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ORIGINAL ARTICLE

Influence of Maternal Anthropometry and Hemoglobin on Neonatal Anthropometry

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ABSTRACT

Background: Maternal anthropometric and hematological parameters are important determinants of fetal growth and neonatal anthropometric outcomes. Identification of simple maternal predictors may help in early detection of pregnancies at risk for adverse neonatal outcomes, particularly in resource-limited settings.

Objectives: To evaluate the correlation between maternal anthropometric parameters and neonatal anthropometric measurements, and to assess the association between maternal hemoglobin levels and neonatal birth weight.

Materials and Methods: This prospective longitudinal observational study was conducted at Sagar Hospitals from April 2019 to March 2020 among 150 pregnant women aged 18–35 years delivering singleton live neonates between 37–40 weeks of gestation. Maternal weight, height, body mass index (BMI), gestational weight gain, and hemoglobin levels were recorded. Neonatal anthropometric measurements including birth weight, crown–heel length, head circumference, chest circumference, and mid-arm circumference were measured within 24 hours of birth. Statistical analysis was performed using appropriate tests, with $p<0.05$ considered significant.

Results: The mean maternal age was 28.03 years. Mild anemia was observed in 11.33% subjects, while 88.67% had normal hemoglobin levels. Mean neonatal birth weight was 2.70±0.28 kg. Low birth weight incidence was significantly higher among mildly anemic mothers compared to non-anemic mothers (29.41% vs 6.78%). Maternal anemia was significantly associated with lower neonatal birth weight, length, head circumference, chest circumference, and mid-arm circumference.

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Maternal BMI showed a significant positive correlation with neonatal birth weight (r=0.23, p=0.005). Maternal weight >50 kg and gestational weight gain >11 kg were associated with significantly higher neonatal birth weight, whereas maternal height showed no significant association with neonatal anthropometric measurements.

Conclusion: Maternal hemoglobin status, BMI, maternal weight, and gestational weight gain significantly influence neonatal anthropometric outcomes, particularly birth weight. Routine maternal anthropometric assessment and hemoglobin estimation during antenatal care may serve as simple and cost-effective tools for identifying pregnancies at risk for adverse neonatal outcomes.

KEYWORDS

• Maternal Anthropometry • Maternal Anemia • Birth Weight • Neonatal Anthropometry • Body Mass Index • Gestational Weight Gain • Low Birth Weight • Hemoglobin • Neonatal Outcomes • Pregnancy

INTRODUCTION

Maternal anthropometry is an important tool for assessing maternal nutritional status and predicting neonatal anthropometric outcomes. World Health Organization estimates that nearly 25 million low birth weight (LBW) infants are born annually worldwide, with 95% occurring in developing countries.[1] In India, nearly one-third of newborns have a birth weight ≤2500 g, reflecting a significant burden of neonatal malnutrition.[2] Maternal anthropometric parameters and hemoglobin levels have therefore gained importance as potential screening tools for fetal growth restriction and adverse neonatal outcomes.

Birth weight remains the most widely used indicator of neonatal size and intrauterine growth because of its simplicity and strong association with neonatal morbidity and mortality. However, birth weight alone is a non-specific indicator as it reflects the combined contribution of fat mass, lean tissue, skeletal growth, and body water.[3] This has led to increasing interest in additional neonatal anthropometric parameters such as head circumference, crown–heel length, mid-arm circumference (MAC), thigh circumference, foot length, skinfold thickness, and MAC/head circumference (HC) ratio for comprehensive assessment of fetal growth and nutritional status.

Previous studies have demonstrated significant correlations between neonatal anthropometric measurements and gestational age, birth weight, and neonatal nutritional status. Head circumference and MAC/HC ratio are useful indicators of intrauterine growth restriction and neonatal malnutrition.[4,5] Mid-arm and thigh circumferences have shown good predictive value for identifying LBW infants, while foot length has been proposed as a simple and reliable screening tool requiring minimal handling of the newborn.[6,7] MAC/HC ratio has also been shown to differentiate symptomatic from asymptomatic small-for-gestational-age infants better than weight-for-date alone.[8-10]

Maternal nutritional status and hemoglobin concentration also influence neonatal anthropometry. Vasundhara *et al.* reported significant associations between maternal mid-arm circumference, maternal body composition, and neonatal birth weight, crown–heel length, and head circumference.[11] Motwani *et al.* observed that maternal age and gestational weight gain were positively associated with neonatal birth weight.[14] Similarly, studies by Ren *et al.*, Kaur *et al.*, and Behal *et al.* demonstrated significant correlations between maternal hemoglobin levels and neonatal anthropometric outcomes including birth weight, length, and head circumference.[17-19] Both severe maternal anemia and low maternal nutritional reserves have been associated with increased risk of LBW.[17,21,22]

Given regional variations in maternal nutritional status and neonatal outcomes, evaluation of these correlations in local populations is important. Hence, the present study was undertaken to assess the relationship between maternal anthropometric parameters

and neonatal anthropometric measurements, and to evaluate the association between maternal hemoglobin levels and neonatal birth weight in a tertiary care hospital in South India.

METHODOLOGY

This prospective longitudinal observational study was conducted from April 2019 to March 2020 at Sagar Hospitals among pregnant women aged 18–35 years attending the antenatal clinic and delivering live singleton neonates without congenital anomalies between 37–40 weeks of gestation. A total of 162 women fulfilling the inclusion criteria were enrolled, 12 were lost to follow up so 150 were finally analysed. Maternal weight was recorded at the first antenatal visit (≤13 weeks gestation) and during subsequent trimesters using a digital weighing scale, while height was measured using a stadiometer and body mass index (BMI) was calculated. Total gestational weight gain was determined from the difference between first trimester and pre-delivery weight. Maternal hemoglobin estimation was performed at booking and at term using an automated blood cell counter in a NABL-accredited laboratory. Neonatal anthropometric measurements including birth weight, crown–heel length, head circumference, chest circumference, and mid-arm circumference were recorded within 24 hours of birth using standard techniques and calibrated instruments.

STATISTICAL ANALYSIS

Data were analyzed using SPSS Software; results were expressed as mean ± standard deviation, with $p<0.05$ considered statistically significant.

RESULTS

The mean maternal age was 28.03 years (range 19–34 years), with the majority belonging to the 25–30 years age group. Mild anemia was observed in 11.33% subjects, while 88.67% had normal hemoglobin levels.

Mean neonatal anthropometric measurements were: birth weight 2.70±0.28 kg, length 48.50±4.95 cm, head circumference 34.50±0.71 cm, chest circumference 32.50±7.78 cm, and mid-arm circumference 10.75±4.60 cm.

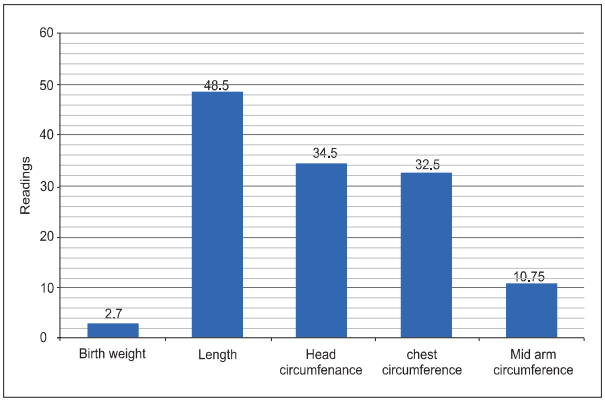

Figure 1: Neonatal anthropometric parameters

The overall incidence of low birth weight (LBW) was 9.33%; LBW was significantly higher among mildly anemic mothers compared to non-anemic mothers (29.41% vs 6.78%, $p<0.05$). Maternal anemia was significantly associated with lower neonatal birth weight (2.97±0.32 vs 3.15±0.36 kg; p=0.01), length (46.92±3.3 vs 48.4±2.8 cm; p=0.041), chest circumference (32.09±0.67 vs 34.56±0.82 cm; p=0.001), head circumference, and mid-arm circumference.

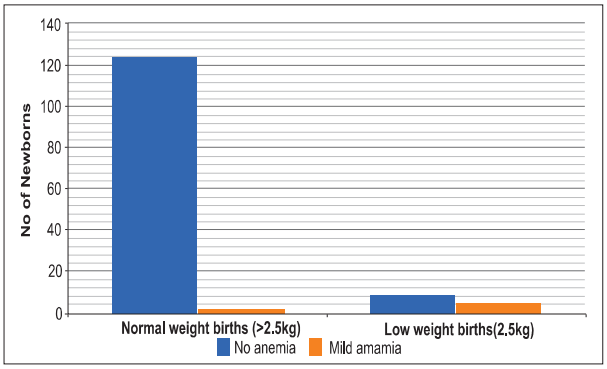

Figure 2: Maternal anemia and low birth weight correlation here

Maternal BMI showed a significant positive correlation with neonatal birth weight (r=0.23, p=0.005), while correlations with other neonatal anthropometric parameters were not statistically significant. Maternal weight >50 kg was significantly associated with higher neonatal birth weight and mid-arm circumference (p=0.01), whereas maternal height showed no significant association with neonatal anthropometric measurements.

Table 1: Correlation between maternal BMI and neonatal anthropometry here

Variable	Weight	Length	HC	CC	MAC
Body mass Index	r=0.23 P=0.005	r=0.03 P=0.72	r=0.13 P=0.11	r=0.22 P=0.54	r=0.19 P=0.62

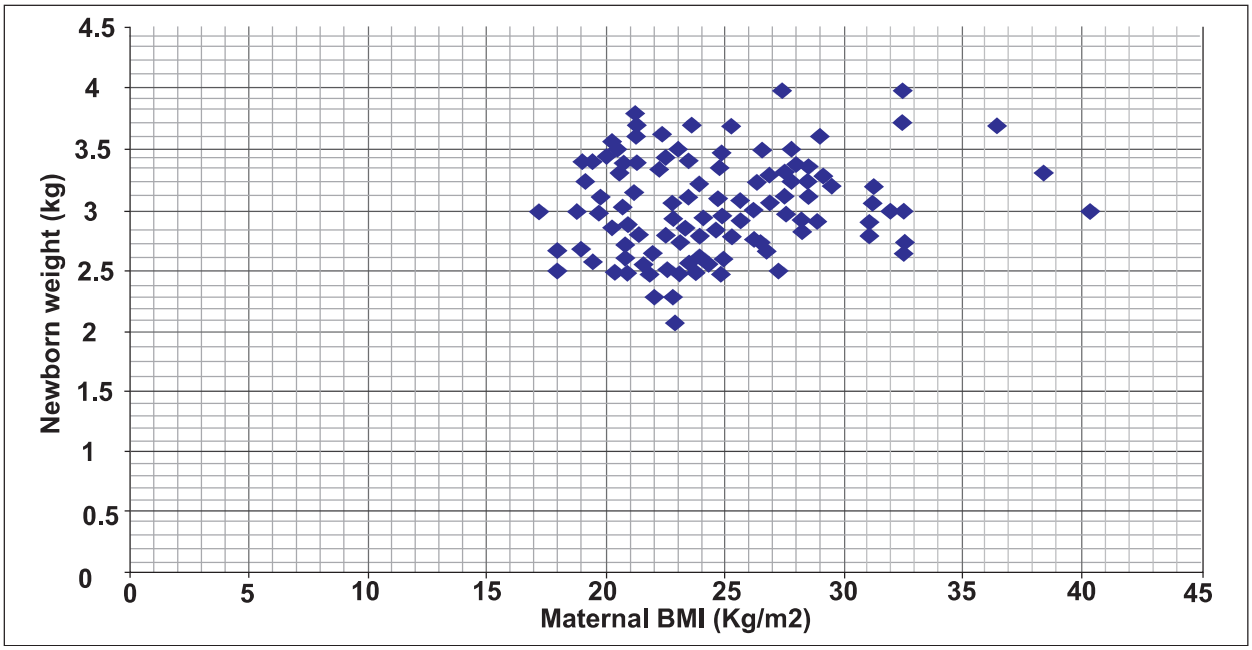

Figure 3: Correlation between maternal BMI and neonatal anthropometry

Greater gestational weight gain (>11 kg) was associated with significantly higher neonatal birth weight compared to lower gestational weight gain categories.

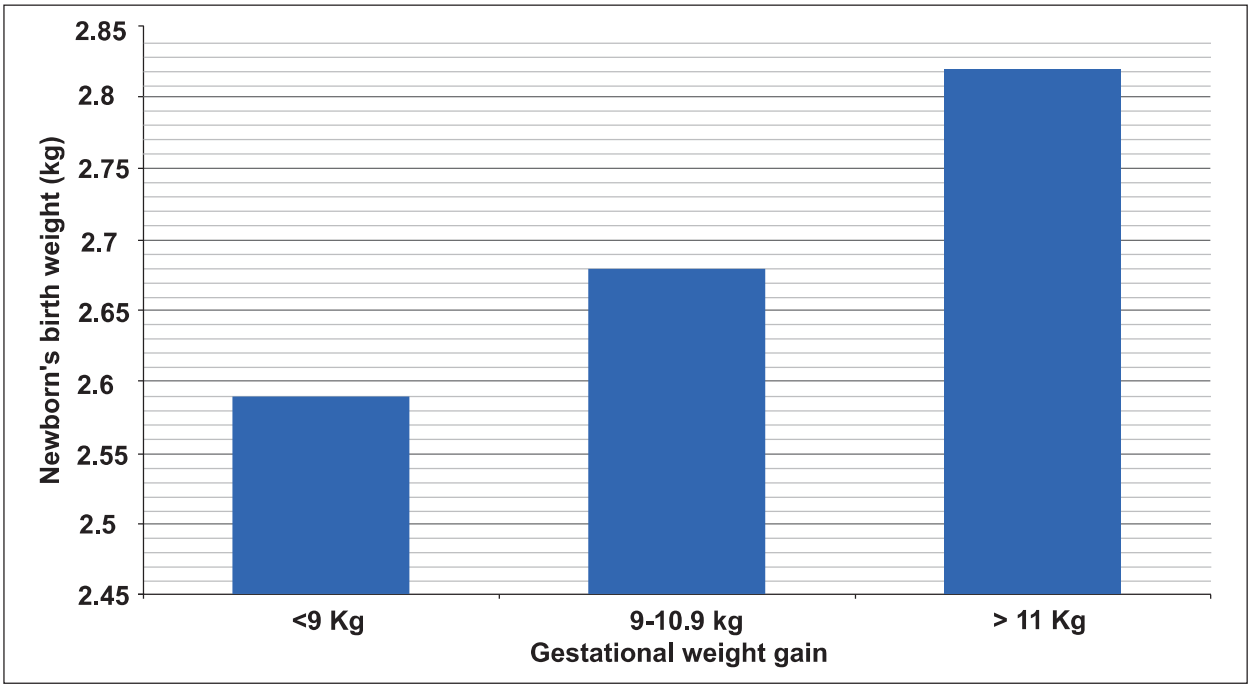

Figure 4: Gestational weight gain and neonatal birth weight here

DISCUSSION

The present study demonstrated a significant association between maternal hemoglobin status and neonatal anthropometric outcomes. Newborns of mildly anemic mothers had significantly lower birth weight, length, head circumference, chest circumference, and mid-arm circumference compared to newborns of non-anemic mothers. The incidence of low birth weight was also substantially higher among anemic mothers. Similar findings have been reported by recent studies demonstrating

that maternal anemia is associated with adverse neonatal anthropometric outcomes and increased risk of low birth weight.[15,16,22] Maternal anemia may contribute to fetal hypoxia, impaired placental perfusion, and intrauterine growth restriction, thereby adversely affecting fetal growth.

In the present study, maternal BMI showed a significant positive correlation with neonatal birth weight, although correlations with other neonatal anthropometric parameters were weak and statistically insignificant. Similar observations have been reported by Mitra et al. and Papazian et al., who found that maternal BMI predominantly influenced neonatal birth weight.[13,23]

Maternal nutritional status is known to play an important role in placental development and fetal growth, while both maternal undernutrition and excessive BMI may adversely influence neonatal outcomes.

Maternal weight >50 kg was significantly associated with higher neonatal birth weight and mid-arm circumference in the present study. Previous studies have similarly demonstrated that lower maternal weight is associated with increased risk of low-birth-weight infants.[12,24]

Gestational weight gain also showed a significant positive association with neonatal birth weight, with mothers gaining >11 kg delivering babies with higher birth weight. Comparable findings have been reported in recent studies evaluating the impact of gestational weight gain on fetal growth.[14,25]

Unlike maternal weight and BMI, maternal height did not show a significant correlation with neonatal anthropometric measurements in our study. Similar findings were reported by Nagmoti *et al*.[12] This suggests that maternal nutritional and hematological parameters may have a greater influence on neonatal anthropometry than maternal stature alone.

The strengths of the present study include its prospective design and comprehensive assessment of multiple neonatal anthropometric parameters. However, the study has certain limitations.

Maternal micronutrient status, paternal anthropometry, and detailed nutritional assessment were not evaluated, which may have influenced neonatal outcomes. In addition, the study was conducted in a metropolitan tertiary care hospital, limiting generalizability to broader populations.

Overall, the present study highlights the significant influence of maternal hemoglobin status, maternal weight, BMI, and gestational weight gain on neonatal anthropometric outcomes. Early identification and optimization of maternal nutritional and hematological status during pregnancy may help improve neonatal growth outcomes and reduce the incidence of low birth weight.

CONCLUSION

Maternal anthropometric and hematological parameters significantly influence neonatal anthropometric outcomes. In the present study, maternal anemia was associated with lower neonatal birth weight, length, head circumference, chest circumference, and mid-arm circumference, with birth weight showing the strongest correlation with maternal hemoglobin status. Maternal BMI, maternal weight, and gestational weight gain demonstrated positive associations with neonatal birth weight, whereas maternal height showed no significant correlation with neonatal anthropometry. These findings emphasize the importance of routine maternal anthropometric assessment and hemoglobin evaluation during antenatal care, particularly in resource-limited settings, as simple and cost-effective tools for identifying pregnancies at risk of adverse neonatal outcomes.

RECOMMENDATIONS

Maternal anthropometric assessment should be incorporated routinely during antenatal visits beginning in the first trimester. Antenatal counseling regarding iron supplementation should emphasize the impact of maternal anemia on neonatal growth and birth weight. Further large-scale studies incorporating maternal nutritional profile and paternal anthropometry are recommended to develop predictive models for neonatal anthropometric outcomes.

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