Original Article

Patterns of Gestational Weight Gain and Its Association with Birthweight in Nigeria

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Abstract

Background: Despite the increasing global importance of gestational weight gain (GWG) and its impact on birthweight, little is known about the patterns of GWG in African populations. **Objectives:** To determine the pattern of GWG and its association with birthweight in Nigeria. **Methods**: It was a longitudinal study of 200 pregnant women receiving antenatal care at two tertiary hospitals in Enugu, south eastern Nigeria. The women were consecutively recruited at <14 weeks gestation and their body mass indexes recorded upon recruitment. Thereafter, weight measurements were taken at each visit until 38–39 weeks. **Results:** Mean total GWG was 10.7 ± 3.4 kg, while mean birthweight was 3.3 ± 0.6 kg. GWG in second trimester had positive correlation with birthweight (r = 0.164, P = 0.02). Obese women gained above the recommended limits by the "institute of medicine" while underweight women gained below the limits. Excessive total GWG was associated with higher risk of macrosomia [8/21 (38.1%) vs. 7/179; RR: 9.74; 95% CI: 3.9–24.2; P < 0.001] while inadequate total GWG was associated with higher risk of low birth weight [7/72 (9.7%) vs. 3/128 (2.3%; RR: 4.15; 95% CI: 1.1–15.4; P = 0.03]. Maternal age of <35 years, high social class, nulliparity, and regular antenatal care were associated with normal GWG while maternal age <35 years and regular antenatal care were associated with normal birthweight (P < 0.05). **Conclusions:** Women should be counseled on the factors that influence GWG and birthweight. Interventions to assist women achieve appropriate GWG may need to include components related to improved dietary intake for the underweight and increased physical activity for the obese.

Keywords: *birthweight, body mass index, pregnancy, Nigeria, weight gain*

Date of Acceptance:
25-Dec-2016

Introduction

Gestational weight gain (GWG) is an important determinant of fetal growth, birthweight, and infant health outcomes.[1,2] In view of this, the Institute of Medicine (IOM) in the United States recommended limits of weight gain for women during pregnancy.[3] This recommendation is with respect to the body mass index (BMI) prior to pregnancy. It is recommended that normal weight women (18.5-24.9 kg/m^2) should gain between 11.5 and 16.0 kg, overweight women (25.0-29.9 kg/m^2) between 7 and 11.5kg, obese women (≥ 30.0 kg/m^2) between 5 and 9 kg, and underweight women (< 18.5 kg/m^2) between 12.5 and 18 kg.[3] There is evidence that GWG within these IOM's recommendations are associated with lower rates of adverse pregnancy outcomes including caesarean section, gestational hypertension, low birthweight (LBW), and macrosomia in Western populations.[4]

However, some researchers recommend that GWG irrespective of pre-pregnancy BMI be within 10–15 kg.[5,6] The GWGs <10 kg and >15 kg are referred to as inadequate and excessive GWGs, respectively.[5,6] There is also evidence that GWGs within the recommended limits of 10-15 kg are associated with better pregnancy outcomes than those outside the recommended limits.[5,6]

Besides the pre-pregnancy BMI, other factors that may influence GWG and birthweight include

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Access this article online

Quick Response Code:

Website: www.njcponline.com

DOI: 10.4103/1119-3077.208958

How to cite this article: Onwuka CI, Ugwu EO, Onah HE, Obi SN, Onwuka CI, Menuba IE, *et al.* Patterns of gestational weight gain and its association with birthweight in Nigeria. Niger J Clin Pract 2017;20:754-60.

maternal age, parity, social class, and frequency of antenatal visits.[7,8]

It has been observed that the maternal weight and BMI remain unchanged in first trimester of pregnancy and before 14 weeks gestation,[9] and that weight gain within this period has no significant relationship with birthweight.[10] Thus, the GWGs from 14 weeks of second trimester and that of third trimester are the ones that have significant impact on birthweight.[1,8,11]

There is little known about the patterns of GWG in Africa including Nigeria. However, monitoring of GWG has for decades been an essential component of prenatal care.[5,12] There is therefore need for a prospective study on patterns of GWG in our environment: to help clinicians in targeting the nutritional, medical and social services of those at high risk of adverse pregnancy outcome. This is the need that this study aims to fulfill.

Materials and Methods

The study was conducted in the antenatal clinics and labor wards of the two teaching hospitals in Enugu, Nigeria: University of Nigeria Teaching Hospital (UNTH) Ituku/Ozalla, Enugu and Enugu State University Teaching Hospital (ESUTH), Parklane, Enugu. The participants for the study were drawn from women attending antenatal care at the antenatal clinics of the hospitals. The hospitals offer antenatal and postnatal care services to women in Enugu State, and practice the traditional model of antenatal care whereby women are generally seen monthly until 28 weeks of gestation, fortnightly until 36 weeks, and then weekly until delivery. Further details of the study centers are described in a recent study.[13]

It was a longitudinal cohort study of women attending the antenatal clinics of the two hospitals over a 9-month period from January to September 2013. The inclusion criteria were women with singleton fetuses and normal (uncomplicated) pregnancy at gestational age of <14 weeks. The exclusion criteria included history of hypertensive disease, diabetes mellitus, sickle cell disease, and early pregnancy complications. The eligible women were consecutively recruited from the booking clinics at gestational age of <14 weeks. The first trimester ultrasound was reviewed to ensure that the estimated gestational age correlated with that calculated from the date of the last menstrual period. All the patients were adequately counselled and their written consent obtained before recruitment into the study. The study was approved by the institutional review board of the UNTH, Enugu (Ref. UNTH/CSA.329/Vol 5). Using a population size (N) of 386 with an assumed abnormal weight gain rate of 50% at a confidence interval (CI) of 95%, and an error margin of 5%, the minimum required "return sample size" (n) was 193. Considering a 10% attrition rate, the minimum sample size was 212. However, a sample of 223 was used for the study.

Data were collected using a questionnaire designed for the study. The information obtained included the sociodemographic data (age, occupation, educational status, marital status, and husband's occupation), the past obstetric history, and the current pregnancy history including date of last menstrual period.

All participants received antimalarial prophylaxis with the use of sulfadoxine-pyrimethamine combination according to the national malaria control guideline.[14] All the women were counseled on the need for adequate nutrition/balanced diet during pregnancy and this was re-emphasized at every time they were weighed. These are parts of routine antenatal care interventions to promote optimum health during pregnancy.

The initial weight measurement was at booking (recruitment) at gestational age of <14 weeks. The heights of the participants were also obtained at this time. The pre-pregnancy weight was assumed to be equivalent to the weight obtained at recruitment. This assumption was adapted from the study by Fattah *et al*.,[9] which observed that maternal weight and BMI remain unchanged before 14 weeks gestation. The weight obtained at <14 weeks (or the pre-pregnancy weight) and the height were used to calculate the pre-pregnancy BMI. Thereafter, weight measurements of the participants were taken at each visit until 38–39 weeks gestation. The BMI was calculated as weight/height^2 (kg/m^2). Normal BMI was defined as 18.5–24.9 kg/m^2, underweight as BMI <18.5 kg/m^2, and overweight as 25.0–29.9 kg/m^2, and obesity as BMI ≥30.0 kg/m^2.[3]

The weight gains in the second (from 14 weeks) and third trimesters were considered in this study. The second trimester GWG was assumed and calculated as weight at the end of 27 weeks gestation minus weight at <14 weeks.[9] The third trimester GWG was calculated as weight at 38-39 weeks gestation minus weight at the end of 27 weeks.[8] Addition of the GWGs in the second and third trimesters was considered as the total GWG. Normal total GWG was considered to be 10-15 kg.[5,6] Total GWG less than 10kg was considered as inadequate and total GWG >15 kg was considered as excessive GWG.[5]

The weighing took place in the clinics with the women barefooted and wearing light clothing to the nearest 0.5 kg. The weighing scales (RGZ-160) were gauged at the onset of the study, and thereafter regularly during data collection, with a known weighted mass. It was

also checked regularly for zero error. The women stood against the stadiometer barefooted without head-gear or cap; with the Achilles, gluteus and occiput touching it, a pointer was then pressed firmly against the scalp and their heights measured in centimeters to the nearest 0.5 cm and then converted to meters.

The weights of the newborns were recorded in a warm room without clothing or diapers, within 1 h of birth. The "Way master" infant scale was used to record the weight of the newborns to the nearest 0.05 kg. The infant weighing scales were also standardized as above. Normal birthweight was defined as birthweight between 2.5 and 4.0 kg, LBW as less than 2.5 kg, and macrosomia as more than 4.0 kg.[13]

A woman is said to have had a regular antenatal care if she made at least eight antenatal visits between the times of recruitment at ≤14 weeks to delivery at ≥38-39 weeks.[8] Thus, the antenatal care was categorized as regular (≥8 visits) or irregular (<8 visits) care. This frequency-based classification was in view of the traditional model of ANC currently practiced in the hospitals. It is different from the standard Focused ANC model, which emphasizes on "quality" rather than "frequency" of visits for uncomplicated pregnancies.

The social classification of the participants was as defined by Olusanya *et al*.,[15] which is based on education of the woman and her husband's occupation. Thus, high social class was defined as belonging to class I or II, while low social class was defined as belonging to class III, IV, or V. Data were analyzed using the Statistical Package for Social Sciences (SPSS) computer software version 17 for windows. The analyses were both descriptive and inferential at 95% confidence level. The continuous variables including age, height, and weight were analyzed using mean, standard deviation, Student's *t* test or analysis of variance (ANOVA). The results were presented in tables, graphs, and scatter diagrams showing the correlation between weight gain in various trimesters and birthweights. The categorical data including parity, social class, and others were analyzed using proportions and Pearson's chi-square test, and relationships expressed using odd ratios.

Results

A total of 223 eligible pregnant women were recruited for the study. However, 200 of the women concluded the study giving a completion rate of 89.7%. The mean age of the women was 30.5 ± 4.9 years. Majority of the women (110/200, 55.0%) were multiparous, had tertiary level of education (128/200, 64.0%), and belonged to low social class (103/200, 51.5%). Further details of the sociodemographic characteristics of the participants were as shown in Table 1.

Table 1: Participants' sociodemographic characteristics and other variables

Variable	Variable subgroup	Frequency	Percent
Age (years)			
	< 20	3	1.5
	20 – 24	16	8.0
	25 – 29	71	35.5
	30 – 34	70	35.0
	35 – 39	33	16.5
	40 and older	7	3.5
Educational Status (of the women)			
	Primary	9	4.5
	Secondary	63	31.5
	Tertiary	128	64.0
Social class			
	Class 1	52	26.0
	Class 2	45	22.5
	Class 3	51	25.5
	Class 4	47	23.5
Parity	Nullipara	82	41.0
	Multipara	118	59.0
Antenatal visits			
	Irregular	86	43.0
	Regular	114	57.0

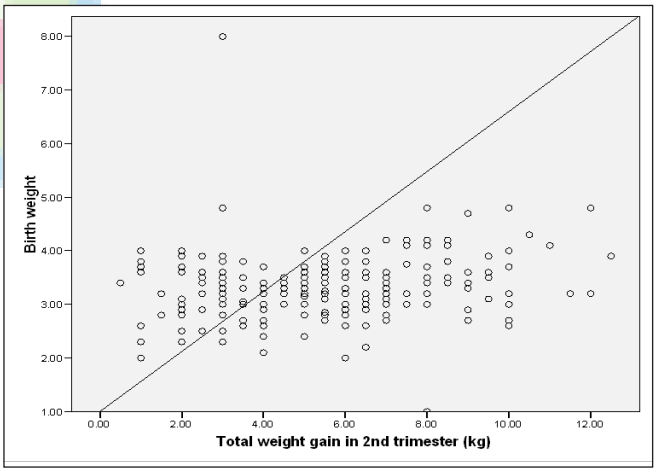

Figure 1: Scatter plot showing relationship between second trimester weight gain and birthweight

Regarding the pre-pregnancy BMI, 51.0% (102/200) of the women were of normal BMI, 28% (56/200) were obese, 17.5% (35/200) were overweight, and 3.5% (7/200) were underweight. In the second trimester, underweight women had the highest mean GWG (6.2 ± 2.0 kg) followed by women with normal weight (5.9 ± 2.6 kg) then overweight women (5.3 ± 2.9 kg), and lastly obese women (4.5 ± 2.4 kg). In the third trimester,

Table 2: Participants' GWG pattern for different BMIs in comparison with different trimesters of pregnancy

Weight gain (kg)	Underweight	Normal	Overweight	Obese	F value	P value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean± SD		
Second trimester	6.21 ± 2.01	5.88 ± 2.59	5.31 ± 2.91	4.54 ± 2.44	3.498	0.02
Third trimester	4.00 ± 1.44	5.62 ± 1.96	4.99 ± 2.62	5.00 ± 2.44	2.097	0.10
Total	10.21 ± 2.90	11.50 ± 2.82	10.30 ± 3.98	9.54 ± 3.65	4.592	< 0.01

BMI = Body mass index; SD = Standard deviation; F=ANOVA (Analysis of variance)

Table 3: Distribution of GWG in relation to neonatal birth weight

Total maternal weight-gain(kg)	Birth weight (kg)			Total
	Low-birth weight	Normal-birth weight	Macrosomia	
<10	7 (9.7%)	63 (87.5%)	2 (2.8%)	72 (36.0%)
10-15	3 (2.8%)	99 (92.5%)	5 (4.7%)	107 (53.5%)
>15	0 (0.0%)	13 (61.9%)	8 (38.1%)	21 (10.5%)
Total	10 (5.0%)	175 (87.5%)	15 (7.5%)	200 (100.0%)

Table 4: Association between normal GWG and certain maternal variables

Variable	Normal gestational weight gain		Odd ratio	95% CI	P value
	Yes (%)	No (%)			
Age (in years)					
< 35	92 (57.5)	68 (42.5)			
≥ 35	15 (37.5)	25 (62.5)	0.44	0.22-0.90	0.03
Social class					
High	60 (61.9)	37 (38.1)			
Low	47 (45.6)	56 (54.4)	0.52	0.29-0.91	0.02
Parity					
Nullipara	54 (65.9)	28(34.1)			
Multipara	53 (44.9)	65 (55.1)	0.42	0.23-0.76	< 0.01
Antenatal visits					
Regular	69 (60.5)	45 (39.5)			
Irregular	38(44.2)	48 (55.8)	0.52	0.30-0.91	0.02

CI = confidence interval.

Table 5: Association between normal birthweight and certain maternal variables

Variable	Normal birthweight		Odd ratio	95%CI	P value
	Yes (%)	No (%)			
Age (in years)					
< 35	146 (91.3)	14 (8.7)			
≥ 35	29 (72.5)	11 (27.5)	3.96	1.6-9.6	< 0.01
Social class					
High	87 (61.9)	10 (38.1)			
Low	88 (45.6)	15 (54.4)	1.48	0.6-3.5	0.37
Parity					
Nullipara	74 (87.8)	8 (12.2)			
Multipara	101 (87.3)	17 (12.7)	1.56	0.3-3.8	0.33
Antenatal visits					
Regular	105 (92.1)	9 (7.9)			
Irregular	70(81.4)	16 (18.6)	2.67	1.1-6.4	0.03

CI = confidence interval.

women with normal weight had the highest mean GWG followed by obese women then overweight women and lastly underweight women (5.62 ± 1.95 kg, 5.0 ± 2.44 kg, 4.98 ± 2.62 kg, and 4.0 ± 1.44 kg, respectively).

The mean total GWG was 10.7 ± 3.4 kg (range = 0.5-15.0). There was no significant difference in the mean GWG in second and third trimesters (5.36 ± 2.6 vs. 5.4 ± 2.4; t = 0.56; P = 0.57). The mean total GWG in the

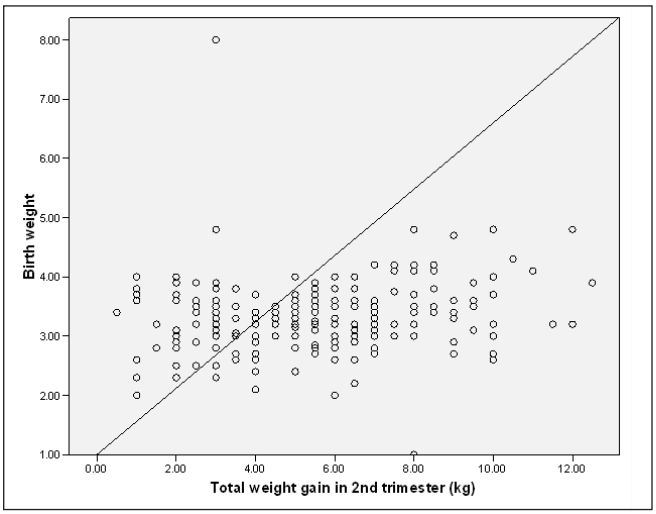

Figure 2: Scatter plot showing relationship between third trimester weight gain and birthweight.

underweight, normal weight, overweight, and obese were 10.2 ± 2.9 kg, 11.5 ± 2.8 kg, 10.3 ± 4.0 kg, and 9.5 ± 3.7 kg, respectively. The difference in mean GWG for the various classes of BMIs in the second trimester was significant ($F = 3.498$, $P = 0.02$). However, there was no significant difference in the mean GWG for the various classes of BMIs in the third trimester ($F = 2.097$, $P = 0.10$). Details were as shown in Table 2.

Concerning the effect of GWG in second and third trimesters on birthweight: there is a significant positive correlation between GWG in second trimester and birthweight ($r = 0.164$, $P = 0.02$) [Figure 1], but no significant correlation between GWG in third trimester and birthweight ($r = 0.125$, $P = 0.08$) [Figure 2]. Majority of the women (107/200, 53.5%) had adequate (normal) total GWG, 36.0% (72/200) had inadequate total GWG, while 10.5% (21/200) had excessive total GWG. Similarly, majority of the neonates (175/200, 87.5%) had normal birthweight, 5% (10/200) had LBW, while 7.5% (15/200) had macrosomia. The overall mean birthweight was 3.3 ± 0.6kg (range: 2.1-4.7). Excessive total GWG was associated with higher risk of macrosomia (8/21 (38.1%) vs. 7/179; RR: 9.74; 95 % CI: 3.9-24.2; $P < 0.001$) while inadequate total GWG was associated with higher risk of LBW [7/72 (9.7%) vs. 3/128 (2.3%; RR: 4.15; 95% CI: 1.1-15.4; $P = 0.03$]. The distribution of GWG in relation to birthweight was as shown in Table 3.

Maternal age of <35 years, high social class, nulliparity, and regular antenatal care were factors significantly associated with normal total GWG ($P < 0.05$). Details were as shown in Table 4. On the other hand, maternal age of <35 years, and regular antenatal care were significantly associated with normal birthweight ($P < 0.05$). Details were as shown in Table 5.

Discussion

GWG in Enugu, Nigeria depends largely on the pre-pregnancy BMI. It is reassuring that more than half of the women (53.5%) gained adequate weight in pregnancy, and most (87.5%) had babies with normal birthweight.

The data on GWG patterns from developing countries are scarce as a result of difficulties in obtaining population based samples and collecting data before and throughout pregnancy.[16] Thus, the BMI of most women in developing countries are rarely known prior to pregnancy necessitating the use of estimates (as used in this report) on the assumption that there is no significant increase in weight or BMI in the first trimester and before 14 weeks gestation.[9] Consequently, comparing the results of the present study with that from developed countries where pre-pregnancy BMIs were known with certainty or estimated much earlier in pregnancy,[9,16] was difficult due to considerable heterogeneity in the study design especially as regards the pre-pregnancy BMI.

The mean age of the women in this study was 30.5 ± 4.9 years which was higher than 24.0 ± 4.2 years obtained in a related study from India,[8] but comparable with mean age of 30.3 ± 4.9 years reported from Indonesia.[16] The mean total weight gain of 10.7 ± 3.4 kg was consistent with the report by Dawes and Grudzinskas.[7] However, lower mean weight gains have been recently reported by Fattah *et al*.[9] and Shrestha *et al*.[17] in 2010. The majority of the women (64.0%) had tertiary education, and almost half (48.5%) belonged to high social class, implying that the women involved in this study are educated and thus might have had adequate nutrition. This high educational level could also explain why the majority (57.0%) was regular with antenatal care, and had adequate GWG (53.5%). The peculiar distribution of the participants' characteristics especially educational level is difficult to explain, however, may be related to the current location of the hospital at the outskirts of Enugu city. "Thus, it is possible that the more educated are more likely to see the need for specialist care during pregnancy and hence seek for such services in a distant hospital like UNTH, Ituku/Ozalla, Enugu."[18]

This study also showed that second trimester weight gain (unlike third trimester weight gain) has significant association with birth weight of newborns, similar to reports from previous studies.[1,8,9,19,20]

In comparison with the IOM recommendation,[3] the mean GWG of 11.50 ± 2.82 by women with normal pre-pregnancy BMI is within the recommended limits

(11.5-6.0 kg) for the category. Similarly, the mean GWG by overweight women (10.30 ± 3.98) is within the limits (7-11.5 kg) recommended by the IOM. On the other hand, the mean GWG by underweight women (10.21 ± 2.90 kg) is below the recommended limits (12.5-18 kg) while that by obese women (9.54 ± 3.65 kg) is above the recommended limits (5.0-9.0 kg). These findings are in comparison with previous reports from developed countries where obese women were found to be more likely to exceed the recommended weight gain in pregnancy, and the underweight more likely not to gain up to the recommended weight.[16,21,22] The clinical effects of excessive weight gain and inadequate weight gain in pregnancy on fetal/neonatal health have been documented by previous authors.[3,22-24]

Besides pre-pregnancy BMI, the study found an association between GWG and certain maternal characteristics including maternal age, parity, social class, and antenatal visits, similar to previous reports.[7,8] The observed association between birthweight, maternal age, and frequency of antenatal visits has also been previously documented.[5,17]

The limitations of this study include the use of pre-pregnancy BMI as calculated with the weight and height obtained at recruitment, on the assumption that maternal weight remains unchanged in first trimester and before 14 weeks gestation, and that weight gain within this period has no relationship with birthweight.[9,10] The second trimester GWG was calculated as weight at the end of 27 weeks gestation minus weight at <14 weeks, which excluded the weight gain at 13th week in cases recruited at this gestation. The GWG in third trimester was based on weights obtained at 38-39 weeks gestation which may be lower when compared with weights at higher gestation (40-42 weeks) in cases where the pregnancy progressed beyond 38-39 weeks gestation. Most importantly, this study is hospital based and as such the result cannot be generalized to the entire population. Despite these limitations, this study is very relevant as it has commenced the process of filling the gap in the current pattern of weight gain in pregnancy and its association with birthweight in an African population.

In conclusion, excessive total GWG is associated with higher risk of macrosomia while inadequate total GWG is associated with higher risk of LBW. Mothers should be counseled that the most sensitive period of GWG for birthweight is in the second trimester. Interventions are needed to assist women, particularly those who are underweight or obese at the time of conception, in meeting their appropriate GWG. These interventions may need to include components related to improved dietary intake for the underweight and increased physical activity for the obese. Where feasible, women should be encouraged to complete child bearing at young age (≤34 years) as the incidence of inadequate GWG and abnormal birthweight are higher after 34 years of age; however, this advantage should be weighed against the possible negative effect of early childbearing on education and carrier pursuit.

Financial support and sponsorship

Nil

Conflicts of interest

There is no conflicts of interest.

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