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# Impact of Maternal Nutrition on Fetal Development: A Biochemical Analysis

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**ABSTRACT**
**Background:** Maternal nutrition during pregnancy significantly impacts placental-fetal development, affecting offspring's health and productivity. Maternal anemia during pregnancy is a major public health issue, leading to fetal growth retardation and reduced birth weight. Therefore, this study aims to determine the impact of maternal nutrition on fetal development through biochemical analysis.
**Methods:** The study comprised 300 pregnant women, who met the eligibility requirements and delivered throughout the study period. Face-to-face interviews using pre-tested questionnaires were used to obtain socio-demographic data and obstetric information. Physiological variables, including height, weight, and maternal BMI, were measured using suitable equipment. Maternal blood samples were obtained to evaluate haemoglobin levels, while serum samples were analysed for total protein and cholesterol levels. Soon after birth, the newborn's weight was measured with a conventional beam balance.
**Results:** The research involved 300 pregnant women, the average age being 28.5 years. Muslims were the most common religion among the ladies, followed by Hindus and Christians. The neonates had an average birth weight of 3.20 kg, with 93.3% falling into the normal birth weight category. In simple regression analysis, all maternal characteristics were found to be strongly linked with the birth weight of the newborn. Multiple regression studies identified parity, Hbg level, pregnancy weight increase, and pregnancy BMI as significant predictors of childbirth weight ($p<0.05$).
**Conclusion:** The study findings underscore the importance of optimizing maternal nutrition to support healthy fetal development and improve birth outcomes. This highlights the need for interventions and strategies to ensure adequate intake of essential nutrients during pregnancy, particularly fats, proteins, and iron, to promote optimal fetal growth and development.

**Key-words:** Biochemical analysis, Fetal development, Maternal nutrition, Multiple regression analysis Simple regression

## INTRODUCTION

Nutrition has a significant impact on mother and child health. Poor maternal nutritional status has been linked to poor birth outcomes; however, the relationship between maternal nutrition and birth outcomes is complicated and impacted by a variety of physiological, socioeconomic, and demographic variables that fluctuate greatly between populations [1]. Most research on the impact of nutrition during pregnancy has focused on the second and/or third trimesters when essential processes such as organogenesis are complete [2]. Ensuring that the fetus receives an appropriate quantity of nutrients during gestation is also dependent on placental function, which is determined in early pregnancy and may be altered by maternal diet [2,3]. Early maternal endocrine and metabolic responses impact the availability and use of available nutrients for the rapidly developing fetus later in pregnancy [4,5]. Several observational studies have found that body size measurements such as height, weight, and body mass index (BMI) are linked with poor

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delivery outcomes such as low birthweight (LBW) and small-for-gestational-age (SGA) [6-8].

The growth of the fetus is completely dependent on maternal nutritional intake and storage, particularly lipids and proteins. Thus, insufficient fat and protein consumption reduces the fetus's nutritional availability [9]. Furthermore, maternal protein and lipid consumption have a considerable impact on fetal development and delivery outcomes [10]. Biochemical research revealed that maternal blood lipid levels in late pregnancy were linked to infant anthropometry. Elevated blood lipids during pregnancy are required for the fetus's proper growth [11-14].

Low maternal haemoglobin concentration during pregnancy also contributes to poor fetal development, in addition to deficiencies in protein and fats [10,15]. Pregnancy-related maternal haemoglobin levels have a significant impact on neonatal anthropometry, particularly the birth weight of the child [10]. A mother may become susceptible to nutritional deficiency anaemia if her diet does not provide enough iron to fulfil the increased nutritional requirements during pregnancy [16]. Pregnancy-related maternal anaemia is a serious public health issue because it can cause fetal development retardation, which lowers the birth weight of the resulting children [17]. Thus, the purpose of the current study was to use biochemical analysis to ascertain how maternal diet affected fetal development.

## MATERIALS AND METHODS

This cross-sectional study was conducted at the Department of OBG, Kasturba Hospital, Delhi, for a period of study from 8/04/2023 to 29/09/2023.

**Inclusion Criteria-** The research included all pregnant women aged 20 to 35, who were in labour and had a singleton-term pregnancy (37–42 weeks).

**Exclusion Criteria-** This study did not include pregnant women, who had a history of smoking, alcohol or drug misuse, chronic illness, diagnosis of fetal abnormality, or stillbirth.

**Methodology-** A total of 300 pregnant women, who met the eligibility requirements and gave birth throughout the research period were included in the study. Pre-tested questionnaires were used in face-to-face interviews to gather information about the pregnant women's socio-demographic traits and obstetrics. Using the proper measurement equipment, physiological variables, including height, weight, and maternal BMI were ascertained. The World Health Organisation (WHO) established BMI cutoffs, which were then used to classify people into three categories: underweight (BMI<18.5), normal weight (BMI<18.5–24.99), and overweight (BMI>25) [18]. Based on their BMI prior to becoming pregnant, women were categorized as having low, recommended, or high gestational weight increases, according to 2009 Institute of Medicine standards [19].

Blood samples from mothers were taken to measure their haemoglobin levels. For this investigation, the WHO classifications of anaemia for pregnant women were utilized. Haemoglobin concentrations less than 11 g/dL were considered anaemia. Mild (10–10.9 g/dL), moderate (7–9.9 g/dL), and severe (<7 g/dL) categories were added [20]. Furthermore, the blood samples were examined to determine the amount of total protein and total cholesterol. The Biuret technique [21] was utilized to measure total protein, whereas the cholesterol oxidase/peroxidase colorimetric (ENDPOINT) method [22] was employed to measure total cholesterol.

The weight of the infant was assessed shortly after birth by skilled staff members using a conventional beam balance. Neonatal were categorized as LBW (less than 2500 g), normal birth weight (between 2500 and 4000 g), and macrosomia (more than 4000 g) based on their birth weight [23,24].

**Statistical Analysis-** All statistical analysis was carried out with SPSS software. The study participants' socio-demographic variables were described using descriptive statistics. Simple regression models were used to investigate relationships between maternal factor factors and the result of baby birth weight. Multiple regression analyses were also used to investigate the independent impacts of maternal variables. The factors that were statistically significant in multiple linear regression models were identified as the most accurate predictors of neonatal birth weight. A p-value of <0.05 was considered significant.

## RESULTS

This research included 300 pregnant participants in total. The pregnant women's age ranged from 20 to 35 years old, with a mean age of 28±5 years. Muslims made up most of the expectant mothers, followed by Hindus and Christians. Approximately 148 pregnant women had high levels of education, and many of them did not have a job. Additionally, it was discovered that 180 women (60%) were multiparous and 120 women (40%) were nulliparous. The average birth weight of the infants in our research was 3.20±0.37 kg. Twenty (6.7%) of them had low birth weights, and the rest 280 (93.3%), had normal birth weights (Table 1).

**Table 1:** Socio-demographic and parity outcomes of pregnant women (n=300)

| Factors | n (%) |
|---|---|
| **Age** | |
| ≤25 | 135 (45%) |
| ≥26 | 165 (55%) |
| **Religion** | |
| Hindu | 110 (36.7%) |
| Muslim | 115 (38.3%) |
| Christian | 75 (25%) |
| **Educational Level** | |
| Uneducated | 27 (9%) |
| Primary level | 125 (41.7) |
| Graduate and above | 148 (49.3%) |
| **Occupational Status** | |
| Employed | 70 (23.3%) |
| Self-employed | 35 (11.7) |
| Unemployed | 195 (65%) |
| **Parity** | |
| Nulliparous | 120 (40%) |
| Multiparous | 180 (60%) |

The mean height and weight of the pregnant women in this research were 67.02±8.20 cm and 157.65±5.03 kg, respectively. The research further disclosed that the moms' average weight increase was 9.95±2.27 kg, falling between the 5–12 kg weight growth range. Pregnant women with BMI (kg/m$^2$) of less than 18.5, between 18.5 and 24.9, and greater than 25 were 20 (8.6%), 250 (83.3%), and 30 (10%), respectively. The average BMI of the research subjects during pregnancy was 22.75±1.98 kg/m$^2$ (Table 2).

**Table 2:** Anthropometric outcomes of pregnant women

| Variables | Mean±SD |
|---|---|
| Height (cm) | 157.65±5.03 |
| Weight (kg) | 67.02±8.20 |
| Pregnancy weight gain (kg) | 9.95±2.27 |
| Pregnancy BMI (kg/m$^2$) | 22.75±1.98 |

Table 3 presents the findings from the study of a maternal blood sample. Haemoglobin levels in mothers were 11.73±1.51 g/dL on average. 54 (17.7%) of the women had anaemia, with 39.6% (21/53) having moderate anaemia and 60.4% (32/53) having mild anaemia, according to haemoglobin concentration. This research showed no evidence of severe anaemia. In addition, the moms' mean total serum cholesterol was 182.25±24.06 mg/dL of cholesterol. Out of the women, 60% had total cholesterol levels less than 200 mg/dL, whereas the percentages with cholesterol levels between 200 and 239 mg/dL and beyond 239 mg/dL were 35.6% and 4.4%, respectively. Analysis of the maternal blood sample also showed that the mean total serum protein level was 5.80±0.90 g/dL.

**Table 3:** Biochemical profile of pregnant women

| Parameters | Mean±SD |
|---|---|
| Hemoglobin (g/dL) | 11.73±1.51 |
| Total cholesterol (mg/dL) | 182.25±24.06 |
| Total protein (g/dL) | 5.80±0.90 |

Table 4 displays the findings of a regression analysis conducted to ascertain the relationship between maternal variables and the birth weight of newborns. Parity, haemoglobin (Hbg) level, total protein, total cholesterol, pregnancy weight gain, and pregnancy BMI were the maternal variables taken into consideration in the analysis. All maternal characteristics were substantially correlated with the birth weight of the newborn in simple regression analysis. However, only parity, Hbg level, pregnancy weight gain, and pregnancy BMI were shown to be significant predictors of the birth weight of the newborns ($p<0.05$) in the multiple regression analysis.

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**Table 4:** Regression analysis for determining the association of maternal factors with birth weight of newborns

| Maternal Factors | Simple Regression Analysis | | | | Multiple Regression Analysis | | | |
|---|---|---|---|---|---|---|---|---|
| | β-Coefficient | SE | 95% CI | p-value | β-Coefficient | SE | 95% CI | p-value |
| Parity | 0.150 | 0.010 | 0.130 to 0.169 | 0.01 | 0.115 | 0.005 | 0.105 to 0.125 | <0.001 |
| Hbg | 0.040 | 0.005 | 0.029 to 0.051 | <0.001 | 0.012 | 0.004 | 0.008 to 0.016 | 0.003 |
| Total Protein | 0.037 | 0.015 | 0.008 to 0.066 | 0.01 | 0.003 | 0.015 | -0.006 to 0.012 | 0.271 |
| Total Cholestrol | 0.003 | 0.001 | -0.001 to 0.008 | 0.003 | 0.002 | 0.001 | 0.00004 to 0.004 | 0.046 |
| Pregnancy Weight Gain | 0.077 | 0.008 | 0.061 to 0.093 | 0.002 | 0.069 | 0.009 | 0.051 to 0.127 | <0.05 |
| Pregnancy BMI | 0.030 | 0.008 | 0.015 to 0.045 | <0.001 | 0.027 | 0.008 | 0.012 to 0.042 | <0.001 |

## DISCUSSION

Pregnancy outcomes can be optimized by improving a woman's diet both before and throughout her pregnancy since it is acknowledged to have a significant impact on reproductive health [25]. In resource-poor environments, women are frequently malnourished before becoming pregnant; they may also underweight and anaemic due to illnesses and insufficient food intake, and they may be short due to early childhood malnutrition. Because of inadequate eating, overweight and obesity are also becoming issues in some contexts [26,27]. Low birth weight is linked to a higher risk of neonatal morbidity and death, making it a serious public health concern [28]. The newborn's birth weight serves as a gauge for the mother's nutritional state [29,30].

According to this study, the newborn's birth weight was favourably correlated with the biochemical profile of the pregnant women, as shown by the levels of haemoglobin, total cholesterol, and total protein. In keeping with research by Misra *et al.* [31] and Geraghty *et al.* [11], no significant correlation was seen between birth weight and total cholesterol level. Likewise, there was no statistical significance in the favourable correlation between birth weight and maternal total protein. This conclusion is supported by another study that evaluated the protein consumption of mothers throughout pregnancy and found no significant correlation between the birth weight of the offspring and protein intake during the second trimester or later [32].

On the other hand, a statistically significant positive correlation was discovered between the mother's haemoglobin level and the baby's birth weight. Sekhavat *et al.* [33] and Steer [34] showed in comparable investigations that the incidence of low birth weight reduced as maternal haemoglobin levels increased. Therefore, there was a higher chance of delivering LBW infants for moms with lower haemoglobin levels during pregnancy. According to research by Sharma and Mishra [9], anaemia during pregnancy was linked to a noticeably higher risk of low birth weight (LBW), which is consistent with this finding.

In addition, the current study found a substantial positive correlation between the birth weight of the offspring and mother anthropometry, which included pre-pregnancy BMI and total weight increase throughout pregnancy. Numerous research studies [9,10] have revealed findings like ours, indicating a substantial correlation between the baby's birth weight and the mother's anthropometric characteristics, such as height, weight, BMI, and gestational weight increase.

## CONCLUSIONS

The present study concludes that maternal haemoglobin concentration during pregnancy was identified as a crucial factor influencing neonatal anthropometry, particularly birth weight. Maternal anaemia during pregnancy can lead to fetal growth retardation and reduced birth weight of neonates, emphasizing the need for proper management of maternal nutrition and addressing anaemia during pregnancy. These findings also highlight the need for interventions and strategies to ensure adequate intake of essential nutrients during pregnancy, particularly fats, proteins, and iron, to promote optimal fetal growth and development.

More large-scale research employing various maternal characteristics is needed to understand the association between pregnant women's nutritional health and baby birth weight.

## LIMITATIONS

Pregnancy-specific food consumption was not examined in this study, which would have provided more in-depth information about the connection between foetal development and mother nutrition. The study's exclusion of pregnancies in all trimesters and the absence of long-term patient observation are other limitations.

## CONTRIBUTION OF AUTHORS

**Research concept-** Dr. Simarpreet Kukreja, Dr. Sagan Jeet Kaur, Dr. Kanchan Taneja

**Research design-** Dr. Simarpreet Kukreja, Dr. Sagan Jeet Kaur

**Supervision-** Dr. Kanchan Taneja

**Materials-** Dr. Sagan Jeet Kaur, Dr. Kanchan Taneja

**Data collection-** Dr. Simarpreet Kukreja, Dr. Sagan Jeet Kaur

**Data analysis and Interpretation-** Dr. Simarpreet Kukreja, Dr. Sagan Jeet Kaur

**Literature search-** Dr. Simarpreet Kukreja, Dr. Sagan Jeet Kaur

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**Critical review-** Dr. Simarpreet Kukreja, Dr. Sagan Jeet Kaur

**Article editing-** Dr. Simarpreet Kukreja, Dr. Sagan Jeet Kaur

**Final approval-** Dr. Kanchan Taneja

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