

## Effect of maternal body mass index on gestational weight gain, pregnancy and perinatal outcomes

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### ABSTRACT

**Background:** In recent years, the prevalence of obesity has risen among pregnant women worldwide with a concomitant increase in the risk of maternal and fetal complications. **Aim:** This study aimed to determine the effect of maternal body mass index on gestational weight gain, pregnancy and perinatal outcomes. **Materials and Methods:** A prospective study was conducted among 281 pregnant women presenting consecutively at the Antenatal Clinic of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. Anthropometric measurement was done for the participants at booking (in addition to questionnaire administration); their weight was subsequently monitored periodically until two-weeks postpartum, while fetal assessment was done at delivery. Data were analyzed using IBM SPSS version 20 statistical computer software package. **Results:** Of the 263 participants that completed the study, 2.7, 32.2 and 28.5% were underweight, overweight and obese respectively at booking. The weight gain in pregnancy ranged from 5.0 to 19.0kg (mean =  $9.86 \pm 2.84$ kg). The mean weight gain increased progressively from  $2.74 \pm 1.81$ kg in the first trimester to  $3.79 \pm 1.62$ kg in the third trimester. Antepartum hemorrhage, preterm labour, prematurity and fresh stillbirth were more prevalent among underweight participants, while instrumental delivery, caesarean section, low birth weight babies and babies with congenital anomaly were more prevalent among overweight and obese participants. **Conclusion:** Abnormal BMI conditions with adverse maternal and fetal outcomes were very prevalent among the participants in this study. Antenatal care providers should consistently educate their clients on the importance of adequate nutrition and optimal weight gain in pregnancy.

**Keywords:** Maternal body mass index, gestational weight gain, pregnancy and perinatal outcomes

### INTRODUCTION

Obesity is one of the most prevalent health problems worldwide, a report by the World Health Organization (WHO) in 2005 indicated that nearly 1.6 billion people were overweight and at least 400 million people were obese worldwide. In recent years, the prevalence of obesity has risen among pregnant women in both developed and developing countries, mirroring the situation in the general population; and this has been attributed to the increased intake of energy-dense foods that are high in fat, and the increasingly sedentary lifestyle across the globe sequel to urbanization and industrialization.<sup>1-5</sup>

In the United States, the prevalence of obesity among pregnant women ranged from 18.5 to 38.3%, making it one of the most frequent high-risk obstetrics condition.<sup>6</sup> The Health Survey in England in 2004 revealed a steady rise in the prevalence of obesity in women from 16.4%

in 1993 to 23.8% in 2004.<sup>7</sup> Similar to the situation in many developing countries, studies conducted in the sub-Saharan African countries including Nigeria and Ghana majorly reported high prevalence of obesity among pregnant women.<sup>8,9</sup>

Maternal obesity is a growing health concern across the world as obese women have been found to have increased risk of several complications of pregnancy including hypertensive disorders, gestational diabetes, pre-and post-term deliveries, induction of labour, instrumental deliveries, and postpartum hemorrhage.<sup>10-13</sup>

In addition, obese women are more likely than normal weight-women to require caesarean sections, and they experience more complications from caesarean sections and other obstetric surgical procedures (particularly wound infection).<sup>6,10-13</sup>

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Another cause for concern is the concomitantly high risk of fetal complications in obese women including miscarriages, preterm birth, perinatal mortality, birth defects (especially neural tube defects), neonatal trauma, low Apgar scores, feeding difficulties and fetal macrosomia.<sup>6,14-17</sup>

As with maternal obesity, excess weight gain during pregnancy places both mother and child at increased risk of serious complications during pregnancy and after delivery.<sup>18</sup> Gestational weight gain recommendations are directly related to pre-pregnancy BMI. The Institute of Medicine and Health Canada suggests that the maximum weight gain for women who are obese should be 9 kg. The Society of Obstetricians and Gynecologists of Canada recommend that the optimal weight gain for obese women is 7kg. While controlling weight gain to 7 kg or less has been associated with reduced rates of macrosomia, pre-eclampsia, caesarean section and other adverse outcomes, the safety of weight loss and maintenance during pregnancy is yet to be determined.<sup>19,20</sup> However, it is believed that there is a critical need for effective personal and public health initiatives designed to decrease pre-pregnancy weight and optimize gestational weight gain.<sup>21,22</sup>

Many women are unaware of the risks of excess weight in pregnancy and appropriate weight gain for pregnancy. This may be exacerbated by the fact that a large number of women are not being weighed in early pregnancy, and that many women are not aware of their true body size, with the vast majority of overweight and obese women underestimating their body size. Although, a previous study in Sokoto, Nigeria (the study area) had established a strong positive correlation ( $r = 0.607$ ,  $p < 0.001$ ) between maternal BMI at booking and the birth weight of babies,<sup>23</sup> the prevalence of obesity among pregnant women, gestational weight gain and the effect of maternal BMI on pregnancy and perinatal outcomes have never been assessed; hence the need for this study. The findings of this study will help determine the disease burden and its impact on pregnancy and perinatal outcomes. It will also help in drawing up an appropriate management protocol for this group of patients.

## **MATERIALS AND METHODS**

### **Study Design, Population and Area**

A prospective study was conducted among pregnant women attending the Antenatal Clinic (ANC) of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria, from December 2015 to November 2016. All consenting pregnant women whose gestational age was  $\leq 13$  weeks, and without any co-morbidity were

considered eligible for enrollment into the study. Those with co-morbidities such as previous caesarean section, heart disease and diabetes mellitus were excluded.

### **Sample Size Estimation, Sampling Technique and Data Collection**

The sample size was statistically estimated at 281 and eligible participants were selected by convenient sampling as they present consecutively at the clinic until the desired sample size was obtained. The methods of data collection comprised personal interview and physical assessment. A semi-structured interviewer-administered questionnaire was used to obtain information on the research variables. The questionnaire and the other instrument for the study were pretested on 30 pregnant women attending the antenatal clinic after the training of the research assistants (nurses at the ANC and Gynaecological emergency clinics of the hospital) on the objectives of the study, selection of participants and use of survey instrument, in order to check the feasibility of use, and familiarize the research assistants with the instrument.

The booking weight and height of the participants were taken and recorded. Regular monitoring of maternal weight at each visit using the traditional method of ANC was done subsequently, and they were followed up till delivery and two weeks postpartum. Weight was measured with shoes off to the nearest 0.5kg using a Salter ultra slim black glass electronic scale; it was validated with a standard weight and corrected for zero error. The participants were weighed in light clothing; coats, jackets and shoes were removed. Handbags, pockets containing money or keys were emptied and any heavy jewelry removed. Height was measured without shoes to the nearest 0.5cm using a stadiometer.

Body mass index (BMI) was calculated as weight (kg) divided by height<sup>2</sup> (m<sup>2</sup>) and used as marker for abnormal BMI status.<sup>24</sup> Underweight was defined as BMI less than 18.5kg/m<sup>2</sup>, normal weight was defined as BMI of 18.5 to 24.9kg/m<sup>2</sup>, overweight was defined as BMI of 25.0 to 29.9kg/m<sup>2</sup>, while obesity was defined as BMI of 30.0kg/m<sup>2</sup> and above. The study participants' body mass index was computed at 38 weeks gestation, in labour (for those that came in first stage of labour), and at 2 weeks postpartum. Also, neonatal birth weight, APGAR scores and any anomaly noted were recorded.

### **Data Analysis**

Data were analyzed using IBM SPSS version 20 computer statistical software package. Quantitative variables were summarized using mean and standard

deviation, while qualitative variables were summarized using frequencies and percentages. Frequency distribution tables were constructed; and cross tabulations were done to examine the relationship between categorical variables. The chi-square test was used to compare differences between proportions. All levels of significance were set at  $p < 0.05$ .

### Ethical Consideration

Institutional ethical clearance was obtained from the Research and Ethical Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. Informed consent was also obtained from the participants before questionnaire administration.

## RESULTS

### Socio-demographic characteristics of participants

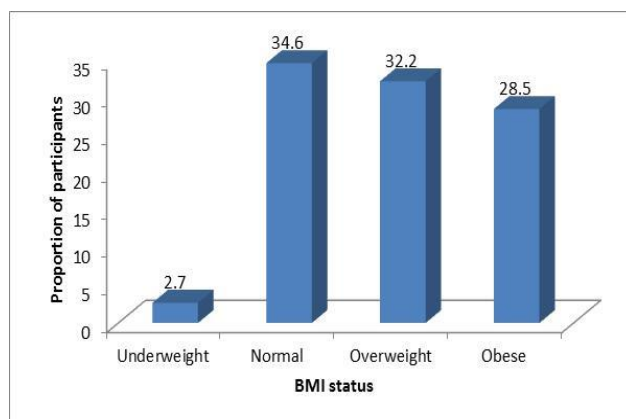
Two hundred and sixty-three (93.6%) of the 281 participants recruited into the study completed it; 8 (2.8%) had spontaneous miscarriages during the antenatal period, while 10 (3.6%) did not complete antenatal care with the institution and eventually had home deliveries. The ages of the participants ranged from 17-42 years (mean =  $26.84 \pm 5.35$  years), and majority of them (65.4%) were aged 21-30 years. Majority of participants belong to Hausa/Fulani ethnic group (73.0%), had at least secondary education (89.4%), were unemployed (63.0%), and were primigravidae (59.7%) as shown in Table 1.

**Table 1: Participants' socio-demographic characteristics**

Variables	Frequency (%) n = 263
Age group (years)	
16-20	31 (11.8)
21-25	92 (35.0)
26-30	80 (30.4)
31-35	42 (16.0)
≥36	18 (6.8)
Tribe	
Hausa/Fulani	196 (73.0)
Yoruba	18 (6.8)
Igbo	16 (6.1)
Others	37 (14.1)
Level of education	
No formal education	11 (4.2)
Primary	17 (6.5)
Secondary	93 (35.4)
Tertiary	142 (54.0)
Occupation	
Unemployed	166 (63.1)
Student	27 (10.3)
Civil servant	54 (20.5)
Business woman	16 (6.1)
Parity	
Primigravidae	157 (59.7)
Multigravidae	90 (34.2)
Grandmultipara	16 (6.1)

### Participants' BMI status at booking

A larger proportion, 91 (34.6%) of the 263 participants had normal weight, about a third 90 (32.2%) were overweight; while close to a third 75 (28.5%) were obese (Figure 1). Of the 75 obese participants, majority of them 48 (64.0%) had mild obesity, 17 (22.7%) had moderate obesity, while 10 (13.3%) had morbid obesity. Underweight was more prevalent among the primigravida (3.2%), overweight was more prevalent among the multigravida (37.8%), while obesity was more prevalent among the grandmultipara (43.75%). The differences in the distribution of the respondents' BMI status by their parity were significant ( $p < 0.05$ ) as shown in Table 2.



**Figure 1: Participants' BMI status at booking**

### Weight gain in pregnancy among participants

The weight gain in pregnancy among the participants ranged from 5.0 to 19.0kg (mean =  $9.86 \pm 2.84$ kg). The mean weight gain increased progressively from  $2.74 \pm 1.81$ kg in the first trimester to  $3.79 \pm 1.62$ kg in third trimester. Also, the mean weight gain in pregnancy was highest among participants with overweight ( $3.05 \pm 0.55$ kg) and least among participants with underweight ( $2.41 \pm 0.73$ ) as shown in Table 3.

**Table 3: Mean weight gain in pregnancy among participants**

Variables	Mean $\pm$ SD
Trimester	
First	$2.74 \pm 1.81$
Second	$3.14 \pm 1.32$
Third	$3.79 \pm 1.62$
Maternal BMI status	
Underweight	$2.41 \pm 0.73$
Normal	$3.02 \pm 0.54$
Overweight	$3.05 \pm 0.55$
Obese	$2.99 \pm 0.76$

**Effects of maternal BMI on pregnancy and fetal outcomes**

Whereas, all the underweight participants (100%) and most of the participants with normal weight (85.7%) had normal vaginal delivery, most of the overweight participants (96.7%) had instrumental delivery, while caesarean section was more prevalent among obese participants (22.7%). A higher proportion of underweight participants had antepartum hemorrhage (42.9%) and preterm labour (14.3%) as compared to the participants in the other groups.

A higher proportion of underweight participants had prematurity (66.7%) and fresh stillbirth (33.3%) as compared to the participants in the other groups. Also, a higher proportion of obese participants had low birth weight babies (31.9%) and babies with congenital anomaly (10.6%) as compared to the participants in the other groups. However, the differences in the prevalence of maternal and fetal outcome among the respective BMI groups were not significant ( $p < 0.05$ ) as shown in Table 4.

**Table 2: Distribution of respondents' BMI status by parity**

BMI status	Parity			Test significance of
	Primigravida (n = 157) Frequency (%)	Multigravida (n = 90) Frequency (%)	Grandmultipara (n = 16) Frequency (%)	
Underweight	5 (3.2)*	2 (2.2)	0 (0)	$\chi^2 = 14.586,$ $p = 0.024$
Normal	66 (42.0)	20 (22.2)	5 (31.25)	
Overweight	52 (33.1)	34 (37.8)*	4 (25.0)	
Obese	34 (21.7)	34 (37.8)	7 (43.75)*	

\*Statistically significant

**Table 4: Effect of maternal BMI on pregnancy and fetal outcomes**

Variables	Maternal BMI				Test significance of
	Underweight (n = 7) Frequency (%)	Normal (n = 91) Frequency (%)	Overweight (n = 90) Frequency (%)	Obese (n = 75) Frequency (%)	
Maternal complications					
None (normal)	3 (42.9)	71 (78.0)	70 (77.8)	55 (73.3)	$\chi^2 = 11.870,$ $p = 0.065$
Ante-partum haemorrhage	3 (42.9)	18 (19.8)	10 (11.1)	14 (18.7)	
Preterm labour	1 (14.3)	2 (2.2)	10 (11.1)	6 (8.0)	
Mode of delivery					
Vaginal delivery	7 (100)	78 (85.7)	2 (2.2)	58 (77.3)	$\chi^2 = 9.237,$ $p = 0.161$
Instrumental delivery	0 (0)	1 (1.1)	87 (96.7)	0 (0)	
Caesarean section	0 (0)	12 (13.2)	1 (1.1)	17 (22.7)	
Fetal outcome	(n = 6)		(n = 89)	(n = 47)	
Low birth weight	0 (0)	18 (19.8)	20 (22.5)	15 (31.9)	$\chi^2 = 23.858,$ $p = 0.160$
Prematurity	4 (66.7)	59 (64.8)	57 (64.0)	14 (29.8)	
Congenital anomaly	0 (0)	5 (5.5)	6 (6.7)	5 (10.6)	
Birth asphyxia	0 (0)	0 (0)	1 (1.1)	2 (4.2)	
Fresh stillbirth	2 (33.3)	8 (8.8)	5 (5.6)	10 (21.3)	
Perinatal death	0 (0)	1 (1.1)	0 (0)	1 (2.1)	

**DISCUSSION**

This study assessed the effect of maternal body mass index on gestational weight gain, pregnancy and perinatal outcomes. The relatively young population of participants in this study with a mean age of  $26.84 \pm 5.35$  years could be due to the fact that the study was conducted among women of reproductive age group; and the preponderance of Hausa/Fulani ethnic group among them essentially reflects the population distribution in the study area.

The 28.5% prevalence of obesity among the participants in this study is quite high, and it is by far higher than the findings in studies conducted in many developed countries including United Kingdom (10.9%),<sup>18</sup> and Australia (11.0%).<sup>21</sup> Although, whereas studies conducted in developing Asian countries including Iran, generally reported lower BMI as compared to developed countries, a study conducted among pregnant women in Saudi Arabia<sup>25</sup> reported > 52% prevalence of

overweight, obesity and extreme obesity. The wide variations in the prevalence of obesity among pregnant women across the globe could be due to variations in dietary habits and lifestyle, and these are also influenced by socioeconomic and cultural factors.

The findings of significantly higher prevalence of underweight among the primigravida, overweight among the multigravida, and obesity among the grandmultipara in this study are in agreement with the findings in other studies; and it has been found that multiparous and grandmultiparae gain more weight with each successive pregnancy, and common medical disorders in pregnancy that can cause poor appetite are commoner in primigravidae. Also, in addition to the tendency to gain weight with each pregnancy, parous women tend to retain more of the weight gained during pregnancy.<sup>26,27</sup>

Whereas, there was no uniform pattern in weight gain with respect to the participants' BMI status at booking, the mean weight gain increased progressively from  $2.74 \pm 1.81\text{kg}$  in the first semester to  $3.79 \pm 1.62\text{kg}$  in the third trimester among the participants in this study, and it could be due to the increasingly sedentary lifestyle often indulged in by pregnant women as pregnancy advances. Although, the weight gain among the participants in this study (ranging from 5 to 19kg, and with a mean weight gain of  $9.86 \pm 2.84\text{kg}$ ) is less than the  $11.79 \pm 5.31\text{kg}$  average weight gain reported in a study by Bautista-Castano *et al.*,<sup>27</sup> it is clearly above the 7kg optimal weight gain in pregnancy recommended by the Society of Obstetricians and Gynecologist of Canada, and slightly higher than the 9kg maximum weight gain recommended for obese women by the Institute of Medicine and Health, Canada.<sup>19,20</sup>

These findings confirm the relevance of regular weight monitoring in pregnancy, particularly in the developing countries, and they underscore the need for healthcare providers to provide pregnant women with comprehensive information regarding appropriate weight gain during pregnancy.<sup>2,28,29</sup> However, while controlling weight gain to 7kg or less, (including weight loss and no weight gain), has been associated with reduced rates of macrosomia, pre-eclampsia, caesarean section and other adverse outcomes, the safety of weight loss and maintenance during pregnancy is yet to be determined.<sup>19,20</sup>

The finding of higher prevalence of adverse maternal and fetal outcomes including antepartum hemorrhage, preterm labour, prematurity and fresh stillbirth among the underweight participants as compared to those in the

other groups in this study could be related to the increased demand for macro and micro nutrients during pregnancy; and it highlights the importance of adequate nutrition during pregnancy. Health care providers are expected to consistently encourage pregnant women to eat a variety of healthy foods necessary to ensure that they receive adequate amounts of vitamins and minerals necessary for a healthy pregnancy; and with emphasis on taking prenatal vitamins and other specific nutrients required for maintaining a healthy pregnancy including adequate levels of folic acid, iron, and calcium.<sup>2,28,29</sup>

The finding of higher prevalence of adverse maternal outcomes among participants with obesity as compared to those in the other groups in this study is in consonance with the findings in previous studies across the globe that majorly reported higher risk of poor maternal and fetal outcomes among obese women as compared to normal-weight women.<sup>6,10,11,13,14-17</sup> These findings bring to the fore the importance of healthy dietary habit and regular physical activity during pregnancy. It has been recommended that health care providers should encourage healthy pregnant women to remain active during pregnancy, and it is believed that women who exercise regularly before pregnancy will be able to maintain much of their exercise regimen with certain modifications to ensure safety during pregnancy.<sup>28</sup>

Also, pre-conception care is considered to be very important, and it is believed that obese women may benefit from pre-pregnancy counseling regarding specific problems associated with obesity in pregnancy and advised to aim for a moderate weight loss prior to conception. Although, few data exist on the effects of pre-pregnancy weight loss on maternal and fetal outcomes, epidemiological studies have indicated that even a modest reduction of 10 pounds can reduce the risk of gestational diabetes and caesarean section among obese women.<sup>30,31</sup>

It is therefore imperative for health care providers to promote healthy eating, regular physical activity, and achievement of optimal gestational weight gain among pregnant women. It has been recommended that the pre-pregnancy BMI and booking BMI should be recorded at the first visit in the first trimester, followed by regular monitoring of gestational weight gain throughout the pregnancy.<sup>7,28</sup>

Also, the woman should be counseled regarding the implications of obesity on the course of pregnancy and its outcome, and the proposed care plan to address these

implications; and the discussion should be clearly documented. It is believed that she is likely to benefit from consistent support and advice regarding preventing excess weight gain (supported by written information); and regular visits to the dietician, incorporating dietary and healthy lifestyle advice including exercise may also be beneficial.<sup>7,32</sup>

## CONCLUSION

Abnormal BMI conditions including underweight, overweight and obesity were very prevalent among the participants in this study, and with adverse maternal and fetal outcomes being more common among those with the conditions. These findings underscore the need for antenatal care providers to consistently educate their clients on the importance of adequate nutrition and optimal weight gain in pregnancy.

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## Source of support

Nil.

## Conflict of interest

None declared.

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