Maternal Anthropometry and Weight Gain as Risk Factors for Low Birth Weight in Singleton Uncomplicated Pregnancies

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Abstract

Objectives: The present cross sectional study was done to investigate the maternal anthropometry and weight gain in relation to pregnancy outcomes of mothers in Hail city of Saudi Arabia.

Methods: The study was carried out in two maternity hospitals of Hail, Saudi Arabia. Sample size of 522 mothers who delivered single live baby without any congenital abnormality were selected to be included in the present study. Mother’s and infant’s anthropometric measurements were taken with standard techniques. Hemoglobin, blood sugar and blood pressure were recorded using electronic devices. Information regarding the demographic characteristics, health status of mothers, antenatal checkups and health related habits were accessed through structured questionnaire. Data was entered and analyzed through the Statistical Package for Social Sciences (SPSS) 17.0 Software. Odds Ratios, Means, Pearson’s correlation, Analysis of Variance were done to find out the risk factors associated with poor pregnancy outcome.

Results: The mean birth weight of the infants was 3.16 kg ranging from 1.7 kg to 5.4 kg. Male babies tend to be heavier, whereas 100% of the very low birth weight deliveries were only females. Other factors like maternal Body mass Index before pregnancy, Weight gain in pregnancy, Maternal anemia, presence of chronic illnesses like diabetes, Hypertension and hypo/hyperthyroidism had effected the birth weight of newborn infants.

Conclusion: The present study provides some useful data to promote healthy pregnancy outcomes. Maternal factors like nutritional status, poor pregnancy weight gain and unhealthy obstetric history are found to be the major risk factors.

Keywords: Anthropometry; Maternity; Hemoglobin; Pregnancy; Body Mass Index

Introduction

"Birth weight" is the first weight of the fetus or infant obtained after birth and should be measured during the first hour after birth, before the significant postnatal loss of weight occurs [1]. Low birth weight (LBW), a preventable and a major public health problem common in developing countries has been defined by the World Health Organization (WHO) as weight at birth of less than 2500g (5 pounds 8 ounces) [2]. Worldwide 15.5 percent of all infants are born with LBW among 20 million infants, where 95.6 percent of them from the developing countries. In developing countries, the level of low birth weight is 16.5 percent more than double the level compared with developed countries which is 7 percent [3,4]. According to World Health Rankings by WHO data published in May 2014 Low Birth Weight Deaths in Saudi Arabia reached 1,496 or 1.86% of total deaths [5].

LBW is associated with multiple health related problems resulting in high rates of infant’s mortality and morbidity in developing coun-
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tries. LBW at birth may be due to either premature birth or preterm birth (before 37 weeks of gestation) or retarded fetal (intrauterine) growth attributed to poor uteroplacental perfusion or small for gestational age [6,7]. Thus, LBW and preterm birth are consider as the important indicators of child morbidity and mortality, as well as maternal health and nutrition prior to or during pregnancy [8].

Researchers have found many maternal and fetal factors as significantly associated with birth weight [9]. Among them the most common include nutrient intake, resistance to infections and other illness. Several studies suggest other factors like maternal age, increase in weight, stature, parity, close birth spacing, lifestyle, health related habits as responsible for LBW infants [10]. Poor nutrient intake will affect the growth of the fetus, the plasma volume, the maternal tissue supporting the fetus resulting in LBW [11]. Nutrient and oxygen supply, maternal infections transmitting through placenta, utero placental blood flow, the size of the uterus and the gestational period has a strong emphasis on the fetal growth [12]. Chronic diseases like maternal hypertension can affect the fetal growth due to reduction in blood flow or due to an increased risk of preeclampsia [13]. By overlooking these factors as a relevant public health issue and by the fact that limited community based studies are available, we carried out this study aiming to identify and investigate maternal risk factors associated with low birth weight.

Methods

Demography of the Study area: The present cross sectional study was conducted in the maternity wards of two hospitals - Hail General Hospital and Maternity and Children Hospital- in the centre of Hail city of Saudi Arabia. Hail is located in the northern region of the country. It has an area of 103,887 km² and a population of 527,033 (2004 census) consisting 49.9% women [14]. According to the data of the ministry of health, the birth rate is 18.78 births/1,000 population and the fertility rate is 2.17 children born/woman [15]. Also, the percentage of Low Birth Weight deliveries is estimated to be 8% [15].

Study population

For the purpose of getting permission, letters were given to the administrative and higher authorities of the hospitals from the Principal investigator and head of the department of clinical Nutrition, University of Hail. The study was initiated after getting an informed consent from the Hospitals as well as the patient. All those mothers who were willing to participate in the present study were interviewed. The sample size was calculated on the basis of total prevalence rate of Low Birth Weight deliveries in previous studies. A total of 522 cases (irrespective of the mode of delivery) aged 18 to > 40 years, who delivered a single live baby through without any congenital malformation and completed gestational age of ≥ 37 weeks were enrolled for the present study. Data was obtained from hospital records within 1 day of delivery. Mothers who had twin births or triplets or gave birth to babies with congenital abnormalities were excluded.

Procedure

A pre-tested and modified questionnaire was used for the purpose of data collection, which was translated into Arabic for the ease of the mothers. Information was gathered from interviews with mothers of the new born babies, from the medical files and biochemical examination of the mothers. Hospital records were checked to identify cases.

Information regarding age, education of both parents and other socio demographic characteristics were asked from the mother and crosschecked from the medical records for validation. Other variables included parity, total number of abortions, number of Anti Natal Visits (ANC) during pregnancy, nutritional status of mother, amount of physical activity including household work and hours of rest and sleep. The socioeconomic status was assessed from the employment of mother, total family income and the type of family (joint/nuclear). The interval between present and previous delivery was also recorded. The total number of Anti Natal Checkups were recorded as 1, 2, 3, or ≤ 4 visits as according to WHO standards [16].

Maternal nutritional status was assessed with the help of pre-pregnancy weight and Body Mass Index (BMI), Hemoglobin level before and after delivery, Blood pressure, Blood sugar level and presence of any chronic illness (like CVD, Diabetes, asthma or thyroid problems).

Pre-pregnancy weight was asked from the mothers and crosschecked from the medical file of the patient. Height was measured up to the nearest centimeter.

Maternal hemoglobin was checked both before and after the delivery by portable electronic hemoglobinometer with disposable strips using spectrophotometric technique. Random blood sugar was measured using electronic glucometer (One touch, ultra- Lifescan Johnson & Johnson, Milpitas, USA). One single prick was done to draw blood for both measurements. Blood pressure was measured using electronic wrist blood pressure machine (Beurer medical - Germany). Medical records of the biochemical parameters were also checked and the average of all readings was considered for evaluation.

Information regarding the gestational age, parity, number of abortions were taken from the medical file. Weight gain during pregnancy was obtained by subtracting the final weight before delivery from the pre-pregnancy weight.

Use of iron and calcium tablets were considered as appropriate only if taken for ≥ 3 months during pregnancy. An account of the household works done, hours of mid-day rest and night sleep, and exercise frequency was taken with the help of questionnaire to judge the level of physical activity.

**Anthropometry of the new born:** Sex of the Infant, birth weight, height, head circumference and weight of placenta were measured soon after the delivery and recorded in the file of the mother and neonate.

**Ethics:** The present study has been approved by the research deanship, University of Hail, Hail, Saudi Arabia (AMS 13-4). Study was initiated only after getting informed consent from the hospital authorities.

**Results:** Total sample size was calculated to be 522. Descriptive statistics of the study population is represented in Table 1. Present study shows that the mean age of the mothers was 30.3 years (range 18 - 48 years). The mean birth weight of total deliveries was found to be 3.16 kilo grams (range 1.7 - 5.4 kg). The average BMI of the mothers before pregnancy was 26.86 ± 5.3 which means that the average mothers were overweight before conception.

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Range</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of placenta</td>
<td>522</td>
<td>880 - 1210</td>
<td>330</td>
<td>1210</td>
<td>636.07</td>
<td>± 138.85</td>
</tr>
<tr>
<td>Head circumference of the baby</td>
<td>522</td>
<td>15.0 - 45.0</td>
<td>30.0</td>
<td>45.0</td>
<td>34.79</td>
<td>± 1.86</td>
</tr>
<tr>
<td>Height of the baby</td>
<td>522</td>
<td>15 - 58</td>
<td>43</td>
<td>58</td>
<td>49.98</td>
<td>± 2.83</td>
</tr>
<tr>
<td>Birth weight of the baby</td>
<td>522</td>
<td>3.7 - 15.0</td>
<td>1.7</td>
<td>5.4</td>
<td>3.16</td>
<td>± 0.61</td>
</tr>
<tr>
<td>Age of the mother</td>
<td>522</td>
<td>30 - 175</td>
<td>18</td>
<td>48</td>
<td>30.28</td>
<td>± 6.31</td>
</tr>
<tr>
<td>Height of the mother</td>
<td>522</td>
<td>90 - 175</td>
<td>85</td>
<td>175</td>
<td>157.97</td>
<td>± 5.44</td>
</tr>
<tr>
<td>Weight of mother before pregnancy</td>
<td>522</td>
<td>120 - 156</td>
<td>36</td>
<td>156</td>
<td>67.40</td>
<td>± 14.29</td>
</tr>
<tr>
<td>BMI before pregnancy</td>
<td>522</td>
<td>25.8 - 41.8</td>
<td>16.0</td>
<td>41.8</td>
<td>26.86</td>
<td>± 5.26</td>
</tr>
<tr>
<td>Total weight gain in pregnancy</td>
<td>522</td>
<td>16 - 8.24</td>
<td>2</td>
<td>18</td>
<td>8.24</td>
<td>± 3.19</td>
</tr>
</tbody>
</table>

**Table 1:** Descriptive Statistics of the study population.

Figure 1 shows the distribution of birth weight (classified according to the WHO standards [3]) according to the sex of the baby. It is clear from the present data that the total number of very low birth weight deliveries (< 2 kg) were only females. Among the category of

**Citation:** Rafia Bano., *et al.* "Maternal Anthropometry and Weight Gain as Risk Factors for Low Birth Weight in Singleton Uncomplicated Pregnancies*. *EC Paediatrics* 3.2 (2016): 325-333.
Low Birth weight (2 kg - less than 2.5 kg) the higher percentage (78%) were female babies as compared to 22% males. Among the normal birth weight babies, a higher percentage (53%) were males as compared to 47% females. Lastly, the high birth weight babies (greater than 4 kg) were only males (100%). These findings clearly show that the male infants tend to be heavier and healthier.

Table 2 shows the correlation between Birth weight and total weight gain in pregnancy. According to chi square test and Pearson's correlation, the relation was found to be highly significant ($P < 0.001$).

<table>
<thead>
<tr>
<th>Birth weight category</th>
<th>Total weight gain in pregnancy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 5 kg</td>
<td>6 - 12 kg</td>
</tr>
<tr>
<td>Low birth weight</td>
<td>67</td>
<td>35</td>
</tr>
<tr>
<td>Normal Birth weight</td>
<td>50</td>
<td>327</td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>362</td>
</tr>
</tbody>
</table>

$\chi^2 = 138.7$ df 2, $P < 0.001$

Table 2: Birth weight in relation to Total weight gain in pregnancy.

Analysis of variance (ANOVA) was performed to find out the correlation between pregnancy outcome and maternal parameters with total weight gain in pregnancy. The results are presented in table 3. It was observed that weight gain in pregnancy was significantly correlated with the important birth outcomes like birth weight, weight of placenta, and gestational age. On the other hand, maternal factors like age of mother and Pre-pregnancy BMI was also found to strongly correlated with Weight gain during pregnancy.

The present study demonstrated that the most significant factors responsible for low birth weight Spacing of ≤ 2 years, Maternal Height, pre-pregnancy weight and BMI, Thyroid disorders and < 4 visit to any health care centre during pregnancy (Table 4). However, the results from table 4 also indicate that mothers with hypertension had more prevalence of having a Low Birth weight baby (OR – 2.307; 95% CI 0.896 – 5.939). In our study Primigravida was not found to be significantly correlated to Birth weight.

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Table 3: Analysis of Variance for Pregnancy outcome and maternal parameters with Total weight gain in pregnancy.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total weight gain in pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 5 kgs (n = 117)</td>
</tr>
<tr>
<td>Birth weight of the baby</td>
<td>2.8 ± 0.7</td>
</tr>
<tr>
<td>Weight of placenta</td>
<td>555.7 ± 131.7</td>
</tr>
<tr>
<td>Gestational age at birth</td>
<td>38.2 ± 1.7</td>
</tr>
<tr>
<td>Age of the mother at the time of birth</td>
<td>31.5 ± 7.3</td>
</tr>
<tr>
<td>BMI before pregnancy</td>
<td>28.3 ± 6.4</td>
</tr>
<tr>
<td>Total weight gain in pregnancy</td>
<td>4.54 ± 0.8</td>
</tr>
</tbody>
</table>

Table 4: Odds Ratio (95% CI) for the significant risk factors of low birth weight.

<table>
<thead>
<tr>
<th>Health related parameters</th>
<th>Low birth weight</th>
<th>Normal birth weight</th>
<th>OR</th>
<th>95% Confidence Interval</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>13</td>
<td>86</td>
<td>0.622</td>
<td>0.36 - 1.07</td>
<td></td>
</tr>
<tr>
<td>House wife</td>
<td>89</td>
<td>334</td>
<td>1.097</td>
<td>1.004 - 1.199</td>
<td></td>
</tr>
<tr>
<td>Exercise#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.001**</td>
</tr>
<tr>
<td>&lt; 3 days/week</td>
<td>87</td>
<td>288</td>
<td>1.244</td>
<td>1.22 - 1.379</td>
<td></td>
</tr>
<tr>
<td>&gt; 3 days/week</td>
<td>15</td>
<td>132</td>
<td>0.468</td>
<td>0.287 - 0.782</td>
<td></td>
</tr>
<tr>
<td>Mid-day rest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.004**</td>
</tr>
<tr>
<td>Sufficient</td>
<td>57</td>
<td>297</td>
<td>0.790</td>
<td>0.658 - 0.949</td>
<td></td>
</tr>
<tr>
<td>No rest</td>
<td>45</td>
<td>123</td>
<td>1.506</td>
<td>1.157 - 1.962</td>
<td></td>
</tr>
<tr>
<td>Getting night sleep ≥ 6hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.603</td>
</tr>
<tr>
<td>Yes</td>
<td>63</td>
<td>271</td>
<td>0.957</td>
<td>0.809 - 1.133</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>39</td>
<td>149</td>
<td>1.075</td>
<td>0.816 - 1.424</td>
<td></td>
</tr>
</tbody>
</table>

Physically active in house##

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>83</td>
<td>324</td>
<td>1.055</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
<td>96</td>
<td>0.815</td>
</tr>
</tbody>
</table>

Table 5: Risk estimate for health-related habits of mother according to birth weight.
#Walking for at least 20 minutes/day
##Doing house work without domestic help

Table 5 shows the estimate of risk through logistic regression for the health-related habits affecting birth weight. It was found that the amount of exercise (generally walking) done and the mid-day rest had significantly affected the birth weight.

Table 6 shows the correlation of pregnancy outcomes and the maternal anthropometric measurements as judged by the Odds ratio and Chi Square test. It was found that the Low Birth weight was significantly associated with short height (< 152 cms), Lower weight (< 52 kgs) and lower BMI (< 19 kg/m²). Also the poor maternal nutritional status was found to be significantly correlated with weight of placenta at the time of birth. However poor maternal weight and BMI had affected the gestational age irrespective of height of the mother.

**Discussion**

The present study shows mean birth weight of infants as 3.16 kg falling in the normal range. When considering the preconception weight of the mothers, it was found that majority of the women were overweight (with BMI > 26) which has shown to have a lesser impact on the birth weight of the infant as the mean weight of the infant falls in the normal weight category. This is comparable to other studies concluding that overweight and obese women are at higher risk of giving birth to a preterm baby and a lower risk to deliver a LBW infant when compared to women with normal weight [17,18].

The present study clearly shows that female babies had a significantly higher incidence of low birth weight than male babies. Also, higher percentage of normal birth weight and high birth weight were noticed in their male counterparts. The findings were in agreement with other studies of LBW in relation to gender of the baby [19,20], concluding that female babies were significantly more prone to low

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birth weight. Contrary to the present findings some researchers found that male babies are generally more vulnerable to LBW resulting in multiple infections [21].

Strong relationship was found between the total weight gain during pregnancy and Birth weight. The risk of having Low Birth Weight was more than two folds for the women whose total weight gain is less than 5 kg compared to total weight gain 6 - 12 kg. The results were found to be similar to another study conducted in Northern Ethiopia [22]. Present study also demonstrated that the maternal weight less than 52 kg have more risk of having LBW infants as compared to mothers with weight more than 52 kg. This is in line with the studies conducted by various researchers in India and Pakistan [23]. These findings could be attributed to the fact that the weight gain less than 5 kg might be related to poor nutrient intake during young age which continues during pregnancy affecting the fetal growth. In our study the poor nutritional status of the mother and weight of the placenta less than 500 g was significantly correlated with LBW.

Our results showed that the risk of LBW increases with maternal age, spacing, maternal height, weight gain during pregnancy, pre-pregnancy BMI. This was consistent with results from a number of other studies [17,24,25]. When considering the maternal age, early marriage and early childbearing, along with repeated pregnancies and short birth spacing increases the risk of having a LBW infant. Similar results are observed in the research conducted by S A Rizvi, et al [26].

When considering the maternal height, values less than 152 cms were more prone to have LBW infants and our results are in accordance with the findings of other studies [27,28], which stated that short stature of mothers have higher risk of LBW. Short stature of mothers is associated with a narrow pelvis, which increases the likelihood of cephalopelvic disproportion and obstructed labor with insufficient supply of nutrients to the fetus. These finding are in line with the literature results concerning the harmful consequences of short statured mothers on fetus and infants in Northern Brazil [29].

Results of the present study show that the risk of LBW increased to some extent with anemia. On contrary a strong relation was found between anemia and LBW with the studies done on anemic pregnant women [30,31]. In the present study prevalence of low birth weight was found to be significantly correlated to the number of antenatal visits. This is in agreement with the findings of other researchers [32] which states about 21.3% were LBW infants with minimum number of antenatal visits. In the present study presence of thyroid disorders was highly significant for LBW infants. This is in consistent with the findings of Millar, et al study [33] which proves that lack of control of hyperthyroidism significantly increases the risk of low birth weight infants and severe preeclampsia.

According to an online report in the Journal of Clinical Endocrinology & Metabolism states that exercise during pregnancy reduces the birth weight of offspring. In agreement with this statement, present study shows a statistically significant correlation with exercise and LBW prevalence. According to Hopkins, et al [34] regular exercise was associated with lower birth weights and has an effect on decreased endocrine stimulation of fetal growth. In addition, inactive women had slightly lower risk of LBW infants. The other factors in our study such as hypertension, diabetes, physical activities and sleep did not attain statistical significance in the analysis. However, the clinical significance cannot be ruled out based on the findings of the present study.

Conclusion

Low birth weight is a condition from the health and nutritional status of the mother resulting in a health status of the infant determining its survival, healthy growth and development in adult life. The present study revealed that the proportion of low birth weight was around 20% in Hail, Saudi Arabia. The present study clearly shows that female babies had a significantly higher incidence of low birth weight than male babies. Also, higher percentage of normal birth weight and high birth weight were noticed in their male counterparts. Present study results showed that the risk of LBW increases with maternal age, spacing, maternal height, weight gain during pregnancy, pre-pregnancy BMI. Among all the risk factors discussed, low weight gain during pregnancy, short stature of the mother, exercise and antenatal care were the important predictors of low birth weight. To overcome these problems, special training and attention should be
encouraged in order to strengthen the mother and child health condition not only in health care services but also in social development and welfare sectors of the community.

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Authorship Statements

Conception and design of the study: Dr. Rafia Bano
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Drafting the article and revising: Dr. Rafia Bano, Ms. Shahida Banu
Final approval of the manuscript: Dr. Rafia Bano, Shahida Banu and Syeda Busha Fatima

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