



Relationship between maternal nutritional status during pregnancy and neonatal birth outcomes: assessment of birth weight, gestational age, length, and early neonatal complications.

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Abstract

Background: Maternal nutritional status during pregnancy plays an important role in fetal growth and neonatal health. Both maternal undernutrition and excessive maternal weight may influence birth weight, gestational age, and early neonatal morbidity.

Objective: To assess the relationship between maternal nutritional status during pregnancy and neonatal birth outcomes, including birth weight, gestational age, birth length, and early neonatal complications. **Materials and Methods:** A prospective observational study was conducted in the Department of Obstetrics and Gynaecology, KLE JGMMMC, Hubballi, over a period of 6 months. A total of 150 pregnant women with singleton pregnancies and their live-born neonates were included. Maternal nutritional status was assessed using body mass index (BMI), along with relevant dietary and obstetric information. Neonatal outcomes including birth weight, birth length, gestational age, and early neonatal complications were recorded. Data were analysed using appropriate descriptive and comparative statistical methods, with $p < 0.05$ considered statistically significant. **Results:** Among the 150 mothers, 24 (16.0%) were underweight, 76 (50.7%) had normal BMI, 38 (25.3%) were overweight, and 12 (8.0%) were obese. Mean birth weight was lowest among neonates born to underweight mothers (2.54 ± 0.38 kg) and increased across higher BMI categories. Low birth weight was observed in 41.7% of neonates of underweight mothers compared with 15.8% among mothers with normal BMI. Mean birth length and gestational age were also lower among neonates of underweight mothers. Early neonatal complications occurred in 37.5% of neonates born to underweight mothers compared with 17.1% among those born to mothers with normal BMI. Maternal BMI showed a positive correlation with birth weight ($r=0.38$) and birth length ($r=0.29$). **Conclusion:** Maternal nutritional status was associated with neonatal birth outcomes. Maternal undernutrition was associated with lower birth weight and length, shorter gestational age, increased low birth weight, and greater early neonatal morbidity. Early nutritional assessment, appropriate weight management, dietary counselling, and regular antenatal monitoring may help improve maternal and neonatal outcomes.

Keywords: Maternal nutritional status; Pregnancy; Body mass index; Birth weight; Gestational age; Birth length; Neonatal complications.



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INTRODUCTION

Maternal nutritional status during pregnancy is an important determinant of fetal growth, pregnancy outcome, and neonatal health. Pregnancy is associated with increased nutritional requirements to support maternal physiological adaptations, placental development, fetal growth, and preparation for lactation. Inadequate maternal nutrition may impair fetal growth and increase the risk of low birth weight, small-for-gestational-age birth, and preterm delivery. Conversely, excessive maternal weight and obesity may increase the risk of excessive fetal growth, macrosomia, and other maternal and neonatal complications. [1,2]

Maternal body mass index (BMI) is one of the commonly used anthropometric indicators for evaluating maternal nutritional status. Pre-pregnancy BMI and gestational weight gain provide useful information regarding maternal energy reserves and nutritional adequacy during pregnancy. Maternal underweight has been consistently associated with adverse pregnancy outcomes, particularly low birth weight and preterm birth. In contrast, maternal overweight and obesity have been associated with increased fetal growth and a higher risk of large-for-gestational-age birth and macrosomia. [3,4]

Fetal growth depends on adequate maternal nutrient availability, placental function, uteroplacental circulation, and fetal metabolic and genetic factors. Maternal undernutrition can restrict the supply of essential nutrients required for fetal tissue development, resulting in impaired intrauterine growth. Birth weight is therefore an important indicator of fetal growth and neonatal health. However, assessment of birth length and gestational age provides additional information regarding the overall effect of maternal nutritional status on fetal development. [5]

Maternal nutritional status may also influence neonatal morbidity. Low birth weight and prematurity are associated with increased vulnerability to hypoglycaemia, feeding difficulties, hypothermia, respiratory problems, jaundice, and the need for neonatal intensive care. At the same time, maternal overweight and obesity may be associated with neonatal metabolic and respiratory complications. Thus, maternal nutrition may influence neonatal health through multiple pathways rather than affecting birth weight alone. [2,6]

Gestational weight gain is another important component of nutritional assessment during pregnancy. Both inadequate and excessive gestational weight gain have been associated with adverse birth outcomes. Inadequate weight gain is associated with small-for-gestational-age birth and preterm birth, whereas excessive weight gain is associated with large-for-gestational-age birth and macrosomia. [7]

Maternal undernutrition remains an important public health concern in India, while overweight and obesity are increasingly prevalent among women of reproductive age. This coexistence of undernutrition and overnutrition creates a dual nutritional burden and emphasizes the need for appropriate nutritional assessment during antenatal care. [8]

Nutritional counselling, appropriate weight monitoring, dietary optimization, and adequate micronutrient supplementation are therefore important components of antenatal care. Early identification of women with nutritional abnormalities may allow timely interventions aimed at improving fetal growth and reducing preventable neonatal morbidity. [1,9]

The present study was undertaken to assess the relationship between maternal nutritional status during pregnancy and neonatal birth outcomes, with particular emphasis on birth weight, gestational age, birth length, and early neonatal complications among 150 mother–newborn pairs at KLE JGMMMC, Hubballi.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted to assess the relationship between maternal nutritional status during pregnancy and neonatal birth outcomes, including birth weight, gestational age, birth length, and early neonatal complications. The study was carried out in the Department of Obstetrics and Gynaecology, KLE JGMMMC, Hubballi, over a period of 6 months.

Study Population

The study included pregnant women who attended the antenatal clinic or were admitted for delivery during the study period and fulfilled the predefined eligibility criteria. A total of 150 pregnant women and their newborns were included in the study.

Sample Size

The sample size consisted of 150 pregnant women–neonate pairs recruited during the six-month study period.

Inclusion Criteria

Pregnant women were included if they:

- Were willing to participate in the study and provided informed consent.
- Had a singleton pregnancy.
- Presented for antenatal care and/or delivery during the study period.
- Had available maternal nutritional and obstetric information.
- Delivered a live newborn during the study period.

Exclusion Criteria

Women were excluded if they:

- Had multiple pregnancies such as twins or higher-order gestation.
- Had a known major fetal congenital anomaly.
- Had significant chronic systemic illness likely to independently influence fetal growth or neonatal outcome.
- Had incomplete or unreliable maternal or neonatal records.
- Declined participation in the study.

Assessment of Maternal Nutritional Status

Maternal nutritional status was assessed during pregnancy using anthropometric and clinical parameters. Maternal height and weight were recorded using standard techniques, and body mass index (BMI) was calculated using the formula:

$$\text{BMI} = \text{Weight (kg)} / \text{Height (m}^2\text{)}$$

The maternal nutritional status was categorized according to the recorded BMI and relevant clinical nutritional assessment. Maternal dietary and nutritional history was obtained through a structured interview, including information regarding dietary intake, meal pattern, and relevant nutritional supplementation during pregnancy.

Maternal and Obstetric Data Collection

A structured data-collection proforma was used to record maternal demographic and obstetric characteristics, including:

- Maternal age
- Gravidity and parity
- Gestational age at delivery
- Antenatal nutritional status
- Maternal weight and height
- BMI
- Antenatal supplementation
- Relevant pregnancy-related complications
- Mode of delivery

Gestational age was determined from the antenatal record, preferably based on the last menstrual period and/or early ultrasonography when available.

Neonatal Assessment

Each newborn was assessed immediately after delivery. The following neonatal parameters were recorded:

1. **Birth weight:**
Birth weight was measured using a calibrated weighing scale soon after delivery and recorded in kilograms.
2. **Birth length:**
Neonatal crown-to-heel length was measured using an appropriate infantometer and recorded in centimetres.
3. **Gestational age:**
Gestational age at birth was recorded in completed weeks based on maternal antenatal records.
4. **Early neonatal complications:**
Newborns were monitored during the early neonatal period for clinically documented complications, including conditions such as respiratory difficulty, hypoglycaemia, neonatal jaundice, feeding difficulties, hypothermia, need for neonatal intensive care, and other clinically significant complications.

Study Variables

The primary maternal exposure variable was maternal nutritional status during pregnancy. The principal neonatal outcome variables were:

- Birth weight
- Gestational age at birth
- Birth length
- Presence of early neonatal complications

Maternal demographic and obstetric characteristics were considered as relevant background variables.

Data Collection Procedure

Eligible pregnant women were enrolled prospectively after obtaining informed consent. Maternal nutritional and anthropometric information was recorded during the antenatal period. Following delivery, neonatal birth weight, length, gestational age, and early neonatal clinical outcomes were documented. Maternal and neonatal information was subsequently compiled for statistical analysis.

Statistical Analysis

The collected data were entered into a Microsoft Excel spreadsheet and analysed using appropriate statistical methods. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. The relationship between maternal nutritional status and neonatal outcomes was assessed using appropriate comparative and correlation tests depending on the distribution and nature of the variables. A p-value <0.05 was considered statistically significant.

RESULTS

The present prospective observational study was conducted in the Department of Obstetrics and Gynaecology, KLE JGMMMC, Hubballi, over a period of 6 months. A total of 150 pregnant women and their newborns were included in the study. Maternal nutritional status was assessed and its relationship with neonatal birth weight, gestational age, birth length, and early neonatal complications was evaluated.

Table 1: Distribution of Study Participants According to Maternal Age

Maternal age (years)	Number (n=150)	Percentage
<20	8	5.3
20–24	43	28.7
25–29	61	40.7
30–34	29	19.3
≥35	9	6.0
Total	150	100.0

The majority of mothers belonged to the **25–29 years** age group (40.7%), followed by 20–24 years (28.7%).

Table 2: Maternal Nutritional Status According to BMI

Maternal nutritional status	BMI category	Number (n=150)	Percentage
Underweight	<18.5 kg/m ²	24	16.0
Normal weight	18.5–24.9 kg/m ²	76	50.7
Overweight	25.0–29.9 kg/m ²	38	25.3
Obese	≥30 kg/m ²	12	8.0
Total		150	100.0

More than half of the mothers (50.7%) had a normal BMI, while **16.0% were underweight** and **33.3% were either overweight or obese**.

Table 3: Distribution According to Gestational Age at Delivery

Gestational age	Number (n=150)	Percentage
<37 weeks	18	12.0
37–38 weeks	39	26.0
39–40 weeks	82	54.7
>40 weeks	11	7.3
Total	150	100.0

The majority of newborns (54.7%) were delivered at **39–40 weeks**, while **12.0% were preterm**.

Table 4: Distribution According to Neonatal Birth Weight

Birth weight	Number (n=150)	Percentage
<2.5 kg	28	18.7
2.5–2.99 kg	48	32.0
3.0–3.49 kg	52	34.7
3.5–3.99 kg	18	12.0
≥4.0 kg	4	2.7
Total	150	100.0

The most frequent birth-weight category was **3.0–3.49 kg (34.7%)**. Low birth weight (<2.5 kg) was observed in **18.7%** of newborns.

Table 5: Distribution According to Birth Length

Birth length	Number (n=150)	Percentage
<45 cm	15	10.0
45–49 cm	76	50.7
50–54 cm	54	36.0
≥55 cm	5	3.3
Total	150	100.0

Half of the newborns (50.7%) had a birth length of **45–49 cm**, while 36.0% had a birth length of 50–54 cm.

Table 6: Maternal Nutritional Status and Mean Neonatal Birth Weight

Maternal nutritional status	n	Mean birth weight (kg)	SD
Underweight	24	2.54	0.38
Normal weight	76	2.94	0.41
Overweight	38	3.12	0.43
Obese	12	3.28	0.46

A progressive increase in mean neonatal birth weight was observed across the maternal BMI categories, with the lowest mean birth weight among newborns of underweight mothers.

Table 7: Maternal Nutritional Status and Gestational Age at Birth

Maternal nutritional status	n	Mean gestational age (weeks)	SD
Underweight	24	37.4	1.8
Normal weight	76	38.7	1.3
Overweight	38	39.0	1.2
Obese	12	39.1	1.1

Newborns of underweight mothers had a lower mean gestational age compared with newborns of mothers with normal or higher BMI.

Table 8: Maternal Nutritional Status and Mean Birth Length

Maternal nutritional status	n	Mean birth length (cm)	SD
Underweight	24	46.7	2.1
Normal weight	76	49.0	1.9
Overweight	38	49.6	1.8
Obese	12	50.0	1.7

The mean birth length was lowest among newborns born to underweight mothers and was higher among newborns of mothers with normal, overweight, and obese BMI.

Table 9: Maternal Nutritional Status and Low Birth Weight

Maternal nutritional status	Low birth weight n (%)	Normal birth weight n (%)	Total
Underweight	10 (41.7)	14 (58.3)	24
Normal weight	12 (15.8)	64 (84.2)	76
Overweight	5 (13.2)	33 (86.8)	38
Obese	1 (8.3)	11 (91.7)	12
Total	28 (18.7)	122 (81.3)	150

Low birth weight was more frequently observed among newborns of **underweight mothers (41.7%)** compared with mothers having normal or higher BMI.

Table 10: Distribution of Early Neonatal Complications

Early neonatal complication	Number (n=150)	Percentage
No complication	120	80.0
Neonatal jaundice	10	6.7
Respiratory difficulty	8	5.3
Hypoglycaemia	5	3.3
Feeding difficulty	4	2.7
Hypothermia	2	1.3
NICU admission for other indication	1	0.7

Overall, **30 newborns (20.0%)** developed at least one early neonatal complication. Neonatal jaundice was the most frequently observed complication (6.7%), followed by respiratory difficulty (5.3%).

Table 11: Maternal Nutritional Status and Early Neonatal Complications

Maternal nutritional status	Complications present n (%)	No complication n (%)	Total
Underweight	9 (37.5)	15 (62.5)	24
Normal weight	13 (17.1)	63 (82.9)	76
Overweight	6 (15.8)	32 (84.2)	38
Obese	2 (16.7)	10 (83.3)	12
Total	30 (20.0)	120 (80.0)	150

Early neonatal complications were more frequently observed among newborns of **underweight mothers (37.5%)** compared with the other maternal nutritional-status groups.

Table 12: Correlation of Maternal BMI with Neonatal Outcomes

Neonatal outcome	Correlation with maternal BMI (r)	Interpretation
Birth weight	+0.38	Positive correlation
Birth length	+0.29	Positive correlation
Gestational age	+0.21	Weak positive correlation
Early neonatal complications	-0.18	Weak inverse correlation

Maternal BMI showed a positive correlation with neonatal birth weight and birth length, while the relationship with gestational age was weaker. A weak inverse relationship was observed between maternal BMI and early neonatal complications.

DISCUSSION

The present prospective observational study evaluated the relationship between maternal nutritional status and neonatal birth outcomes among 150 mother–newborn pairs. Maternal nutritional status was assessed using BMI, while neonatal outcomes included birth weight, gestational age, birth length, and early neonatal complications. The findings demonstrated that maternal nutritional status was associated with important differences in neonatal growth parameters and early neonatal morbidity.

In the present study, 16.0% of mothers were underweight, 50.7% had normal BMI, 25.3% were overweight, and 8.0% were obese. The presence of both underweight and increased BMI in the study population reflects the coexistence of different forms of maternal nutritional risk. Maternal nutritional status is influenced by dietary intake, pre-pregnancy nutritional reserves, socioeconomic factors, physical activity, and maternal health conditions. Both nutritional deficiency and excessive maternal adiposity can alter the intrauterine environment and influence fetal growth. [2,8]

One of the important findings of the present study was the difference in neonatal birth weight according to maternal nutritional status. Newborns of underweight mothers had the lowest mean birth weight, whereas newborns of overweight and obese mothers had comparatively higher mean birth weights. This observation supports the established relationship between maternal nutritional status and fetal growth. Maternal undernutrition may reduce the availability of energy and nutrients required for fetal tissue development and consequently increase the risk of impaired fetal growth and low birth weight. [3,4]

The frequency of low birth weight was also considerably higher among newborns of underweight mothers. In the present study, 41.7% of newborns born to underweight mothers had a birth weight below 2.5 kg, compared with 15.8% among mothers with normal BMI. This finding is consistent with the observations of Han et al., who reported that maternal underweight was associated with increased risks of low birth weight and preterm birth. [3] Similarly, Rahman et al. reported that maternal underweight was associated with adverse birth outcomes, including low birth weight and small-for-gestational-age birth, particularly in low- and middle-income countries. [4]

Maternal undernutrition may affect fetal growth through inadequate maternal energy stores, insufficient nutrient intake, impaired placental nutrient transfer, and alterations in the maternal metabolic environment. Muthayya emphasized that maternal undernutrition remains an important contributor to low birth weight, particularly in developing countries. [8] The higher proportion of low-birth-weight newborns among underweight mothers in the present study is therefore biologically plausible and consistent with previous evidence.

Birth length also demonstrated a relationship with maternal nutritional status. Newborns of underweight mothers had a lower mean birth length than newborns of mothers with normal, overweight, or obese BMI. Birth length reflects linear fetal growth and can provide additional information regarding intrauterine development. The finding that both birth weight and birth length were lower among newborns of underweight mothers suggests that inadequate maternal nutritional status may influence overall fetal growth rather than affecting only fetal weight.

The present study also demonstrated differences in gestational age according to maternal nutritional status. Newborns of underweight mothers had a lower mean gestational age compared with newborns of mothers with normal BMI. Maternal underweight has previously been associated with increased risk of preterm delivery. Han et al., in a systematic review and meta-analysis, reported that maternal underweight was associated with an increased risk of preterm birth. [3] The lower gestational age observed among newborns of underweight mothers in the present study may therefore represent another pathway through which maternal nutritional status contributes to adverse neonatal outcomes.

The findings related to overweight and obesity should also be interpreted carefully. In the present study, overweight and obese mothers had comparatively higher mean neonatal birth weights. Increased maternal BMI has been associated with

increased fetal growth and a greater risk of large-for-gestational-age birth and macrosomia. [2,6] However, higher maternal BMI should not be interpreted as protective against neonatal morbidity. Maternal overweight and obesity may increase the risk of metabolic, respiratory, and other pregnancy-related complications.

Early neonatal complications were observed in 20.0% of newborns in the present study. Neonatal jaundice was the most frequently observed complication, followed by respiratory difficulty, hypoglycaemia, feeding difficulty, and hypothermia. The frequency of early neonatal complications was higher among newborns of underweight mothers than among newborns of mothers with normal BMI. This observation may partly be explained by the higher frequency of low birth weight and lower gestational age among newborns of underweight mothers.

Low birth weight and prematurity are important determinants of early neonatal morbidity. Smaller and preterm newborns may have limited metabolic reserves and immature physiological systems, increasing their susceptibility to hypoglycaemia, temperature instability, feeding problems, respiratory difficulties, and other complications. Therefore, the increased neonatal morbidity observed among newborns of underweight mothers in the present study may reflect the combined effects of impaired fetal growth and reduced gestational maturity.

The present study demonstrated a positive correlation between maternal BMI and neonatal birth weight and birth length. The correlation with gestational age was weaker. These findings suggest that maternal nutritional status contributes to neonatal anthropometric characteristics, although fetal growth and gestational duration are multifactorial outcomes. Maternal health, placental function, fetal genetics, socioeconomic conditions, infections, and obstetric complications may also influence these outcomes.

The relationship between maternal nutritional status and neonatal outcomes is also influenced by gestational weight gain. Goldstein et al. reported that inadequate gestational weight gain was associated with increased risk of small-for-gestational-age birth and preterm birth, whereas excessive gestational weight gain was associated with large-for-gestational-age birth and macrosomia. [7] Therefore, nutritional assessment during pregnancy should ideally include monitoring of maternal weight throughout gestation rather than relying solely on BMI.

The findings of the present study emphasize the importance of nutritional assessment as a component of routine antenatal care. Underweight pregnant women may benefit from early nutritional counselling, dietary optimization, appropriate supplementation, and closer fetal growth surveillance. Similarly, women with overweight or obesity require individualized advice regarding healthy diet, physical activity, and appropriate gestational weight gain. The World Health Organization recommends nutritional counselling and appropriate nutritional interventions as important components of antenatal care. [1,9]

The present findings are particularly relevant in the Indian context, where maternal undernutrition continues to coexist with increasing overweight and obesity. The dual burden of malnutrition requires an individualized approach to antenatal nutritional care. Identification of nutritional risk early in pregnancy may provide an opportunity to improve maternal nutritional status and potentially reduce adverse fetal and neonatal outcomes.

Overall, the findings of the present study indicate that maternal nutritional status is associated with neonatal birth outcomes, particularly birth weight and birth length. Maternal underweight was associated with lower neonatal birth weight and length, lower gestational age, a greater proportion of low-birth-weight newborns, and a higher frequency of early neonatal complications. These findings support the importance of systematic nutritional assessment, appropriate weight management, dietary counselling, and adequate antenatal monitoring to promote favourable maternal and neonatal outcomes.

CONCLUSION

The present study demonstrates that maternal nutritional status during pregnancy is associated with important neonatal outcomes. Maternal undernutrition was associated with lower birth weight and birth length, lower gestational age, increased frequency of low birth weight, and higher early neonatal morbidity. These findings highlight the importance of early nutritional assessment, appropriate weight management, dietary counselling, and regular antenatal monitoring to promote optimal fetal growth and improve neonatal outcomes.

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