Correlation Between Maternal Weight gain and Birth Weight Among term Babies

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Abstract

Introduction: Healthy and well-nourished mother is likely to give birth to a healthy normal child with adequate birth weight. We aimed to determine the correlation of gestational weight gain and newborn’s birth weight.

Methods: We studied participant-level data for 295 pregnant women coming for delivery services between January 2018 and December 2020 at Shree Birendra Hospital, Chhauni, Kathmandu, Nepal. A retrospective data of pre-pregnancy body mass index, maternal weight gain during different trimesters of pregnancy were collected. The prevalence of small and large for gestational babies were compared with mother’s weight gain according to Institute of Medicine (IOM) guidelines. Pearson test was used to assess the correlation between gross maternal weight gain during pregnancy and birth weight.

Results: Among 295 women, 12.2% underweight, 55.6% normal weight, 26.1% overweight and 6.1% were obese. The overall mean gestational weight gain (GWG) was 11.78 kg. Birth weight of the babies ranged from 1500 gm to 5100 gm with mean weight of 3148 gm. Majority of small for gestational age and large for gestational babies were seen among women below and above IOM guidelines respectively.

Conclusions: Findings from this study suggest that maternal weight gain during pregnancy increases the birth weight. Across all BMI categories, insufficient GWG is associated with slightly increased risk of SGA, while relative risk of LGA is higher in excess GWG group.

Introduction

Babies with birth weight less than 10th percentile for their gestational age are designated as Small for Gestational Age (SGA). In contrast, Intrauterine Growth Retardation (IUGR) is a prenatal diagnosis to describe fetus who fails to reach in-utero growth potential. Healthy and well-nourished mother is likely to give birth to a healthy child with adequate birth weight. Maternal weight gain and fetal growth vary greatly throughout pregnancy. There is rapid increase in fetal growth during the last trimester.

Poor maternal nutritional status leads to many complications like anemia, hypoalbuminemia, vitamins and minerals deficiency in mothers as well as IUGR, premature birth, congenital malformations such as neural tube defects in babies. High maternal weight gain tend to decrease incidence of SGA, whereas excessive weight gain may precipitate fetal
as well as maternal complications like metabolic disorders such as gestational diabetes mellitus (GDM) and obesity due to excessive weight gain. Furthermore, excessive, and insufficient gestational weight gain are associated with adverse pregnancy outcomes including SGA, macrosomia, cesarean delivery, GDM, preeclampsia, postpartum weight retention, and offspring obesity. Intrauterine malnutrition has more serious and far reaching consequences that affect tissue structure and function permanently. These concerns make the fetal period a critical window of opportunity for nutrition intervention and improving birth weight will help break the vicious intergenerational cycle of malnutrition.

In 2009, Institute of Medicine (IOM), the National Academy of Medicine (NAM) in United States published a weight gain guideline for singleton pregnancy based on pre-pregnancy BMI classes. (Table 1) These guidelines are directed in primarily minimizing the adverse consequences. However, most of the previous studies were conducted in developed countries, and information regarding the effect of pregnancy weight gain are lacking from developing countries. We aimed to determine the correlation of gestational weight gain and newborn’s birth weight in our region.

### Methods

This is a cohort study, commenced from Jan 2018 and Dec 2020, in Shree Birendra Hospital after getting ethical clearance from the Institutional review Committee of our institute. Shree Birendra Hospital, Chhauni, Kathmandu, Nepal, is a tertiary care hospital that caters military and beneficiaries of Nepalese Army. We included 295 women over 18 years, with singleton full term pregnancies (delivering after 37 weeks of gestation). The mothers having high risk pregnancies, any underlying systemic disorders such as hypertension, diabetes mellitus, anemia or complications of pregnancy were excluded from the study. Infants were excluded if they were preterm, multiple gestation, neural tube defects, chromosomal anomalies, or other severe congenital disease.

Maternal demographic characteristics, anthropometric measurements, age, pre-pregnancy age, total pregnancy weight gain and birth weight were recorded for analysis. The maternal height and weight (light clothing) were measured to the nearest 0.5 cm or 0.1 kg respectively and taken with the same instruments that were calibrated in regular intervals for the whole population at each visit. The body mass index (BMI) was calculated as BMI = weight (kg) / height (m$^2$). Self-reported pre-gestational weight in kilograms (kg) was used.

Total pregnancy weight gain was defined as the difference between the final recorded maternal weight at the time of delivery and the maternal pre-pregnancy weight recorded at the first prenatal visit in antenatal clinic. The first visit was no later than the first month of pregnancy. Measurements in the hospital were taken using a KRUPS Digital BO12 weighing scale and stadiometer (Bio + plus). BMI and recommended gestational weight gain was classified according to IOM guidelines (Table 1).

![Table 1: Gestational weight gain recommendation of IOM](image)

<table>
<thead>
<tr>
<th>Category</th>
<th>BMI</th>
<th>Recommended total gestational weight gain(kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5 Kg/m$^2$</td>
<td>12.5 - 18</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5 – 24.9 Kg/m$^2$</td>
<td>11.5 – 16</td>
</tr>
<tr>
<td>Overweight</td>
<td>25 – 29.9 Kg/m$^2$</td>
<td>7 – 11.5</td>
</tr>
<tr>
<td>Obese</td>
<td>≥ 30 Kg/m$^2$</td>
<td>5 - 9</td>
</tr>
</tbody>
</table>

Newborn infants were weighed unclothed immediately after delivery using a Rossmax WE300 digital baby weighing scale. Neonates were classified as small, normal or large for gestational age in accordance with specific centiles for the Asian population as recommended by Clauson et al. Small if the birth weight was below 10th percentile; normal if it was between 10th and 90th percentiles and large if it was above 90th percentile. Small and large for gestational age (LGA) were defined as a weight at birth of < 2500 gm and > 4000 gm respectively.

The mean was calculated by the following formula:

$\text{Mean} = \frac{\sum X}{N}$

And Standard Deviation is calculated with the formula

$\text{S.D} = \sqrt{\frac{\sum (X-\mu)^2}{N}}$

Similarly, the correlation calculated by following formula

$r = \frac{\sum N \sum X \sum Y - \sum X \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} \times \sqrt{N \sum Y^2 - (\sum Y)^2}}$

### Results

A total of 295 women met the inclusion criteria. The age of the subjects ranged from 20 to 45 years old with mean age of 27.74 years, mean height and weight at the initial conception was 158 cm and 57.9 kg, respectively. Each maternal BMI category was examined for the association between gestational weight gain and the probability of delivering an infant too small or too large for gestational age.
Maternal weight gain and birth weight among term babies

Table 2: Correlation between maternal BMI and birth weight

<table>
<thead>
<tr>
<th>BMI</th>
<th>Pearson Correlation</th>
<th>Birth weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>1</td>
<td>.151</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.009</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>295</td>
<td>295</td>
</tr>
</tbody>
</table>

Birth weight

- Pearson Correlation: .151
- Sig. (2-tailed): .009
- N: 295

Correlation is significant at the 0.01 level (2-tailed)

Table 3: Descriptive of birth weight and gestational period

<table>
<thead>
<tr>
<th>Gestational Period</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>CI 95% for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 weeks</td>
<td>26</td>
<td>2729.62</td>
<td>458.462</td>
<td>89.912</td>
<td>2544.44 - 2914.79</td>
</tr>
<tr>
<td>38 weeks</td>
<td>66</td>
<td>3002.12</td>
<td>421.705</td>
<td>51.908</td>
<td>2898.45 - 3105.79</td>
</tr>
<tr>
<td>39 weeks</td>
<td>65</td>
<td>3225.78</td>
<td>406.663</td>
<td>50.440</td>
<td>3125.02 - 3326.55</td>
</tr>
<tr>
<td>40 weeks</td>
<td>132</td>
<td>3252.95</td>
<td>459.403</td>
<td>39.986</td>
<td>3173.85 - 3332.06</td>
</tr>
<tr>
<td>41 weeks</td>
<td>6</td>
<td>3420.00</td>
<td>656.658</td>
<td>268.080</td>
<td>2730.88 - 4109.12</td>
</tr>
<tr>
<td>Total</td>
<td>295</td>
<td>3148.12</td>
<td>471.820</td>
<td>27.470</td>
<td>3094.06 - 3202.19</td>
</tr>
</tbody>
</table>

Table 4: ANOVA of the baby’s birth weight and gestational period (F₄ = 10.453, P < 0.05)

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>8246927.711</td>
<td>K-1 (5-1)</td>
<td>4</td>
<td>2061731.928</td>
<td>10.453</td>
<td>000.</td>
</tr>
<tr>
<td>Within Groups</td>
<td>57201739.896</td>
<td>N-K (295-5)</td>
<td>290</td>
<td>197247.379</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>65448667.607</td>
<td>N-1 (295-1)</td>
<td>294</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Our cohort showed approximately two third of pregnant women did not comply with the current IOM guidelines of gestational weight gain. Rasmussen et al. in his study mentioned two third of women gained weight outside the IOM recommendations.13 Xue Liu et al. in a retrospective cohort study mentioned 72.4% of women had GWG outside the IOM guidelines.16 A systematic review and meta-analysis of more than one million pregnant women pointed that 47% had gestational weight gain greater than IOM recommendations and 23% had gestational weight gain less than IOM recommendations.17 Another study observed every second woman with overweight or obesity and more than one third of the normal weight women gained more weight than recommended, whereas the majority of underweight women failed to gain sufficient weight.18 Available data suggest that 37% of normal-weight women and 64% of overweight women gain more than IOM recommendations.19,20 Although there is a broad range of weight changes that are associated with healthy pregnancy outcomes,20 weight gains that exceed the IOM recommended levels have been connected to gestational complications.
Maternal weight gain and birth weight among term babies

One third of the women in this study were characterized by overweight and obesity. Overall, 5.8% and 2.7% of all infants born to participant mothers were too small or too large for gestational age, respectively. The proportion of infants born small for gestational age varied in accordance with maternal BMI. Among women with low, normal and high BMI, the percentage whose infants were SGA was found to be 11.1%, 4.8% and 5.2% respectively and whose infants were LGA at an increasing rate of 0%, 2.4% and 4.2% respectively. Similarly rate of LBW babies among low, normal and high BMI women who gained less weight according to IOM guidelines 9%, 6.8% and 5% respectively. The proportion of normal weight babies born to all BMI group was 91.5% (Ranges from 88% to 92.6%) irrespective of the recommended weight gain guidelines of IOM. Women who gained weight within recommended guidelines and below, gave birth to normal weight babies ranging from 85.7% to 93.9%. However, the incidence of LGA babies increased in subjects who gained excess weight in comparison to women who gained below and recommended guidelines. Pregnancy weight gain, irrespective of pre-pregnancy BMI, is an independent predictor and is found to have a significant effect on fetal growth.21,22 Compared with GWG within IOM guidelines, GWG below guidelines was associated with higher odds of preterm birth and SGA whereas maternal GWG above guidelines was associated with higher odds of macrosomia seen in another cohort.16 The study confirms that none of the women with inadequate weight gain delivered LGA babies. This risk was lowest among the underweight BMI group where irrespective of gestational weight gain none of the women had large babies. Significantly large number of normal weight babies were born to all BMI group of pregnant women which ranges from 88 to 92.6%. The mean birth weight increased progressively in overweight and obese BMI groups with increasing antenatal weight gain. Charles Savona et al. confirms that irrespective of maternal BMI, there is a statistically significant trend towards LBW with decreasing antenatal weight gain and conversely macrosomia with increasing antenatal weight gain.23 A significantly lowered mean birth weight was noted in the Dutch population who experienced severe famine during the winter of 1944 - 45.24 Gestational weight gain above guidelines was associated with multiple adverse neonatal outcomes, whereas gestational weight gain below guidelines was only associated with SGA status.25

The proportion of SGA babies is highest within the below guidelines weight gain group and similarly large babies were seen in the above guidelines weight gain group. Another study done in Iran observed birth weight markedly improved in overweight groups when weight gain increased from below the IOM recommended range to within it, rate of LBW was slightly decreased, and macrosomia increased when they gained weight more than the recommended range.26 Compared with recommended gestational weight gain, gain below guidelines was associated with 2% higher risk of SGA babies. Weight gain above guidelines was associated with 1.1% and 5.2% higher risk of delivery of SGA and LGA babies respectively in comparison to recommended weight gain group. The greater the gestational weight gain, the lower the risk of delivering an infant too small for gestational age. A large systematic review and meta-analysis by Goldstein RF et al observed gestational weight gain below guidelines was associated with lower risks of LGA and this association was lowest in underweight women.27 Weight gain above guidelines was associated with higher risks of LGA and macrosomia, and underweight status was associated with the greatest risk.27 Similar findings were observed by multiple studies where pregnancy weight gain below the recommended range was associated with LBW and preterm birth, and weight gain above the recommended range was associated with birth weight more than 4000 gm or macrosomia, cesarean delivery and postpartum weight retention.4,18,28,30

Conclusions

Our findings suggest that high maternal weight gain during pregnancy increases birth weight. Across all BMI categories, insufficient GWG is associated with slightly increased risk of SGA, while relative risk of LGA is higher in excess GWG group. The IOM weight gain recommendation guidelines may not be applicable to all the women. Further studies need to be conducted to review the existing IOM guidelines in our context where information regarding health education, weight monitoring and nutritional interventions during pregnancy is lacking. Proper counseling directed to these issues of pregnancy demand high priority by ANC providers in developing countries.

References

2. Singh M. Care of the newborn. Revised.(2016)
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