mean birth weight of 2.47kg. Onankpa et al[24] studied a population that included preterm babies and this can explain the much lower birth weight. It is also possible that lifestyle, nutritional and behavioural characteristics of different populations of pregnant women in different parts of Nigeria also contributed to the reported differences.

The present study showed that third trimester weight gain had significant impact on the birth weight of babies but the same effect was not found for GWG in the second trimester of pregnancy. This is in contrast to the report of Onwuka et al[14] who found that excessive weight gain in the second trimester was associated with large babies while poor GWG also in the second trimester predisposed to low birth weight. However, Sridhar et al[25] in their study reported that the trend in weight gain in both second and third trimesters was likely to impact on the birth weight when the GWG is observed to be above the IOM/NRC recommendation for the BMI of the woman. It appears reasonable to expect significant impact on fetal weight when GWG exceeds a certain threshold in both the second and third trimesters, or if GWG remains below a critical level.[22] The lack of association between GWG and birth weight in the second trimester in the present study is likely reflective of the overall poor weight gain in our population of patients.

The roles of parity, maternal pre-pregnancy BMI and GWG on birth weight and risk of preterm birth have previously been established.[26,27] In the present study, low parity women were more likely to book early, whereas higher parity women delayed initiation of antenatal care, hence GWG and birth weight comparison based on parity will appear skewed. However, parity did not significantly influence the trend of MWC, nor did it affect the birth weights of the babies.

The social status of clients has been suggested as one of the determinants of pre-pregnancy BMI and GWG as well as fetal outcome. In the present study, lower social class was significantly associated with lower birth weight. Similarly, Kehinde et al[23] found a negative impact of lower social class on birth weight. In contrast, Gaillard[5] reported a link between low income or education and maternal obesity in a European population, while Wright et al[28] found little influence of socioeconomic status on birth outcome. The high proportion of women of upper social class in our study may be due to the urban location of our hospital. It is also possible that upper social class women with better education and favoured occupations are more likely to patronize a university hospital which is often viewed as a facility meant for the elite. Furthermore, the women with upper social class may also exhibit a better health-seeking behavior of early booking for antenatal care.

In this study, we have shown that the majority of women attending antenatal care in UBTH tended to initiate antenatal care beyond the first trimester, especially among the older multiparous clients. The average GWG was much lower than the IOM/NRC recommended range for underweight and normal BMI categories but this observation did not impact negatively on the mean birth weight of their infants. Furthermore, maternal age, parity and social class were not significantly associated with GWG, but birth weight was lower with lower social class. It is known that birth weight is determined by many factors during pregnancy in addition to the role played by GWG. Hence when GWG is marginal especially in low parity women who initiate antenatal care early, the birth weight at term may be more influenced by factors other than pre-pregnancy BMI or GWG. Therefore, future research interest in this area will attempt to focus on birth weight determinants with particular emphasis on nutritional, environmental, social and psychological variables.

We found that birth weight was not significantly influenced by GWG. Despite the inherent limitations of a retrospective design, the information captured in our electronic database was easily accessible for the period studied. However, our study population was largely skewed toward the small proportion of women who commenced antenatal care early.

CONCLUSION

GWG in early initiators of antenatal care in our hospital appears poor. Weight gain in the third trimester is more likely to impact on the birth weight, and a gain below 5kg increases the risk for low birth weight infants. Other determinants of birth weight such as social class appear to act through the pathway of inadequate nutrition and poor financial support during pregnancy. A large-scale prospective study will be instructive to confirm the findings of the present study.

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Author Contribution
NO Enaruna: Project development, Data analysis, Manuscript writing
OO Peter: Project development, Data collection, Initial draft
Both authors read and approved the final manuscript

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