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Association of maternal weight gain with offspring birth size

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Abstract

Gestational weight gain (GWG) is influenced by numerous causes in prenatal health which are of great public health concerns. GWG during the 2nd and 3rd trimesters is an essential determinant of fetal development. However, this study was aimed to scrutinize the association between GWG and birth size of baby. In this regard, birth weight of the offspring was considered as the determinant of birth size. This was a cross sectional observational study, was carried out among 100 pregnant women admitted in the Department of Obstetrics and Gynecology, Rangpur Medical College and Hospital, Rangpur, Bangladesh and during the period of June 2017 to June 2018. All of the data were collected using a pre-designed data collection sheet. According to the result of age distribution, maximum (36%) were of age group 21-25 years followed by 28% were of 20 years, 24% were of 26-30 years, 8% were of 31-35 years and only 4% were of 36-40 years. The average age was 25.5 years. Among the pregnant women, in case of maternal BMI, it was observed that only 12% were underweight who have <18.5 kg/m² BMI, 30% were normal weight (18.5-23 kg/m² BMI), and 58% were overweight/obese (≥23 kg/m² BMI). The mean GWG was 10.02 ± 2.87 kg, and the mean birth weight was 2.87 ± 0.37 kg. However, increased GWG there was a corresponding significant ($P < 0.05$) increase in the mean birth weight. Finally, this study concluded that maternal GWG significantly increased birth size of the offspring.

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Introduction

Birth weight is an important indicator for health and survival (Viswanathan *et al.*, 2008). Infants with a low birth weight (less than 2,500 g or more than 4000 g) are usually in augmented prenatal morbidity and mortality as well as live with increased risk of adulthood hypertension and type 2 diabetes (Rode *et al.*, 2007). For decades, the focusing point is increasing birth weight which is positively connected with maternal weight gain during the pregnancy period. However, although a high maternal GWG tend to reduce the frequency of low birth weight, an excessive GWG may become fetal as well as maternal complications, such as pregnancy and delivery complications and obesity in future life (Ludwig and Currie, 2010). GWG during pregnancy has been associated with high birth weight and measures of adiposity early in life. High birth weight might also increase risk of other diseases later in life, including asthma, atopy, and cancer (Ludwig and Currie, 2010). Prepregnancy body mass index (BMI) is also an important indicator of birth weight. The American Institute of Medicine (IOM) introduced weight gain recommendations for pregnant women with different recommendations for underweight (BMI less than 19.8 kg/m^2), normal weight (19.8 - 26.0 kg/m^2), overweight (26.1-29.0 kg/m^2), and obese women (BMI more than 29.0 kg/m^2) (Rode *et al.*, 2007). Because high birth weight predicts BMI in later life, excessive GWG during pregnancy could raise the long-term risk of obesity-related disease in offspring. Inadequate GWG during pregnancy is linked with greater risk of preterm delivery, particularly if women are underweight or of average weight before pregnancy. But, the controversy is higher GWG during pregnancy does not improve infant outcomes and instead may increase risk of chronic disease in mother (Karim *et al.*, 2011). It was reported that mean birth weight of infant increased by 20.2 g/kg of GWG (Nahar *et al.*, 2007). Another study reported that the mean birth weight of the infant increased by 22.6 g/kg GWG (Lederman *et al.*, 1999).

Birth weight is linked both with GWG in early pregnancy and with GWG during pregnancy, but only 10% of the variation in birth weight has been explained by these maternal factors. Women with a positive net weight gain may give birth heavier babies than women with a negative net GWG. Maternal anthropometric features also are important fundamental indicators of intrauterine growth and birth weight (Möller *et al.*, 1989).

Birth weight (BW) is an important determinant of infant's well being. Several factors such as genetic trait of mother, socio-cultural, demographic, behavioral factors, prepregnancy BMI, GWG etc. contribute to birth weight. Low birth weight is linked to increased risk of diseases like type-2 diabetes and ischemic heart disease later in adult phase (Padilha *et al.*, 2009).

On the other hand, GWG is linked with large infants i.e., macrosomia (>4000 g) which is a major fetal complication, consisting of cases of infants born weighing more than 4,000 g, regardless of the gestational age (Costa *et al.*, 2012). This large weight is linked with complications for both the mother and the child. The most frequent complications in macrosomic fetuses are augmented risk of intrauterine death, hypertrophic cardiomyopathy, need for intensive care, shoulder dystocia, humeral and clavicle fractures, meconium aspiration, hypoglycemia, neonatal hyperbilirubinemia, paralysis of the facial and brachial plexus and obesity in childhood and adulthood. In mothers, the most frequent complications are amplified risk of cesarean section, cephalopelvic disproportion, prolonged labor, soft-tissue lacerations and postpartum hemorrhage (Stotland *et al.*, 2006).

Taking the above information in consideration, this study was designed to investigate the correlation between the GWG and offspring birth size.

Materials and methods

Study population and design

This experiment is a cross sectional observational study which was carried out on 100 pregnant women who were admitted in the Department of Obstetrics

and Gynaecology, Rangpur Medical College and Hospital, Rangpur, Bangladesh and during the period of June 2017 to June 2018.

Pregnant women who were in regular antenatal checkup having 37 completed weeks of gestational age were included in this study. The pregnant women suffering from hypertension, pre-eclampsia, eclampsia, diabetes mellitus, thyroid dysfunction, nephritis were excluded from this study. Data were gathered using a pre-designed data collection sheet. Consent was taken from each participant by explaining the purpose of data collection.

Exposure: gestational weight gain (GWG)

The total GWG was defined as the difference between self-reported pre-pregnancy weight and last recorded weight before delivery. Mother's weight was measured by using a valid and reliable weighing machine.

Outcome: child anthropometry

Weight of the newborn during birth was extracted from register book stored in hospital.

Assessment of covariates

Mother's pre-pregnancy BMI was measured by dividing self-reported pre-pregnancy weight in kilograms by the square of measured height in meters. Pre-pregnancy BMI were categorized as underweight (BMI <18.5 kg/m²), normal-weight (18.5 kg/m² ≤ BMI < 23 kg/m²) or overweight/obese (BMI ≥23 kg/m²) according to WHO record determined for Asian population. Overweight and obese mothers were combined into a single group because of limited sample. Data on maternal age, education, and household income were collected using interviewer-administered questionnaires.

Statistical analysis

Chi-square test was used to describe association between GWG during pregnancy and offspring birth size.

Results

Maternal age

According to the result of age distribution, maximum (36%) were of age group 21-25 years followed by 28% were of 20 years, 24% were of 26-30 years, 8% were of 31-35 years and only 4% were of 36-40 years (Figure 1). The average age was 25.5 years.

Educational attainment

In case of maternal education level (Figure 2), it was found that the maximum participants (38%) were of college level. And the minimum participants (12%) were of graduate or above.

However, 31% mothers were educated upto primary level and 19 % were of high school level.

Table 1. Association between BMI and birth weight.

BMI	Frequency	Birth weight (Mean ± SD)	P value
Underweight (<18.5 kg/m²)	12	2.21 ± 0.19	
Normal-weight (18.5 – 23 kg/m²)	30	2.58 ± 0.32	0.0013
Overweight/obese (≥23 kg/m²)	58	2.93 ± 0.37	

Household income

Household income ranging from 1,20,000-3,00,000 taka/year was observed in maximum (32%) participants (Figure 3). The minimum number (18%) of the participants belongs to ≤1,20,000 taka/year household income. Second largest household income (3,00,000-6,00,000 taka/year) was of 23% while 27% participants were from family having income >6,00,000 taka/year.

Maternal BMI

In case of maternal BMI (Figure 4), it was observed that only 12% were underweight who have <18.5 kg/m² BMI, 30% were normal weight (18.5-23 kg/m² BMI), and 58% were overweight/obese (≥23 kg/m² BMI).

GWG during pregnancy

Regarding GWG during pregnancy, it was found that only 8% of women GWG during pregnancy was within 5 kg, 62% women GWG was 6-10 kg, and 32% women GWG was >10 kg (Figure 5). The mean weight gain was 10.02 ± 2.87 kg.

Birth weight of new born

Result regarding birth weight of new born babies (Figure 6) shows that 26% of the new born babies had birth weight ≤2.5 kg and 74% had birth weight >2.5 kg. The mean birth weight was 2.87 ± 0.37 kg.

Association between BMI and birth weight

Result regarding association between BMI and birth weight showed (Table 1) that mothers with lower than normal weight had considerably lower birth weight while overweight/obese mother had notably higher birth weight.

Therefore, this finding suggests a significant ($P < 0.05$) association between BMI and birth weight.

Table 2. Association between GWG and birth weight.

GWG (Kg)	Frequency	Birth weight (Mean ± SD)	P value
≤ 5	8	2.37 ± 0.17	
6-10	62	2.71 ± 0.32	0.0064
≥10	30	3.1 ± 0.21	

Association between GWG and birth weight

Result regarding relationship between GWG and birth weight of new born showed (Table 2) that 2.37 kg birth weight was resulted due to maternal GWG 5 kg, 2.71 kg birth weight was found due to maternal GWG 6-10 kg, 3.1 kg birth weight was an outcome due to GWG >10 kg. Hence, it was indicated that with an increase in GWG during pregnancy there was a corresponding significant ($P < 0.05$) increase in mean birth weight of the new born babies.

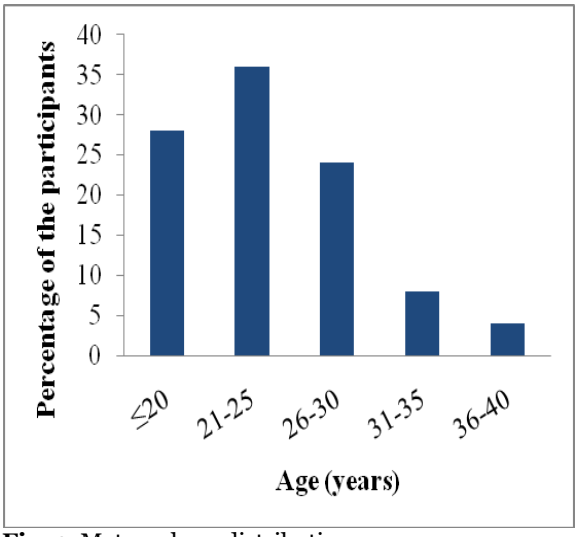

Fig. 1. Maternal age distribution.

Discussion

Maternal GWG during pregnancy is predisposed by numerous factors in prenatal health which are of immense public health concerns. However, mothers are progressively gaining weight during pregnancy and complications linked with excess GWG including large sized babies.

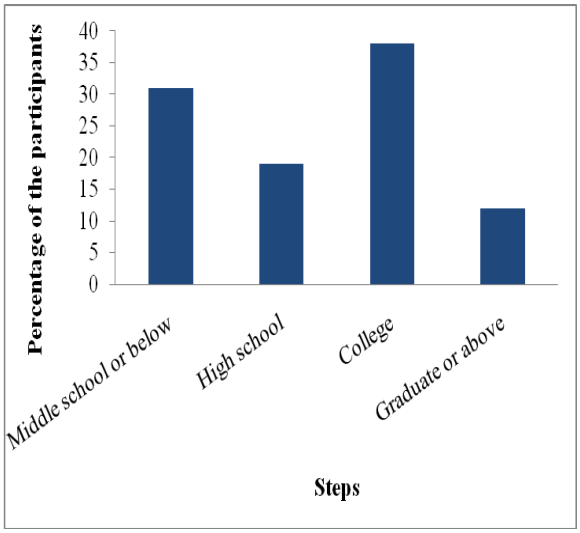

Fig. 2. Maternal educational attainment level.

This is an important cause of increased occurrence of cesarean delivery. GWG during the 2nd and 3rd trimesters is an essential indicator of fetal growth. Inadequate GWG is associated with an increased risk of small sized infants, especially in normal-weight and below normal-weight women (Misra *et al.*, 2010; Rijvi *et al.*, 2018). Weight of new born babies is possibly the most significant and trustworthy determinant for the survival of the new born babies,

its physical and mental development as well. As an universal determinant, it is usually being utilized to explain the health, nutrition and socio-economic condition of population in both developed and developing countries.

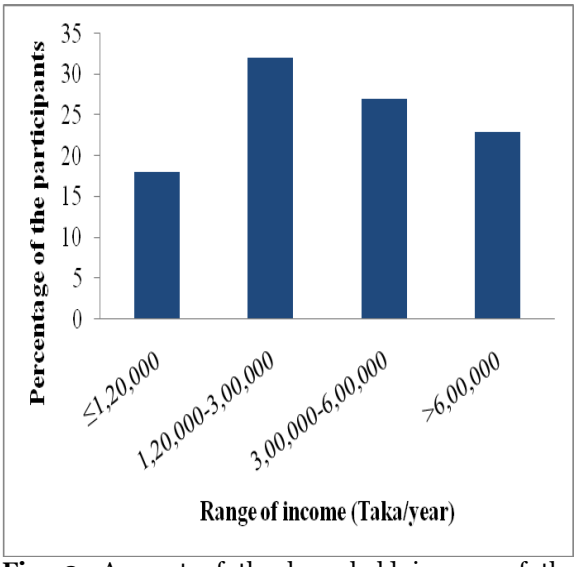

Fig. 3. Amount of the household income of the participants.

However, in this study, we found that maximum (36%) mother were of age group 21-25 years followed by 28% were of 20 years, 24% were of 26-30 years, 8% were of 31-35 years and only 4% were of 36-40 years. The average age was of pregnant women was 25.5 years. This finding is consisted almost with a study (Rijvi *et al.*, 2018) on Bengali population which found average age 25 years. In case of educational status, it was observed that almost 90% of the study subjects studied upto primary/high school/college level and rest of them were graduate/above. In yearly income, 18% were from ≤1,20,000 taka income group, 32% belonged in 1,20,000-3,00,000 taka income group, 27% were from 3,00,000-6,00,000 taka income group, and the rest were from >6,00,000 taka income group. In case of BMI among 100 women, it was observed that only 12% were underweight who have <18.5 kg/m² BMI, 30% were normal weight (18.5-23 kg/m² BMI), and 58% were overweight/obese (≥23 kg/m² BMI). These women were categorized in BMI underweight, normal, and overweight/obese. While, Rijvi *et al.* (Rijvi *et al.*, 2018) showed that among 50 pregnant women, 4% had BMI 18.5 kg/m², 30% had a BMI 18.5-24.9 kg/m², 66% had a BMI >25 kg/m².

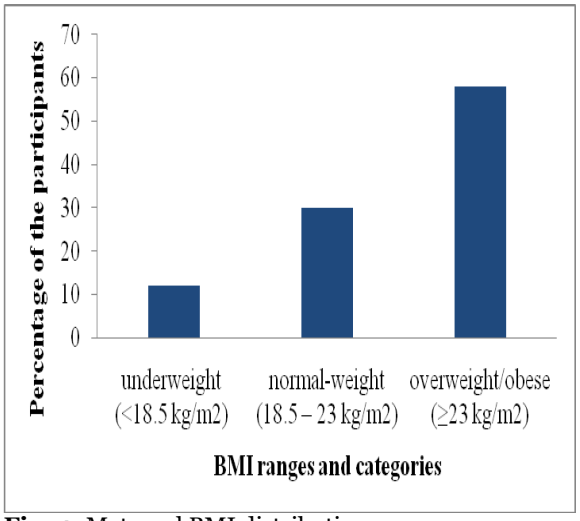

Fig. 4. Maternal BMI distribution.

Regarding GWG during pregnancy, it was found that only 8% of women GWG during pregnancy was within 5 kg, 62% women GWG was 6-10 kg, and 32% women GWG was >10 kg (Figure 5). The mean weight gain was 10.02 ± 2.87 kg. This finding is also analogous with previous studies (Rao *et al.*, 2001; Rijvi *et al.*, 2018).

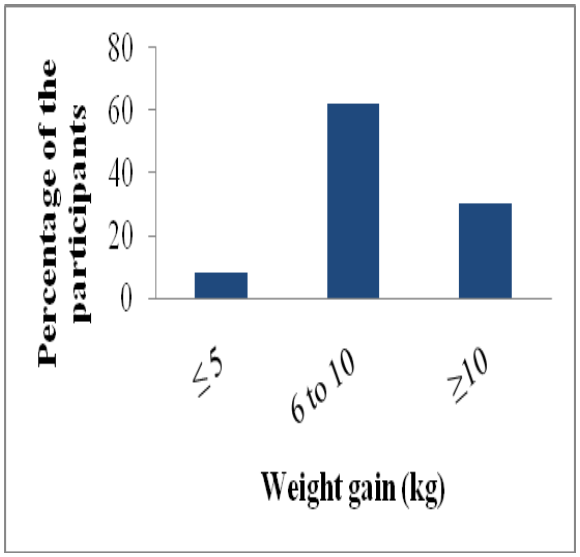

Fig. 5. GWG of the participants during pregnancy.

The mean GWG during pregnancy obtained in this study was also analogous to other study carried out in India (Viswanathan *et al.*, 2008). However, a study (Stevens-Simon and McAnarney, 1992) showed mean weight gains during pregnancy of 15.4 kg (SD=5.2 kg) which was higher than the findings of our study. Result regarding birth weight of new born babies (Figure 6) shows that 26% of the new born babies had

birth weight ≤2.5 kg and 74% had birth weight >2.5 kg. The mean birth weight was 2.87 ± 0.37 kg. The experiential mean birth weight in the present study is comparable to studies conducted by Prasad *et al.* (Prasad *et al.*, 1994), Rijvi *et al.* (Rijvi *et al.*, 2018) and Rodrigues *et al.* (Barros *et al.*, 2017) who observed a mean birth weight of 2823.6 gm, 2770 gm and 2815.0 gm respectively. Therefore, we found a noteworthy correlation between maternal GWG and fetal birth weight. It indicated that with an increase in maternal GWG during pregnancy there was a corresponding significant ($P < 0.05$) increase in mean birth weight leading to the larger size babies as an outcome. These findings consisted with previous studies (Misra *et al.*, 2010; Rijvi *et al.*, 2018) and they found significant correlation between maternal GWG during pregnancy and birth size of the new born.

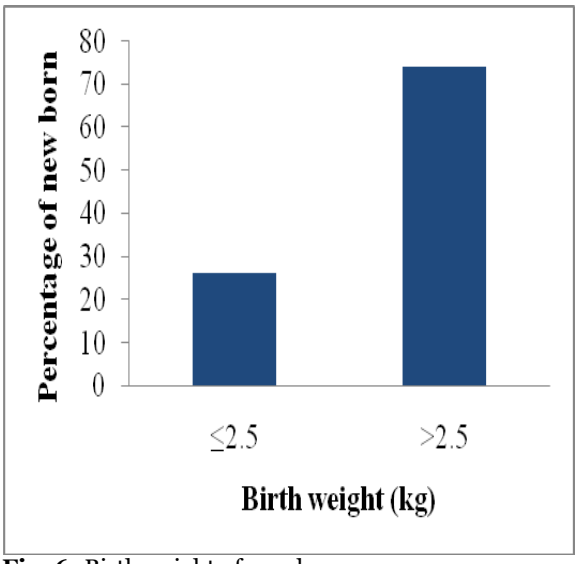

Fig. 6. Birth weight of new born.

A study (Blomberg, 2011) stated that maternal GWG during gestation is positively correlated with birth size. A population-based study performed in the United States showed that maternal GWG during pregnancy correlates with birth weight (Potti *et al.*, 2010). Many studies conducted in India (Rao *et al.*, 2001) and in dissimilar parts of the world (Yazdani *et al.*, 2012) have showed the positive connection between GWG and weight of new born babies. We also found noteworthy association of BMI during pregnancy and birth weight of the new born. It was found that BMI below normal is associated with low birth weight and BMI >30 kg/m² higher birth weight. The latter finding is consistent with other experiments (Prasad and Rao, 1994; Yazdani *et al.*, 2012) which have reported that BMI below normal is associated with a low birth weight, while a BMI >30 kg/m² increases the chance on a higher birth weight (2500-4000 or higher).

Therefore, this only suggests that GWG during pregnancy is maybe the most imperative variable irrespective of maternal height and period of gestation leading to larger birth size.

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Conflict of Interest

The authors have no conflict of interest.

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