

## A study on the correlation of maternal physical parameters and anthropometry of first newborn

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### Abstract

**Background:** Child health remains a global priority, emphasized in India's National Health Policy 2017 and the Sustainable Development Goals (SDGs). This study aims to determine LBW prevalence in institutional deliveries, assess socio-demographic and maternal determinants, and examine links between maternal anthropometry and neonatal outcomes.

**Material and methods:** This prospective observational study was conducted in the Department of Pediatrics, Government Medical College, Kota, to determine the prevalence and determinants of LBW among institutional deliveries. Data were collected from 422 primigravida mothers with singleton pregnancies. Maternal anthropometric measurements (weight, BMI, height), socio-demographic variables, and infant birth weight and length were recorded and analyzed.

**Results:** Results revealed significant associations between lower maternal weight, BMI, and height and increased risk of low birth weight (LBW). Socio-economic disparities were evident, with mothers from lower SES categories more likely to have LBW infants.

**Conclusion:** The study highlights the importance of routinely monitoring maternal anthropometric parameters during pregnancy. Addressing socio-economic disparities through targeted public health interventions is crucial to improving neonatal outcomes. Maternal anthropometry remains a simple, portable, and cost-effective method for assessing maternal and fetal health.

**Keywords:** anthropometry; BMI; antenatal care; birth weight; socioeconomic status

### Introduction

Child health challenges are being addressed with greater urgency than ever before. Improving child health and survival remains central to India's National Health Policy 2017 and is integral to the country's commitments under the Sustainable Development Goals (SDGs) [1].

The neonatal period, particularly the first month of life, is the most vulnerable time for child survival. Globally, neonatal mortality was estimated at around 19 per 1,000 live births in 2021, and India's neonatal mortality rate stood at 19 per 1,000 in 2021 as well [2].

Anthropometry is a simple, portable, cost-effective, and non-invasive method for assessing body size, proportions, and composition. Birth weight is a reliable measure of intrauterine growth and a strong predictor of neonatal survival, subsequent growth, and long-

term physical and psychosocial development. India and South Asia continue to report the highest prevalence of low birth weight (LBW) infants globally, with national LBW prevalence estimated at approximately 17–18% in 2019–21 [3].

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The physiological condition and health status of the mother significantly influence neonatal outcomes. Maternal nutritional status—reflected in weight, height, and BMI—is strongly associated with birth weight and risk of LBW [4]. Additionally, lower maternal education, poor socioeconomic status, and inadequate antenatal care are consistently shown to increase LBW risk in recent Indian cohorts [5].

Policymakers and healthcare providers require robust current evidence on maternal and neonatal health to design effective maternity services and targeted interventions. Improving maternal education, nutrition, and access to antenatal and delivery care services are essential strategies to reduce neonatal and childhood mortality [5].

This study aims to estimate the proportion of LBW infants in institutional deliveries, identify socio-demographic and maternal determinants of LBW, and explore associations between maternal anthropometry and neonatal outcomes in the study population.

## Materials and methods

This hospital-based prospective observational study was conducted in the Department of Pediatrics, Government Medical College, Kota, between December 2021 and November 2022. The study aimed to assess the association between maternal factors and neonatal anthropometry. Both the exposure variables (maternal anthropometric and socio-demographic factors) and the outcome variables (infant's birth weight and length) were measured simultaneously during the study period. Before data collection, ethical approval for conducting the study was obtained from the Institutional Ethics Committee of Government Medical College, Kota.

The study population comprised pregnant women admitted for delivery in the hospital wards during the study timeframe. A total sample size of 422 was determined, considering the prevalence of low birth weight and statistical requirements for the study objectives. The inclusion criteria were: primigravida mothers aged between 18 and 35 years, with singleton pregnancies, and no obstetric complications. Newborn anthropometric measurements were taken within 24 hours after birth to ensure accuracy. Mothers with twin pregnancies and neonates with congenital anomalies were excluded from the study.

## Statistical analysis

Data collection was performed using a structured proforma designed based on the study objectives. Maternal anthropometric measurements recorded

included height, weight at the time of delivery, body mass index (BMI), and head circumference. Infant anthropometry included birth weight, crown-heel length, head circumference, and chest circumference. All neonatal measurements were taken within the first 24 hours of birth using standardized techniques to minimize variability.

Maternal socio-demographic data, including age, educational status, occupation, and antenatal care visits, were also recorded. Socio-economic status (SES) was assessed using the Modified Kuppuswamy Socioeconomic Scale, updated as of January 2018, which considers the family's occupation, education, and income of the family to determine SES classification.

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) version 21. Descriptive statistics were calculated for maternal and neonatal anthropometric parameters, including means and standard deviations (SD). Frequencies and percentages were used to classify infants into different birth weight categories and mothers into various delivery weight groups. The correlation between maternal anthropometric factors and neonatal anthropometry was assessed using Pearson's correlation coefficient. The association between maternal socio-demographic factors and infant birth weight and length was evaluated using the Chi-square test. Additionally, independent sample t-tests were employed to compare the means of maternal anthropometric measurements and selected socio-demographic factors between mothers who delivered normal birth weight and LBW infants. Statistical significance was set at a p-value of less than 0.05, with a 95% confidence interval.

## Results

A total of 422 mother-infant pairs were enrolled in this study. The data analysis focused on evaluating the influence of maternal anthropometric measurements and socio-demographic factors on neonatal birth outcomes. Descriptive statistics were used to observe trends in birth weight, head circumference (HC), and other anthropometric parameters across different maternal weight groups, BMI categories, socio-economic strata, and levels of antenatal care. Correlation coefficients and significance levels were computed to assess the strength of associations between these maternal factors and neonatal outcomes.

Table 1 presents the relationship between maternal weight and newborn birth weight. A clear trend of increasing neonatal birth weight was observed with rising maternal weight. Mothers weighing less than 45 kg delivered infants with a mean birth weight of  $2.22 \pm$

0.37 kg, while those in the 45–55 kg group had infants with a mean birth weight of  $2.61 \pm 0.38$  kg. Mothers weighing more than 55 kg delivered infants with a mean

birth weight of  $2.83 \pm 0.39$  kg. The correlation coefficient ( $r = +0.399$ ) indicated a significant positive association between maternal weight and birth weight ( $P < 0.05$ ).

**Table 1:** Relationship of newborn birth weight with maternal weight.

Maternal weight (Kg)	Total number	Birth weight (Kg) Mean	$\pm$ SD
<45	10	2.22	0.37
45-55	238	2.61	0.38
>55	174	2.83	0.39

Table 2 shows the distribution of LBW infants across different maternal weight categories. The incidence of LBW was highest (80%) among mothers weighing less than 45 kg, while it reduced to 29.83% in the 45–55 kg

group and further to 13.22% among mothers weighing over 55 kg. This data highlights the inverse relationship between maternal weight and the likelihood of delivering a LBW infant.

**Table 2:** Number of LBW babies in different maternal weight groups.

Maternal weight (Kg)	Total number	Birth weight <2.5 Kg (Number)	Percentage	Birth weight $\geq$ 2.5 Kg (Number)	Percentage
<45	10	8	80	2	20
45-55	238	71	29.83	167	70.17
>55	174	23	13.22	151	86.78

Table 3 explores the relationship between maternal weight and newborn head circumference. Infants born to mothers weighing less than 45 kg had a mean head circumference of  $32.17 \pm 0.79$  cm, whereas those born to mothers in the 45–55 kg and >55 kg categories had mean head circumferences of  $33.67 \pm 0.90$  cm and  $34.22 \pm 0.86$  cm, respectively. The correlation coefficient ( $r = +0.426$ ) indicates a strong positive association between maternal weight and neonatal head circumference.

$18.5 \text{ kg/m}^2$  delivered infants with a mean birth weight of  $1.85 \pm 0.50$  kg, while those in the  $18.5\text{--}24 \text{ kg/m}^2$  and  $>24 \text{ kg/m}^2$  groups had infants with mean birth weights of  $2.64 \pm 0.40$  kg and  $2.75 \pm 0.40$  kg, respectively. The correlation coefficient ( $r = +0.345$ ) confirms a direct positive association between maternal BMI and birth weight.

**Table 3:** Relationship between maternal weight and newborn head circumference.

Maternal weight (Kg)	Total number	Newborn HC mean (cm)	$\pm$ SD
<45	10	32.17	0.79
45-55	238	33.67	0.90
>55	174	34.22	0.86

**Table 4:** Effect of maternal socioeconomic status on newborns' head circumference.

SES	Total number	Newborn HC mean (cm)	$\pm$ SD
I	41	34.44	0.84
II	111	34.02	0.98
III	195	33.83	0.82
IV	58	33.76	0.95
V	17	32.15	0.53

Table 4 evaluates the effect of maternal socio-economic status (SES) on newborn head circumference. Infants born to mothers in the highest SES category had the largest mean head circumference ( $34.44 \pm 0.84$  cm), while those in the lowest SES group had a significantly smaller mean head circumference ( $32.15 \pm 0.53$  cm). A gradient of decreasing HC was noted with declining SES, emphasizing the impact of socio-economic disparities on neonatal anthropometry.

**Table 5:** Correlation of mean birth weight with maternal BMI.

Maternal BMI ( $\text{Kg/m}^2$ )	Total number	Mean birth weight (Kg)	$\pm$ SD
<18.5	2	1.85	0.50
18.5-24	294	2.64	0.40
>24	126	2.75	0.40

Table 5 depicts the relationship between maternal BMI and neonatal birth weight. Mothers with a BMI less than

Table 6 provides the distribution of LBW infants among different maternal BMI categories. All mothers with a BMI below  $18.5 \text{ kg/m}^2$  delivered LBW infants (100%).

Among mothers with a BMI of 18.5–24 kg/m<sup>2</sup>, 24.82% delivered LBW infants, while the proportion decreased to 21.43% in mothers with a BMI exceeding 24 kg/m<sup>2</sup>.

This data reinforces the significant role of maternal BMI in determining neonatal birth weight (P < 0.05).

**Table 6:** Relationship of LBW babies with different maternal BMI groups.

Maternal BMI (Kg/m <sup>2</sup> )	Total number	Birth weight <2.5 Kg (Number)	Percentage	Birth weight ≥2.5 Kg (Number)	Percentage
<18.5	2	2	100	0	0
18.5-24	294	73	24.82	221	75.18
>24	126	27	21.43	99	78.57

Table 7 examines the relationship between socio-economic status and LBW prevalence. The occurrence of LBW was minimal (4.87%) among mothers from the highest SES category but increased progressively in

lower SES groups. Alarming, 76.47% of infants born to mothers from the lowest SES category were classified as LBW. These findings underline the critical influence of socio-economic factors on birth outcomes.

**Table 7:** Number of LBW babies in different socioeconomic status.

SES	Total number	Birth weight <2.5 Kg (Number)	Percentage	Birth weight ≥2.5 Kg (Number)	Percentage
I	41	2	4.87	39	95.13
II	111	19	17.12	92	82.88
III	195	47	24.10	148	75.90
IV	58	21	36.20	37	63.80
V	17	13	76.47	4	23.53

Table 8 illustrates the impact of antenatal care on birth weight. Infants born to mothers who had booked antenatal visits had a higher mean birth weight of 2.91 ± 0.412 kg compared to 2.56 ± 0.39 kg among those born to unbooked mothers. This indicates a positive association between adequate antenatal care and improved neonatal birth weight outcomes.

**Table 8:** Relationship of antenatal care and birth weight.

Antenatal care	Number of babies	Mean birth weight (Kg)	± SD
Booked	350	2.91	0.412
Unbooked	72	2.56	0.39

Table 9 assesses the relationship between maternal height and neonatal birth weight. A significant positive correlation (r = +0.352, P < 0.01) was found, with mothers shorter than 145 cm delivering infants with a mean birth weight of 2.55 ± 0.51 kg. Mothers within the 145–160 cm height range had infants with a mean birth weight of 2.67 ± 0.38 kg, while those taller than 160 cm delivered infants with a mean birth weight of 3.06 ± 0.447 kg.

**Table 9:** Relationship of maternal height to birth weight.

Maternal height (cm)	Number of babies	Mean birth weight (Kg)	± SD
<145	40	2.55	0.51
145-160	357	2.67	0.38
>160	25	3.06	0.447

### Discussion

This hospital-based prospective observational study was conducted in the Department of Pediatrics, Government Medical College, Kota, involving 422 mothers and their full-term, first-born newborns. Among the newborns, 225 (53.32%) were male. The mean values of key neonatal anthropometric parameters were as follows: birth weight – 2.68 kg, crown-heel length (CHL) – 47.06 cm, head circumference (HC) – 33.83 cm, and chest circumference (CC) – 31.17 cm.

The prevalence of LBW in this study was 24.17%, which is notably higher than the national average. This elevated prevalence can be attributed to the tertiary care hospital setting, where high-risk pregnancies are more commonly

referred. LBW infants are known to face increased risks of perinatal and infant mortality, as well as long-term morbidity and developmental complications [6]. Similar findings were reported by Malik S et al., where maternal biosocial factors significantly impacted LBW rates [7].

Several maternal factors were observed to have significant associations with neonatal birth weight. Lower SES, reduced maternal education, inadequate gestational weight gain, and shorter maternal height were prominent determinants of LBW in the study population. Maternal occupation, especially among manual laborers, also influenced birth outcomes, with labor-intensive jobs correlating with higher LBW incidence. This aligns with findings from Radhakrishnan T et al., who reported SES, maternal education, and antenatal care as critical factors influencing birth weight in a community-based study in Kerala [8].

Lower SES is repeatedly associated with higher LBW prevalence in various Indian and global studies, attributed to limited health awareness, poor nutritional status, and inadequate prenatal care utilization [9, 10]. Maternal anthropometric measurements, especially weight and BMI, emerged as reliable predictors of neonatal birth weight. Mothers weighing less than 45 kg were significantly more likely to deliver LBW infants, emphasizing the importance of maternal nutrition and body composition [11-13].

Additional risk factors influencing LBW include unplanned pregnancies and maternal smoking habits, as documented in multiple studies [14]. The multifactorial nature of LBW was evident in this study, where maternal demographic attributes, socio-economic background, lifestyle habits, and antenatal care utilization collectively influenced neonatal outcomes. These observations are consistent with findings from other Indian studies, including those by Malik S et al. [7] and Radhakrishnan T et al. [8].

Furthermore, studies conducted in rural regions of Southern India have emphasized similar associations, where maternal factors such as pre-pregnancy weight, maternal age, parity, inter-pregnancy interval, obstetric history, family income, and literacy level significantly affected birth weight outcomes [13].

## Conclusion

Maternal physical parameters such as weight, height, and BMI are significant predictors of neonatal birth outcomes. Regular monitoring of these parameters during pregnancy, along with ensuring adequate antenatal care, is essential to reduce the incidence of low birth weight. Early interventions focusing on maternal

nutrition, education, and socio-economic support can significantly improve neonatal health and survival. This study emphasizes the need for integrating maternal anthropometry assessments into routine antenatal care to identify at-risk pregnancies and implement targeted interventions for better birth outcomes.

## Conflicts of interest

Authors declare no conflicts of interest.

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