

Original Research

Gestational Weight Gain and Associated Factors in a Tertiary Hospital in Southwest Nigeria: A Cohort Study

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Abstract

Background: Gestational weight gain (GWG) is an important determinant of maternal and foetal wellbeing. Evidence suggests that there is heterogeneity in GWG across countries and regions based on the influence of several factors. This study was designed to investigate GWG, associated factors, and pregnancy outcome among women who gave birth at Babcock University Teaching Hospital, Nigeria.

Methodology: A prospective cohort study carried out on 220 pregnant women who registered for antenatal care before gestational age of 13 weeks and recruited between June 2022 and May 2024. GWG was categorized into adequate, inadequate or excessive according to the United States Institute of Medicine (IOM) guidelines. Logistic regression analysis was used to investigate predictors of GWG, while Relative Risk was reported for pregnancy outcomes.

Results: Adequate GWG, inadequate GWG and Excessive GWG were achieved by 29.1%, 40.5% and 30.5% of the women, respectively. The median (95% CI) GWG in all study participants was 9.8 (8.8-10.3) Kg. Older maternal age [OR 2.5(1.3-5.0); P=0.013], multiparity [OR 8.2(1.3-51.8); P=0.025] and middle/upper socioeconomic class [OR 14.6(2.1-99.2); P=0.006] predicted increased likelihood of inadequate GWG while being overweight [OR 0.2(0.1-0.4); P<0.001] and obese [OR 0.06(0.02-0.20); P<0.001] were associated with reduced likelihood of inadequate GWG. None of the variables studied predicted excessive GWG. In terms of pregnancy outcome, women with inadequate GWG had a 30% reduced risk of caesarean delivery compared to those with adequate GWG [RR 0.7(0.6-0.9); P= 0.036]. The mean birth weight of babies born to women with inadequate GWG was significantly lower than that of babies born to women with adequate GWG (T-test = 2.998; P=0.003).

Conclusion: A substantial proportion of study participants had suboptimal GWG (inadequate and excessive), with only a third meeting the IOM recommendations. There is a need for targeted counselling for older, multiparous, and upper socioeconomic class women on adequate GWG.

Keywords: Birth weight; Body Mass Index; Gestational; Institute of Medicine; Nigeria; Predictors; Pregnancy; Weight gain

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Introduction

Maternal nutrient intake during pregnancy and the associated gestational weight gain (GWG) are important determinants of maternal and foetal wellbeing.[1] The increase in weight observed in women during pregnancy is due to several factors. Some of these include increased maternal fat, breast enlargement, and increased size of the uterus. Others are the weight of the developing foetus, amniotic fluid, placenta and membranes.[2] There appears to be a GWG range that is associated with favourable maternal and foetal outcomes.[3] There are individual variations in gestational weight gain, often dependent on the pre-pregnancy weight or body mass index (BMI). Evidence suggests that women who are overweight or obese prior to pregnancy have numerically lower GWG than women with normal BMI, although this reduced GWG often exceeds the recommended gestational weight gain for that population.[4,5] In addition to pre-pregnancy BMI, other factors such as ethnicity, socioeconomic status, dietary intake, parity and length of gestation have also been noted to affect gestational weight gain. [1,5] The most widely used guideline on healthy gestational weight gain is that published by the United States Institute of Medicine (IOM).[6] This guideline prescribes a gestational weight gain range based on the pre-pregnancy BMI. The amount of weight gain during pregnancy has been found to influence maternal and foetal outcomes. Optimal weight gain during pregnancy is associated with favourable maternal and foetal outcomes.[3] In areas where the IOM GWG recommendation is in use, women are counselled to keep gestational weight gain within the prescribed range to have a favourable pregnancy outcome. Multiple studies confirm that adherence to the IOM recommendation helps to achieve better pregnancy outcomes.[3,7,8] However, it appears that many women find it difficult to adhere to the prescribed weight gain recommendations.[7] Recent evidence from a meta-analysis suggests that the majority of women gain weight outside the IOM recommendations, with 23% and 47% of pregnancies with gestational weight gain below and above the recommendation, respectively.[8] It should be noted that both inadequate and excessive gestational weight gain are associated with morbidities in both mother and foetus.[7]

The complications associated with gestational weight gain outside the IOM recommendations vary depending on whether it is above or below the recommendations. Some of these complications include increased risk of caesarean section, large for gestational age (LGA) babies, gestational diabetes mellitus (GDM) and pre-eclampsia. Others are an increased risk of preterm birth, low birth weight, and small for gestational age (SGA) babies. [7-9]

There have been some questions regarding the universal applicability of the IOM GWG recommendations. Some researchers have suggested that the IOM-recommended GWG range was possibly too much for some pregnant population, for each BMI category. [10,11] There is limited data on gestational weight gain among women of African descent. Hence, this study was designed to investigate GWG, associated factors, and pregnancy outcome among women who gave birth in a tertiary hospital in southwest Nigeria.

Materials and Methods

Study setting

This study was carried out at the obstetric unit of Babcock University Teaching Hospital (BUTH), a private tertiary hospital located in Ogun State, southwest Nigeria. Antenatal clinics are held twice weekly. The hospital has fully functional delivery suites, two obstetric theatres and a neonatal ward. Apart from booked clients, the obstetric unit also receives referrals from neighbouring primary and secondary health facilities within Ogun and Lagos states. Obstetrics services are provided by consultant obstetricians, resident doctors, nurses and midwives. BUTH caters for approximately 500 new antenatal clients annually and has an average annual delivery of approximately 350 births.

Study design, study population, inclusion and exclusion criteria

This prospective cohort study was carried out on all consenting women who registered for antenatal care before gestational age of 13 weeks, had regular antenatal visits, had complete antenatal records, and had their deliveries at term in BUTH. Recruitment of study participants occurred over a two-year period between June 2022 and May 2024. Follow-up of eligible participants continued till December 2024, when the last enrolled participant had her delivery. Women carrying multiple pregnancies and those with systemic disorders such as diabetes mellitus, thyroid dysfunction, cardiac diseases, sickle cell disease and autoimmune disorders were excluded. Similarly, women with preterm deliveries and those with foetuses suspected to have congenital or chromosomal abnormalities were also excluded during follow-up and replaced with new recruits.

Sample size determination

The sample size required for the study was calculated using the formula for sample size in a longitudinal study.[12] A previous study [13] reported that the proportion of babies with birth asphyxia was 19% among women who had normal GWG (according to IOM criteria) and 30% among women with abnormal GWG. Assuming 95% CI and 80% power, the calculated sample size was 151. Addition of 10% to account for attrition gave a final sample size of 167. However, a total of 220 women were recruited during the study period.

Sampling technique

A purposive sampling technique was used. All women who met the inclusion criteria were asked to sign an informed consent form. They were then recruited consecutively.

Study procedure and follow-up

All women had their heights and weights determined at booking using a weighing scale with a stadiometer (Seca-Germany). Both measurements were taken with the woman barefoot. Each woman was asked to stand against the stadiometer without wearing any head covering; the pointer was then pressed firmly against her scalp, and the height was measured in centimetres and then converted to the nearest 0.01 metres. Weight was recorded to the nearest 0.1 kilograms. A first-trimester ultrasound scan was ordered and reviewed to ensure that the estimated gestational age corresponded with that calculated from the date of the last normal menstrual period. Women also had routine antenatal booking investigations. Follow-up antenatal appointments were according to departmental protocol: 4-weekly till 28 weeks, 2 weekly till 36 weeks, and weekly till delivery. During each antenatal contact, the weight was measured and recorded. The final weight was measured when the study participant presented for labour or delivery. Antenatal attendees were counselled on the need for a balanced diet and good nutrition during pregnancy. Women also received tetanus toxoid immunization, and antimalarial prophylaxis with Sulphadoxine-Pyrimethamine. Pregnant women were placed on routine haematinics throughout pregnancy.

All newborn babies had their birth weight measured using a digital infant weighing scale (Seca 354-Germany) within 30 minutes of birth. Babies were weighed without clothing or diapers and recorded to the nearest 0.05kg.

Data collection instrument

A data capture sheet was used for data collection. The socio-demographic characteristics, maternal height and weight at booking were recorded. The first recorded maternal weights in the second and third trimesters, and maternal weight at presentation for labour or delivery, gestational age at delivery, mode of delivery and pregnancy outcome were also recorded on the data capture sheet.

Definition of terms

The occupation of the study participants was categorised as follows: Professionals, Civil Servants, Artisans, Traders and Housewives. Housewives, Traders and Artisans were classified as low-status jobs while Civil Servants and Professionals were classified as high-status jobs.

The socioeconomic status of the study participants was determined from their education status and occupation based on a previously validated scoring system.[14] Women with postgraduate education were assigned a score of 1; women with a university first degree and National Certificate of Education (or National Diploma) were assigned scores of 2 and 3, respectively, while women with senior school and junior school certificates were assigned scores of 4 and 5, respectively. The assigned scores for occupation were as follows: top-level professionals (score of 1), top civil servants in directorate grade (score of 2), other civil servants (score of 3), artisans (score of 4), traders (score of 5), full-time housewives (score of 6). The aggregate score was divided by 2 and approximated to the nearest whole number. Socioeconomic status was classified thus: Upper class (scores 1 and 2), Middle class (scores 3 and 4) and Lower class (scores 5 and 6).

Low Birth weight was defined as newborn weight less than 2.5kg

Data management and analysis

Data was analyzed using the IBM-SPSS Statistics for Windows version 23.0 (IBM Corp., Armonk, NY, USA).

The pre-pregnancy weight of the women was determined using the formula: Pre-pregnancy weight = weight in first trimester – 250gms.[15] The pre-pregnancy BMI was calculated, and the women were categorized according to WHO BMI standards.[15] The GWG during the second trimester was determined by subtracting the first recorded weight after 13 weeks from the first recorded weight after 26 weeks, while the GWG during the third trimester was determined by subtracting the first recorded weight after 26 weeks from the last recorded weight in the third trimester, which was the weight when the parturient presented in labour. The total GWG was determined by subtracting the calculated pre-pregnancy weight from the weight when the parturient presented in labour or for delivery.

According to the IOM guideline, the recommended range of weight gain throughout pregnancy for underweight women is 12.5 to 18 kg, for normal weight women is 11.5 to 16 kg, for overweight women is 7 to 11.5 kg, and for obese women is 5 to 9 kg.[6] The total GWG for each participant determined from this study was compared with the IOM recommended range to determine the proportion of women who had adequate, inadequate and excessive GWG.

Continuous variables were summarized using appropriate descriptive statistics such as mean and median at 95% confidence interval. Categorical variables were summarized using frequencies and percentages. Pearson's Chi-square test was used to establish the association between categorical variables. Independent sample t-test and ANOVA test were used to compare the means of normally distributed continuous variables, while Wilcoxon signed-rank and Kruskal-Wallis tests were used to compare the median of variables that were not normally distributed. Multinomial logistic regression analysis was used to explore the predictors of inadequate and excessive GWG. The relative risks of pregnancy outcomes such as need for caesarean delivery, low birth weight, macrosomia, asphyxia (Apgar scores <7), and need for neonatal intensive care unit (NICU) admission were also reported. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Babcock University Health Research Ethics Committee (BUHREC 753/21). The research was conducted in accordance with the World Medical

Association Declaration of Helsinki. Informed consent was obtained as every eligible participant was given detailed information about the study. Consenting women indicated their willingness to participate in the study by appending their signature or thumb impression on the informed consent form. The data set was anonymized to ensure privacy.

Results

The characteristics of the study participants is depicted in Table 1. The mean age (\pm SD) of the study participants was 31.1(\pm 4.8) years. Majority, 115(52.3%) were between the age range 31-40 years. Eighty-seven study participants (39.5%) were nulliparous, and the median parity (IQR) was 1(0-2). Based on the pre-pregnancy BMI, only six study participants (2.7%) were underweight, 88(40.0%) had normal BMI, 80(36.4%) were overweight while 46(20.9%) were obese. The mean pre-pregnancy BMI (\pm SD) was 27.0(\pm 5.9) Kg/m². The mean gestational age at delivery (\pm SD) was 38.2 (\pm 1.4) weeks while the mean birth weight (SD) was 3.2(\pm 0.5) Kg.

Table 1: Characteristics of study participants (N=220)

Variable	n (%)
Age (years)	
<20	1(0.5)
21 -30	102(46.4)
31-40	115(52.3)
\geq 40	2(0.9)
Parity	
0	87(39.5)
1	67(30.5)
2	48(21.8)
3	11(5.0)
4	7(3.2)
Occupation	
Housewives	22(10.0)
Traders	33(15.0)
Artisans	19(8.6)
Civil Servants	51(23.2)
Professionals	95(43.2)
Geopolitical Zone	
Southwest	141(64.1)
Southeast	47(21.4)
Southsouth	16(7.3)
Northcentral	12(5.5)
Northeast	2(0.9)
Northwest	2(0.9)

Pre-Pregnancy BMI categories (Kg/m ²)	
Underweight (<18.5)	6(2.7)
Normal (18.5-24.9)	88(40.0)
Overweight (25.0-29.9)	80(36.4)
Obese (\geq 30)	46(20.9)

BMI Body mass index.

The trimester-specific gestational weight gain across different pre-pregnancy body mass index categories is depicted in Table 2. The median (95% CI) GWG in all study participants was 9.8 (8.8-10.3) Kg. The GWG range were (6.3-19.3), (9.3-13.3), (8.3-10.3) and (5.8-8.8) for underweight, normal weight, overweight and obese women respectively. A Kruskal-Wallis's test provided very strong evidence of statistically significant differences between the median GWG in at least one pair of pre-pregnancy BMI categories in second trimester ($P < 0.001$), third trimester ($P = 0.023$) and throughout pregnancy ($P < 0.001$). Similarly, there were statistically significant differences between the median rates of weight gain in at least one pair of pre-pregnancy BMI categories in both the second ($P < 0.001$) and third ($P = 0.045$) trimesters. Dunn's pairwise tests together with Bonferroni correction were carried out for the six possible pairs of BMI categories. In the second trimester, both women with normal BMI and overweight women had significantly higher GWG compared to obese women ($P < 0.001$, $P = 0.038$ respectively). Similarly, the rates of weight gain were also significantly higher in women with normal BMI and overweight women compared to obese women ($P < 0.001$; $P = 0.012$ respectively). In the third trimester, women with normal BMI had significantly higher GWG compared to overweight women ($P = 0.025$). Similarly, the rate of weight gain in 3rd trimester was also significantly higher in women with normal BMI compared to overweight women ($P = 0.039$). There was no significant difference between the other pairs. Overall, the total GWG in women with normal BMI was significantly higher than the total GWG in obese women ($P < 0.001$). Wilcoxon signed-rank test showed that the weight gain in the second trimester was significantly higher than weight gain in third trimester ($Z = -6.857$, $P < 0.001$). Similarly, the rate of weight gain was also significantly higher in the second trimester compared to third trimester ($Z = -3.014$, $P = 0.003$).

Table 2: Trimester-specific gestational weight gain across different pre-pregnancy body mass index categories

Trimester	All women (N=220)	Underweight (n=6)	Normal (n=88)	Overweight (n=80)	Obese (n=46)	P value
2 nd trimester (kg)	5.0 (4.5-5.7)	6.5 (4.0-11.0)	6.5 (4.5-7.0)	5.0 (4.0-6.0)	2.0 (1.5-5.5)	<0.001*
3 rd trimester (kg)	3.0 (2.5-3.5)	1.0 (1.0-8.0)	4.0 (3.0-4.5)	2.3 (2.0-3.5)	2.8 (2.0-4.5)	0.023*
Rate of GWG in 2 nd trimester (g/week)	393 (346-429)	464 (286-733)	419 (346-591)	393 (357-462)	167 (133-393)	<0.001*

Rate of GWG in 3 rd trimester (g/week)	321 (273-364)	200 (91-889)	364 (318-417)	318 (200-350)	315 (182-500)	0.045*
Total GWG (Kg)	9.8 (8.8-10.3)	12.3 (6.3-19.3)	10.3 (9.3-13.3)	9.8 (8.3-10.3)	7.3 (5.8-8.8)	<0.001*

Median (95% CI) data presented. Kruskal-Wallis's test was used to test for differences in medians across BMI status. * $p < 0.05$ statistically significant

The Gestational Weight Gain status of study participants based on the IOM guideline is depicted in Figure 1. Majority of the underweight and normal weight women had inadequate GWG: 4(66.7%) and 49(55.7%) respectively. The highest proportion of overweight women 29(36.3%) had excessive GWG followed by those with adequate GWG 27(33.8%). However, the highest proportion of obese women 20 (43.5%) had adequate GWG followed by those with excessive GWG 14 (30.4%). Overall, 64(29.1%) of all study participants had adequate GWG, 89(40.5%) had inadequate GWG while 67(30.4%) had excessive GWG.

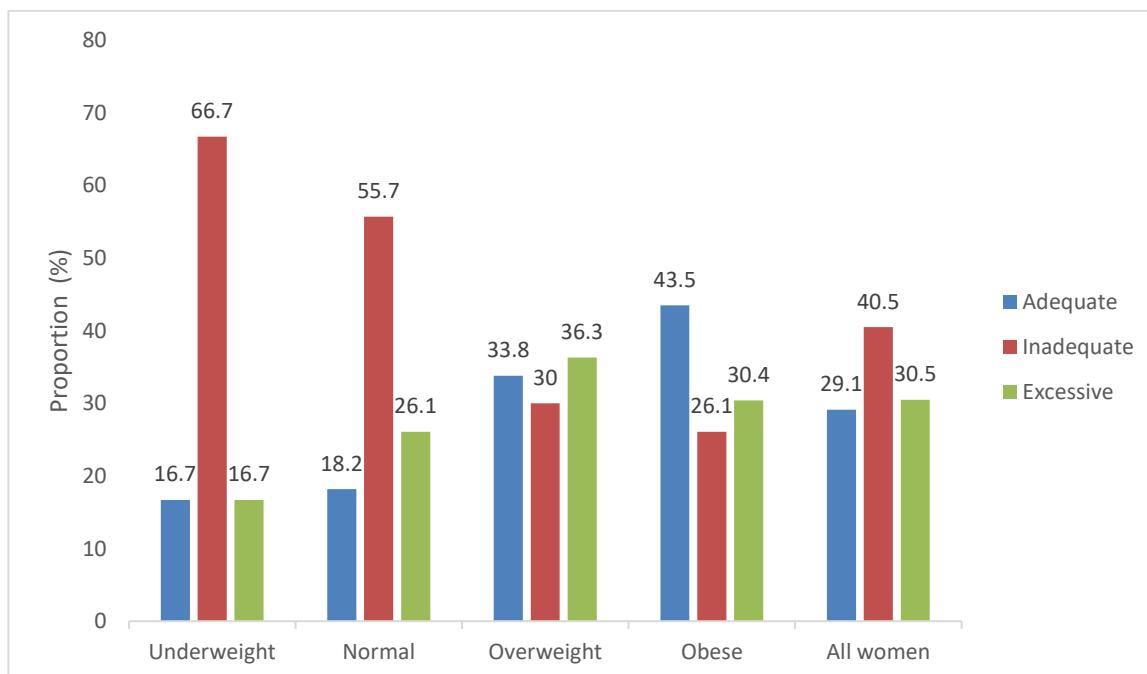


Figure 1: Gestational Weight Gain using the IOM guideline according to pre-pregnancy BMI categories

Bivariate analysis was done to determine the factors associated with total GWG during pregnancy (Table 3). This study showed that only pre-pregnancy BMI was significantly associated with total GWG status ($P=0.003$). Subsequently, a multinomial logistic regression analysis was performed (Table 4) to determine the predictors of both inadequate GWG and excessive GWG using adequate GWG as reference. Maternal age, parity, socioeconomic status and WHO BMI class were significant predictors of inadequate GWG. However, none of the variables in the regression model significantly predicted excessive GWG. Specifically, women 30 years and above were two and half times more likely to have inadequate GWG than those aged below 30 years [OR 2.5(1.3-5.0); $P=0.013$]. Regarding parity, women with parity range 1-2 were four times more likely than nulliparous women to have inadequate GWG [OR 4.3(1.8-10.1); $P=0.001$] while women with parity range 3-4 were eight times more likely than nulliparous women to have inadequate GWG [OR 8.2(1.3-51.8); $P=0.025$]. Women with middle/upper socioeconomic class also had higher likelihood of having inadequate GWG than those with lower socioeconomic class [OR 14.6(2.1-99.2); $P=0.006$]. On the contrary, both overweight [OR 0.2(0.1-0.4);

P<0.001] and obese women [OR 0.06(0.02-0.20); P<0.001] were less likely to have inadequate GWG than women with normal BMI.

Table 3: Factors associated with total gestational weight gain status (N=220)

Variable	Total GWG Status			χ^2	P value
	Adequate n(%)	Inadequate n(%)	Excessive n(%)		
Maternal age (years)					
< 30	33(51.6)	30(33.7)	31(46.3)	5.344	0.069
≥ 30	31(48.4)	59(66.3)	36(53.7)		
Parity					
0	33(51.6)	27(30.3)	27(40.3)	8.587	0.072
1-2	29(45.3)	52(58.4)	34(50.7)		
3-4	2(3.1)	10(11.2)	6(9.0)		
Occupation					
Low status jobs	22(34.4)	34(38.2)	18(26.9)	2.223	0.329
High status jobs	42(65.6)	55(61.8)	49(73.1)		
Geopolitical Zone					
South West	42(65.6)	56(62.9)	43(64.2)	0.119	0.942
Others	22(34.4)	33(37.1)	24(35.8)		
Socioeconomic status					
Lower	6(9.4)	2(2.2)	2(3.0)	4.900	0.086
Middle/Upper	58(90.6)	87(97.8)	65(97.0)		
Pregnancy complications					
None	52(81.3)	79(88.8)	61(91.0)	4.885	0.299
Diabetes Mellitus	6(9.4)	4(4.5)	1(1.5)		
Hypertensive disorders	6(9.4)	6(6.7)	5(7.5)		

Prepregnancy BMI					
Underweight	1(1.6)	4(4.5)	1(1.5)	20.156	0.003*
Normal	16(25.0)	49(55.1)	23(34.3)		
Overweight	27(42.2)	24(27.0)	29(43.3)		
Obese	20(31.3)	12(13.5)	14(20.9)		

*p<0.05 statistically significant

Table 4: Multinomial logistic regression analysis exploring the predictors of inadequate and excessive GWG

Variable	Inadequate GWG		Excessive GWG	
	AOR (95% CI)	P value	AOR (95% CI)	P value
Maternal age (years)				
< 30	Reference		Reference	
≥ 30	2.5(1.3-5.0)	0.013*	1.3(0.6-2.5)	0.786
Parity				
0	Reference		Reference	
1-2	4.3(1.8-10.1)	0.001*	1.9(0.8-4.4)	0.119
3-4	8.2(1.3-51.8)	0.025*	4.2(0.7-26.4)	0.128
Socioeconomic status				
Low	Reference		Reference	
Middle/high	14.6(2.1-99.2)	0.006*	5.0(0.9-29.1)	0.071
Maternal complications				
Diabetes Mellitus	1.3(0.3-5.9)	0.726	0.2(0.02-1.9)	0.167
HDP	1.1(0.2-5.2)	0.902	1.2(0.3-4.5)	0.829
None	Reference		Reference	

WHO BMI Class				
Underweight	3.5(0.3-36.0)	0.288	0.9(0.04-15.3)	0.920
Normal	Reference		Reference	
Overweight	0.2(0.1-0.4)	<0.001*	0.6(0.3-1.5)	0.318
Obese	0.06(0.02-0.20)	<0.001*	0.3(0.1-1.0)	0.056

Reference category: Adequate GWG, *P< 0.05 statistically significant, HDP: Hypertensive disorders of pregnancy

The mean birth weight of babies born to women with inadequate, adequate and excessive GWG were 3.07kg, 3.30 Kg and 3.32 Kg respectively. The mean birth weight of babies born to women with inadequate GWG was significantly lower than that of babies born to women with adequate GWG (T-test= 2.998; P=0.003). Although the mean birth weight in women with excessive GWG was higher than in those with adequate GWG, this was not statistically significant (T-test=-0.310; P= 0.757). The mean gestational age at delivery in women with inadequate, adequate and excessive GWG were 38.16 weeks, 38.23 weeks and 38.18 weeks respectively. There was no significant difference in the gestational age at delivery of women in the three groups (F= 0.058; P= 0.944).

Table 5 presents the pregnancy outcomes based on GWG status of the study participants. Women with inadequate GWG status were found to have a 30% reduced risk of caesarean delivery compared to women with adequate GWG [RR 0.7(0.6-0.9); P= 0.036]. Other pregnancy outcomes such as low birth weight (LBW), macrosomia, asphyxia and neonatal intensive care unit admission were not significantly influenced by gestational weight gain status.

Table 5: Gestational weight gain status and pregnancy outcomes in study participants

Pregnancy outcomes	Relative Risk (95% CI)	P value
Caesarean section		
Inadequate GWG	0.7(0.6-0.9)	0.036*
Excessive GWG	0.9(0.6-1.1)	0.304
Low Birth Weight		
Inadequate GWG	3.2(0.7-14.5)	0.125
Excessive GWG	0.9(0.6-1.1)	0.304
Macrosomia		
Inadequate GWG	0.9(0.3-3.2)	0.870
Excessive GWG	0.9(0.2-3.7)	0.947
Asphyxia at 1st minute		
Inadequate GWG	0.8(0.3-2.4)	0.741
Excessive GWG	0.9(0.3-2.8)	0.934
Asphyxia at 5th minute		
Inadequate GWG	1.3(0.4-4.1)	0.700
Excessive GWG	1.4(0.4-4.8)	0.562

NICU admission		
Inadequate GWG	1.0(0.5-2.1)	0.986
Excessive GWG	0.8(0.3-1.8)	0.542

Reference category: Adequate GWG, *P< 0.05 statistically significant

Discussion

This study assessed gestational weight gain (GWG) and its predictors among a cohort of pregnant women in a Nigerian tertiary hospital. Our findings reveal that only about 30% of the study participants achieved adequate GWG based on IOM recommendations; 40% had inadequate GWG and about 30% had excessive GWG. The median GWG was 9.8 Kg with higher weight gain occurring in second trimester compared to third trimester. Older maternal age, multiparity and middle/upper socioeconomic class predicted inadequate GWG, being overweight and obese were associated with reduced likelihood of inadequate GWG, while none of the variables studied predicted excessive GWG. In terms of pregnancy outcomes, women with inadequate GWG had a 30% lower risk of caesarean delivery and gave birth to significantly smaller babies compared to those with adequate GWG.

The proportion of pregnant women who had normal GWG in this study (29.1%) is higher than 16% reported in Ibadan [13] but lower than 53.5% reported in Enugu.[16] Evidence suggests that there is heterogeneity in GWG across countries and regions.[17] A systematic review of studies from sub-Saharan Africa revealed that majority of women have inadequate GWG unlike in high income countries where majority of women have excessive GWG.[18] The fact that 70% of women had either inadequate or excessive GWG suggests a need for better antenatal nutritional counselling in the study centre. One major factor that influenced GWG in this study was pre-pregnancy BMI. We found an inverse relationship between BMI and the proportion of women with inadequate GWG. More than half of the women with normal BMI had inadequate GWG. This finding is likely a reflection of the influence of other factors like ethnicity, socioeconomic status and dietary habits all of which have been reported to affect GWG and calls to question the suitability of the IOM GWG recommendation for Nigerian women. [1,5]

The total weight gain and the rate of weight gain during the second trimester were significantly higher than the findings observed in the third trimester. This confirms the widely known fact that women gain most weight during the second trimester of pregnancy. [19-22] In accordance with the pattern in the IOM recommendations, the highest weight gain occurred in underweight women while the lowest weight gain occurred in obese women. Specifically, the GWG in women with normal BMI was significantly higher than GWG in obese women. Similar finding was reported in a study done in Enugu, southeastern Nigeria.[16] The median GWG values reported in our study were only within the IOM recommended range for overweight and obese women, but lower than the recommended range in underweight women and women with normal BMI. It is however worthy of note that the proportion of underweight women in the pregnancy cohort was very low (2.7%) and this could be responsible for this disparity. Overall, the median GWG of 9.8 kg is lower than reported in high-income settings [23] but higher than the average reported from studies conducted in sub-Saharan Africa where socioeconomic and nutritional challenges may contribute to suboptimal GWG. [23,24] The significant heterogeneity across the sub regions of SSA may reflect differences in social status, household wealth index and maternal educational status. [24] According to some studies, IOMs recommended GWG range may be excessive for some pregnant women across different BMI categories. [10,11] This appears to be the situation in this study considering the lower GWG range in women with normal BMI. There is thus the need for large longitudinal studies with a view to determining the appropriateness of IOM recommendations and perhaps establish GWG standards for the Nigerian population.

Older and multiparous women were found to be more likely to have inadequate GWG than normal weight women. Similar findings have been reported in other studies. [7,25] Multiple reports have indicated inconsistent findings regarding the relationship between socioeconomic status and GWG. [1,25-27] It is not unusual to expect excessive GWG among women of upper socioeconomic class. However, some women of high social class may lack proper understanding of the importance of a healthy diet or have poor access to nutritious diet.[25] Furthermore, women from higher socioeconomic backgrounds may be more susceptible to social media influences promoting idealized body images, which can result in intentional calorie restriction and meal limitation aimed at minimizing gestational weight gain.[28] These factors may be partly responsible for the unexpected association of high social class with inadequate GWG reported in this study. The discrepancy may also reflect dietary patterns unique to our population or cultural attitudes that women have towards pregnancy weight gain.[29] In some African populations, pregnant women deliberately restrict weight gain due to the belief that links excessive weight to big babies and difficult deliveries.[30]

The pre-pregnancy weight or BMI of women is one of the most important factors that can influence gestational weight gain. Nevertheless, there are conflicting reports regarding this association. There is evidence to suggest that women who are overweight or obese prior to pregnancy have numerically lower GWG than women with normal BMI. [4,5] This agrees with the results of our study and aligns with the pattern seen in the IOM recommendation where the proposed GWG is inversely proportional to the BMI. However, a similar study in Ibadan [13] reported that overweight and obese women had higher odds of excessive weight gain compared to women with normal weight. The authors of the study posited that lack of awareness of the IOM guideline on GWG could be a possible reason for the disparity.[13] It has been suggested that women with higher baseline adiposity have sufficient energy reserves for pregnancy demands.[29] Notably, none of the factors in the regression model of our study predicted excessive weight gain. Gestational weight gain may reflect the health status of the mother and growth of the foetus and could be influenced by several factors including genetics, ethnicity, maternal nutrition and the level of physical activity. Other factors are the presence of intercurrent infections and the duration of interpregnancy intervals. [1,5,6,13] These unmeasured factors may have played a role in determining GWG in this study population. To improve outcomes of pregnancies, there is need for interventions aimed at optimizing GWG. Such interventions targeting modifiable factors include health education regarding the importance of physical activity and proper nutrition, routine self-monitoring of weight, infection prevention and treatment, and adequate pregnancy spacing. [13,31] Women with inadequate GWG gave birth to significantly smaller babies than those with adequate GWG. Similar findings were also reported in other studies done in Turkey. [32,33] It is believed that maternal dietary intake and nutrient stores play important roles in determining foetal growth. [6,34]

Women with inadequate GWG had significantly reduced risk of being delivered by caesarean section compared to women with adequate GWG. Zhong et al reported similar findings in a systematic review assessing outcomes in twin pregnancies.[35] A possible reason for this finding may be the relatively smaller babies associated with inadequate GWG.[29] This may translate to a reduced risk of labour dystocia which has been reported to account for about one in every five caesarean sections in the study centre.[36]

In our study, excessive GWG did not significantly increase the risk of any of the pregnancy outcomes assessed. A similar study done in Ibadan, Nigeria also reported no significant association between excessive GWG and pregnancy outcomes.[13] Excessive GWG has been associated with increased risk of caesarean section and macrosomia.[7,33] It is worthy of note that excessive GWG is often indicative of metabolic imbalances and underlying disease processes such as diabetes and hypertension;[13] and these may contribute to some of the adverse pregnancy outcomes reported in some studies. These medical conditions were excluded in this study, and this may be a plausible explanation for the differences in

findings. There is an obvious need for balanced antenatal counselling to avoid both inadequate and excessive GWG.

Strengths and Limitations

The prospective cohort design of the study allowed for the direct measurement of important variables thus avoiding recall bias which is often associated with retrospective studies. We were also able to prospectively investigate multiple risk factors and pregnancy-related outcomes associated with GWG in the study population. There are however some limitations of the study. The study relied on estimated pre pregnancy weight to calculate the BMI, since the women were recruited in first trimester. The determination of socioeconomic status of the study participant was only based on their educational attainment and occupation without considering their income which is also a recognised determinant of socioeconomic status. This may have affected the classification system used in this study. Since the study population was limited to antenatal attendees of a tertiary hospital, the findings may not be generalisable to the broader obstetric population. The study design did not allow for determination of causality of pregnancy outcomes. The lack of dietary, physical activity and metabolic disease data also contributes to the limitations of this study. Despite these limitations, the findings from this study are very relevant and will be useful in making recommendations for GWG in a Nigerian population.

Conclusion

A substantial proportion of the study participants had suboptimal GWG (inadequate and excessive) with only a third meeting the IOM recommendations. Factors such as older maternal age, multiparity and middle/upper socioeconomic class significantly predicted inadequate GWG while pre-pregnancy overweight /obesity was protective. The lack of predictors for excessive GWG suggests the need for further research to explore the roles of additional factors such as diet, exercise, and cultural beliefs around pregnancy weight. Importantly, women with inadequate GWG gain had smaller babies than those with adequate GWG, underscoring the need for monitoring and supporting optimal GWG in the antenatal period. There is also need for targeted counselling for older, multiparous, and upper socioeconomic class women on adequate GWG.

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