Original Research

ASSOCIATION OF MATERNAL BMI AND ANTHROPOMETRY OF NEW-BORN: A HOSPITAL-BASED CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Higher newborn morbidity and death are associated with low birth weight, which remains a significant public health issue in poor nations. Foetal growth and newborn anthropometric outcomes are significantly influenced by the nutritional state of the mother, particularly BMI (Body Mass Index). The purpose of this study was to evaluate the relationship between the newborn's anthropometry and the mother's BMI.

Methods: A hospital-based cross-sectional study was conducted among 700 full-term pregnant women admitted for delivery at Dr. Prabhakar Kore Charitable Hospital, Belagavi, from January to December 2017. Women with singleton live births were included, while mothers with medical disorders and babies with congenital anomalies were excluded. Maternal anthropometric parameters, including height, weight, and BMI during all trimesters were recorded. Within an hour of birth, newborn anthropometric measurements were taken, including birth weight, length, head circumference, and chest circumference. SPSS version 16.0 was used to analyse the data, and associations were found using the chi-square test and ANOVA.

Results: The mean birth weight of the newborns was 2.82±0.4 kg, and the frequency of LBW was 17.43%. The newborn's birth weight was significantly positively correlated with the mother's BMI throughout all three trimesters ($p<0.05$). Underweight mothers had a higher prevalence of LBW babies compared to overweight/obese mothers. Maternal BMI during the first and second trimesters showed significant association with neonatal length, whereas second and third trimester BMIs were significantly associated with head circumference. No significant association was observed between maternal BMI and chest circumference. Maternal height did not show significant association with neonatal anthropometric measurements.

Conclusion: Maternal BMI and maternal weight significantly influence neonatal anthropometry, particularly birth weight, length, and head circumference. Reducing the prevalence of low birth weight and improving newborn outcomes may be possible with early detection and treatment of maternal nutritional status during pregnancy.

Keywords: Maternal Bmi, Low Birth Weight, Neonatal Anthropometry, Pregnancy, Maternal Nutrition, Birth Weight.

INTRODUCTION

One of the most significant factors influencing newborn survival, good growth, and development is LBW (Low Birth Weight).

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Because LBW is linked to higher newborn morbidity and mortality, it remains a significant public health concern in poor nations.[1] Regardless of gestational age, LBW is defined by the World Health Organization as a birth weight of less than 2500 g.[2] Low birth weight affects approximately 23% of babies in India, which has a substantial negative impact on health outcomes and infant mortality.[3]

Foetal growth and newborn anthropometric parameters, including birth weight, length, head circumference, and chest circumference, are significantly influenced by maternal nutrition throughout pregnancy.[4,5] Anthropometric measures such as BMI (Body Mass Index), maternal weight, height, and gestational weight growth can be used to evaluate the nutritional condition of mothers.[6] Poor maternal nutrition may lead to intrauterine growth restriction, resulting in LBW babies who are at increased risk of perinatal asphyxia, hypoglycemia, hypothermia, impaired neurodevelopment, diabetes mellitus, and hypertension later in life.[4]

Several studies have demonstrated a positive association between maternal BMI and neonatal birth weight.[5,7,8] Maternal weight gain and BMI during pregnancy have also been shown to influence neonatal length and head circumference.[9] However, findings regarding maternal height and its association with neonatal anthropometry remain inconsistent.[4,10] Variations in dietary habits, socioeconomic conditions, and healthcare accessibility across geographical regions may influence maternal nutritional status and fetal growth.

Anthropometric measurements at birth are valuable indicators of intrauterine growth and neonatal health.[11] Therefore, identifying maternal factors associated with adverse birth outcomes is essential for early intervention and improving neonatal survival. Since maternal nutrition and BMI are modifiable factors, understanding their relationship with neonatal anthropometry can help formulate effective maternal health strategies and reduce the burden of low birth weight in developing countries.[12]

Aims and Objectives

The study aimed to evaluate the relationship between the newborn's anthropometry and the mother's BMI. In order to better understand how maternal nutritional status affects foetal growth and neonatal outcomes, the study aimed to assess the impact of maternal BMI during pregnancy on neonatal anthropometric parameters such as birth weight, length, head circumference, and chest circumference.

MATERIALS AND METHODS

Study Design: In the current study, 700 full-term pregnant women who were admitted for delivery and their newborns participated in a cross-sectional study at a tertiary care facility. The study was conducted in the labor room and obstetrics and gynaecology department of the Dr. Prabhakar Kore Charitable Hospital in Belagavi. In order to evaluate the relationship between the mother's body mass index and the newborn's anthropometry, data was gathered during a one-year period, from January 1st to December 31st, 2017.

Inclusion and Exclusion Criteria: The study included registered pregnant women who delivered at Dr. Prabhakar Kore Charitable Hospital, Belagavi, and gave birth to a single live baby. Babies born with congenital anomalies were excluded from the study. Pregnant women with medical disorders such as diabetes mellitus, hypertension, cardiac diseases, and other significant medical conditions were also excluded to avoid confounding factors affecting neonatal anthropometry.

Sample Size Calculation: The total number of deliveries per year at the hospital is about 6000.

After excluding women with medical complications and women who gave birth to babies with congenital anomalies, about 3000 women with no risk deliver at the hospital; hence, a systematic sampling method was used to select pregnant women in the study.

$$\text{Sampling interval} = \frac{\text{total number deliveries at KLE Hospital}}{\text{Sample size}} = \frac{3000}{700} = 4.28$$

Therefore, every 4th pregnant woman who fit into the inclusion criteria was included in the study.

Data Collection Tools: The data collection tools used in the study included a pretested and pre-structured questionnaire for obtaining socio-demographic and obstetric details of the participants. Standardized instruments such as a digital weighing scale, an infantometer, and a non-flexible measuring tape were used to record maternal and neonatal anthropometric measurements. All instruments were regularly checked for validity and reliability throughout the study period to ensure accuracy of measurements.

Data Collection Procedure: Data were collected from pregnant women admitted to the obstetrics and labor wards after obtaining informed consent. Socio-demographic details and obstetric history were obtained through direct interviews using a pretested questionnaire, while information regarding maternal weight at different trimesters and height was obtained from case records. The formula weight in kilograms divided by height in meters squared was used to determine the maternal BMI. Within an hour of birth, newborn anthropometric measurements were taken using standardised tools, including birth weight, length, head circumference, and chest circumference. Before the main trial, 20 pregnant women participated in a pilot study, and the data-gathering procedure was adjusted as needed.

Statistical Analysis: All the collected data was coded, tabulated, and entered into a master chart for analysis. Statistical analysis was performed using the SPSS (Statistical Package for Social Sciences) version 16.0 software. Tables and graphs were prepared using Microsoft Excel 2013. The data were expressed in terms of mean, standard deviation, frequencies, and percentages. To determine the association between maternal BMI and anthropometric parameters of the new-born, the chi-square test was applied with a significance level set at $p<0.05$. Analysis of Variance (ANOVA) was also used to assess the association between maternal BMI during the first, second, and third trimesters, maternal height, and fetal anthropometric measurements including birth weight, length, head circumference, and chest circumference.

RESULTS

Age Group (in years)	Number	Percentage
≤20	91	13.0%
21–25	376	53.7%
26–30	212	30.3%
>30	21	3.0%
Total	700	100%

Table 1: Distribution of Study Participants According to Age (n=700)

Table 1 illustrates that the majority of study participants (53.7%) belonged to the age group of 21–25 years, followed by 30.3% in the 26–30 year age group. Only 3% of mothers were above 30 years of age.

Socio-Economic Class	Number	Percentage
Class I	51	7.3%
Class II	64	9.14%
Class III	119	17.0%
Class IV	271	38.71%
Class V	195	27.85%
Total	700	100%

Table 2: Distribution of Study Participants According To Socio-Economic Status

Table 2 observes that most participants belonged to Class IV socio-economic status (38.71%), followed by Class V (27.85%). Only a small proportion belonged to classes I and II.

Educational Status	Number	Percentage
Illiterate	39	5.5%
Primary School	241	34.5%
High School	308	44.0%
PUC/Diploma	56	8.0%
Graduate	56	8.0%
Total	700	100%

Table 3: Distribution of Study Participants According to Educational Status

Table 3 shows that 44% of mothers had completed high school education, while 34.5% had primary school education. Illiteracy was observed among 5.5% of participants.

BMI Category	1st Trimester	2nd Trimester	3rd Trimester
<18.5 (Underweight)	32.3%	22.0%	10.86%
18.5–24.9 (Normal)	51.7%	58.0%	55.14%
25–29.9 (Overweight)	13.5%	15.0%	25.29%
>30 (Obese)	2.5%	5.0%	8.71%

Table 4: Trimester-Wise BMI Distribution of Pregnant Women

Table 4 demonstrates that the prevalence of underweight mothers decreased progressively from the first to the third trimester, while overweight and obesity increased during pregnancy.

Birth Weight	Number	Percentage
<1.5 kg	2	0.29%
1.5–2.49 kg	120	17.14%
≥2.5 kg	578	82.57%
Total	**700**	**100%**

Table 5: Distribution of New-Borns According to Birth Weight

Table 5 illustrates that 82.57% of babies had normal birth weight, while 17.14% were low birth weight babies. Very low birth weight was observed in only 0.29% of newborns.

Anthropometric Parameter	Mean ± SD
Birth Weight (kg)	2.82 ± 0.4
Length (cm)	50.57 ± 17.6
Head Circumference (cm)	34.71 ± 1.22
Chest Circumference (cm)	31.92 ± 2.05

Table 6: Mean Anthropometric Measurements of New-Borns

Table 6 shows that the mean birth weight of newborns was 2.82 kg. The mean neonatal length, head circumference, and chest circumference were 50.57 cm, 34.71 cm, and 31.92 cm, respectively.

Maternal BMI	LBW (%)	Normal Birth Weight (%)	P-Value
Underweight (<18.5)	23.77%	76.23%	
Normal (18.5–24.9)	16.14%	83.84%	
Overweight/Obese (>25)	9.33%	90.67%	0.0024

Table 7: Association of Maternal BMI at First Trimester with Birth Weight of New-Born

Table 7 observes a significant association between maternal BMI during the first trimester and birth weight of the new-born. The prevalence of low birth weight decreased as maternal BMI increased.

Parameter	1st Trimester P-Value	2nd Trimester P-Value	3rd Trimester P-Value
Length	0.00026	0.0166	0.286
Head Circumference	0.464	0.0035	0.0022
Chest Circumference	0.398	0.159	0.123

Table 8: Association of Maternal BMI at Different Trimesters with Neonatal Anthropometry

Table 8 demonstrates that maternal BMI during the first and second trimesters showed a significant association with neonatal length. Maternal BMI during the second and third trimesters was significantly associated with neonatal head circumference, whereas no significant association was observed with chest circumference.

DISCUSSION

In order to assess the relationship between the mother's BMI and the newborn's anthropometry, 700 mothers giving birth at a tertiary care facility participated in the current hospital-based cross-sectional study. In the current study, LBW prevalence was 17.43%. The newborn's birth weight was significantly positively correlated with the mother's BMI during each of the three trimesters. Maternal BMI during the first and second trimesters was significantly associated with neonatal length, while BMI during the second and third trimesters showed significant association with head circumference. However, no significant association was observed between maternal BMI and chest circumference of the new-born.

Socio-Demographic Profile: The mean age of the mothers in the present study was 24.28 ± 3.34 years. Similar findings were reported by Coutinho et al. in Brazil and Muchemi et al., in Kenya, where the mean maternal age was approximately 25 years.[13,14]

Most of the participants in the present study belonged to the Hindu religion (78.86%), followed by Muslims (13.71%). Similar observations were reported in studies conducted in North Karnataka and Haryana.[15,16]

The majority of participants belonged to joint families (79%). Comparable findings were observed in a study conducted by Gogoi et al., where most mothers were from joint families.[17] Regarding educational status, 44% of mothers had completed secondary education, while only 5.5% were illiterate. Similar educational trends were noted by Muchemi et al. in Kenya and Gogoi et al. in India.[14,17]

More than half of the participants (56.4%) resided in rural areas. Similar findings were observed in studies conducted in North-Eastern India and Tamil Nadu.[17,18] Most mothers belonged to socio-economic classes IV and V according to the modified B.G. Prasad classification, which was comparable with findings reported by Rajashree et al. in Karnataka.[19]

Obstetric Characteristics: In the present study, 44.9% of mothers were primigravida and 12.1% had a history of abortion. Similar observations were reported in studies conducted in Northern Ethiopia.[20] Most mothers were registered at government health facilities and the majority had completed 5–13 antenatal visits, indicating adequate antenatal care utilization.

The mean maternal height was 155.47 ± 7.08 cm, which was comparable with studies conducted in Pakistan and Maharashtra.[21,22] However, studies from Turkey reported slightly higher maternal height, likely due to genetic and environmental factors.[23]

The mean maternal weight during the third trimester was 51.93 ± 9.86 kg, which was similar to observations from Nepal and Ethiopia[8] Approximately one-third of mothers were underweight during the first trimester, while obesity increased progressively across pregnancy. The mean maternal weight gain was 6.18 ± 3.24 kg, which was lower than studies conducted in developed countries, possibly due to differences in nutritional practices and dietary patterns.[24]

Birth Weight and Neonatal Anthropometry: The prevalence of LBW in the present study was 17.43%, which was comparable to studies conducted in Ethiopia and Haryana.[25] The mean birth weight of the new-born was 2.82 ± 0.4 kg. Similar findings were reported by Rao et al.[16]The mean neonatal length, head circumference, and chest circumference were also comparable with previous Indian studies.

Association of Maternal Socio-demographic Factors with Birth Weight: Although mothers aged less than 20 years had a higher prevalence of LBW babies (24%), maternal age did not show statistically significant association with birth weight. Similar findings were reported by Rao et al.[16]

The current study found no statistically significant correlation between birth weight and residence, religion, family type, socioeconomic status, educational status, parity, or the number of living children. The lack of association may be attributed to improved maternal and child health services, nutritional supplementation programmes, and better antenatal care through ASHA and Anganwadi workers.

Association of Maternal Anthropometry with Birth Weight and Other Neonatal Parameters: The newborn's birth weight was significantly positively correlated with the mother's weight during all three trimesters. Mothers weighing less than 40 kg had a higher prevalence of LBW babies compared to mothers weighing more than 50 kg. Similar findings were reported by Jananthan et al., who demonstrated that maternal weight is an important determinant of neonatal birth weight.[4]

The current investigation found no significant correlation between maternal height and birth weight. Similar observations were made. However, some studies, such as Ugwa et al., reported a positive association between maternal height and neonatal birth weight.[5]

Neonatal birth weight was significantly positively correlated with maternal BMI during all three trimesters. The prevalence of LBW was highest among underweight mothers and lowest among overweight or obese mothers. Similar findings were reported by Jananthan et al.,.[4] Frederick et al., however, found no evidence of a significant correlation between birth weight and maternal BMI.[26]

Maternal BMI during the first and second trimesters showed a significant positive association with neonatal length. Similar findings were observed in a study by Tayade et al.[9] Maternal BMI during the second and third trimesters was also significantly associated with neonatal head circumference, which was consistent with previous studies.[9]

In contrast, the current study found no statistically significant correlation between the mother's BMI and the newborn's chest circumference. This finding differed from the observations of Tayade et al., who reported a positive association.[9]

The present study also demonstrated that maternal height was not significantly associated with neonatal birth weight, length, head circumference, or chest circumference. Similar observations were reported by Nagmoti et al.[27]

The findings of the present study emphasize the importance of maternal nutritional status, particularly maternal BMI and weight gain during pregnancy, in determining neonatal anthropometric outcomes and reducing the risk of low birth weight.

Limitations

The present study was hospital-based and therefore the findings cannot be generalized to the entire community. Some of the variables were obtained from hospital records, which may have led to minor inaccuracies or incomplete data. Furthermore, a longitudinal study would have given better knowledge of the link between maternal BMI and newborn anthropometry over time, as the current study was cross-sectional.

CONCLUSION

The current study found a positive correlation between the newborn's anthropometric measures and the mother's weight and BMI. However, maternal height did not demonstrate any significant association with neonatal anthropometry. The study also revealed that maternal BMI during the first and second trimesters was significantly associated with the length of the new-born, while BMI during the second and third trimesters showed a significant association with neonatal head circumference. However, maternal BMI in all three trimesters did not show any significant association with the chest circumference of the new-born.

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