

## Effect of Maternal Nutritional Status on Birth Outcome

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**Abstract** The present cross-sectional descriptive study was conducted to assess the nutritional status, maternal haemoglobin concentration, anthropometric details and its association with neonatal anthropometry. 200 pregnant women aged 18-37 years in the gestational age of 27-41 weeks, without any co-morbidity and having a complete medical record were included in the study. Pregnant women who were in labour in the maternity ward and had visited the tertiary centre in Mumbai for antenatal checkups were enrolled for the study. Predesigned, pretested questionnaire was used to obtain socio-demographic and pregnancy details along with 24-hour dietary recall taken prior to delivery. Maternal and neonatal anthropometry was measured by trained personnel using standardized techniques. Haemoglobin concentration prior to delivery and postpartum, birth weight and length was obtained from the hospital record. Analyses were performed using SPSS software (version 16.0) to determine the effect of nutritional status on birth outcome. P-value <0.05 was considered to be statistically significant. The mean maternal anthropometric details were height-153.13±10.39cm, postpartum weight-57.02±11.57kg, postpartum BMI-24.29±3.54kg/m<sup>2</sup>, haemoglobin concentration prior to delivery-11.19±1.78g/dL and post-partum-9.97±1.68g/dL. The mean neonatal birth weight was 2.77±0.50kg though 22.3% neonates had low birth weight (<2.5kg). The mean neonatal anthropometric details were length-45.72±1.14cm, MUAC-10.48±1.14cm, ponderal index-2.88±0.43g/cm<sup>3</sup> and MUAC/Head circumference-0.31±0.03. However, women (≥28 years) were older (+2.46 years), weighed more both pre- and post-partum and also had a higher interpregnancy interval (+1.3 years) and gravida as compared to women (≤27 years) (p<0.05). Birth outcome was influenced by maternal height, weight, postpartum BMI, haemoglobin levels prior to delivery, gestational age and nutrient intake particularly energy, protein, vitamin C and calcium. Maternal diet prior to pregnancy and during pregnancy along with maternal anthropometry, haemoglobin concentrations prior to delivery and gestational age greatly influences birth outcome. Thus, attention has to be given to nutrition of an adolescent girl by proper nutrition education, pre-pregnancy counseling which will help in better pregnancy outcome.

**Keywords** Diet; Maternal Anthropometry; Neonatal Anthropometry; Pregnancy Outcome

## 1. Introduction

Nutritional status of the mother before and during pregnancy is the most critical for optimum growth and development of the foetus. Maternal nutrition greatly influences not only foetal nutrition but also is a determinant of the child's nutritional status, growth and development after birth, productive and reproductive health of the nation [1]. Poor maternal nutritional status has been related to adverse birth outcomes including preterm delivery, low birth weight, restricted foetal growth and which can have lifelong consequences for development, quality of life and healthcare costs [2, 3]. Poor nutritional status could be due to inadequate diet, lack of availability of food or inadequate absorption of nutrients which leads to various deficiencies, lifestyle behaviours e.g. smoking, alcohol consumption, cultural and traditional fads which lead to the elimination of certain food groups and thereby leads to poor nutritional status and further health implications [3].

The prevalence of obesity has increased overtime; increasing BMI is associated with greater risk of pregnancy complications like induction of labour and cesarean delivery; while underweight women had better pregnancy outcomes than women with normal BMI [4]. Moreover, anaemia which is highly prevalent among preschool-age children, pregnant women and non-pregnant women of child bearing age in developing countries [5] could be due to poor nutritional status which can further affect the maternal and neonatal health.

Numerous studies in India have shown that in chronically undernourished women subsisting on unchanged dietary intake, pregnancy has an adverse effect on maternal nutritional status [6]. Thus, in order to improve foetal growth and reduce the risk of adverse birth outcome, a balanced-protein-energy supplement along with micronutrients should be given to expectant women [7-9].

Nationwide nutrition intervention programmes have been in operation over two decades, this is a nutrition transition stage with coexistence of under and over-nutrition. The purpose of this study is to assess the anthropometry and nutritional status of the pregnant women, their interdependence with neonatal anthropometry and hence its effect on birth outcome. Furthermore, we hypothesized that various maternal factors like anthropometry, diet, haemoglobin prior to delivery are associated with neonatal anthropometry.

## 2. Materials and Methods

A cross-sectional descriptive study was conducted in a tertiary centre in Mumbai among 200 pregnant women during November-December 2015. This sample size was calculated to achieve a statistical power of 0.88. The pregnant women who had visited the tertiary centre for antenatal checkups and were in labour in the maternity ward were enrolled in the study. Two mothers delivered twins thus data on 202 has been presented in the current study.

Inclusion criteria were pregnant women between the age of 18-37 years and in the gestational age of 27-41 weeks. Exclusion criteria were pregnant women suffering from conditions such as asthma, chronic hypertension, tuberculosis, sickle cell anaemia, malignancy, foetal anomaly and diabetes and those who smoke.

Institutional Ethics Committee clearance was taken before the commencement of the study and prior permissions were obtained from Internal Ethics Committee of Lokmanya Tilak Municipal Medical College (L.T.M.M.C.) to interview the pregnant women (21.08.2015). Written informed consent was also taken from the pregnant women after explaining to them the objectives of the study in their own language and only those willing to participate were interviewed for data collection.

Pre-designed, pre-tested questionnaire was used to obtain socio-demographic and pregnancy details along with 24-hour dietary recall taken prior to delivery. Maternal and neonatal anthropometric details were measured by trained personnel using standard measurement techniques [10] and the BMI and neonatal anthropometric indices like MUAC/ Head circumference, the ponderal index was calculated. Neonatal Z-scores were also calculated using WHO Anthro software and compared with the WHO growth standards [11]. Haemoglobin concentration prior to delivery and postpartum, birth weight and length was obtained from the hospital records.

Analyses were performed using SPSS software for Windows (version 16.0, 2007, SPSS Inc, Chicago, IL). For purposes of analysis, women were divided into 2 age groups  $\leq 27$  years and  $\geq 28$  years of age. Many studies suggest that pregnancy-related complications increase from the age of 28 years and hence this threshold was used to make groups. Data are presented as Mean  $\pm$  SD. The frequency distributions were tabulated according to age groups and were compared using cross-tabulations and chi-square test. Independent sample T-Test was used to analyze the difference in various parameters according to age groups. Pearson was used to assess the correlation between maternal anthropometry and dietary intake with neonatal outcome. P-value  $<0.05$  was considered to be statistically significant.

### 3. Results and Discussion

The mean age of the pregnant women was  $25.93 \pm 4.36$  years with most of them being Hindus, 30.7% being Muslims and 2% were either Christians or Buddhists. Also, the majority of them lived in joint family and 46% lived in the nuclear family.

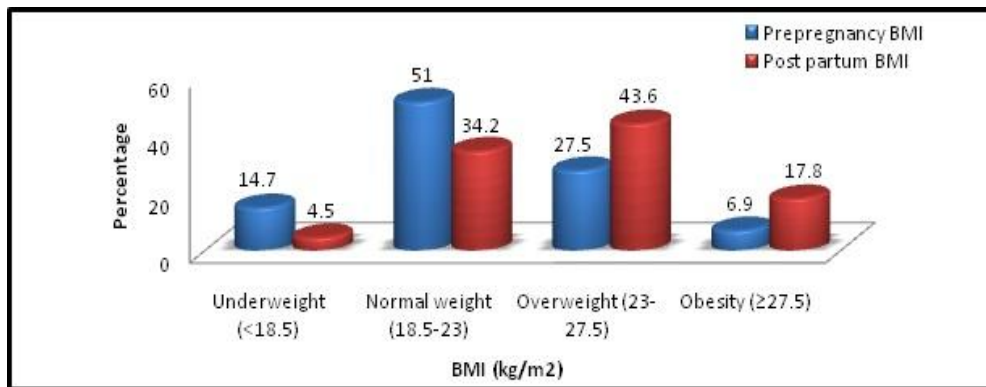
The socioeconomic status of the families was classified according to Kuppuswamy's Classification (2015) on the basis of educational status, work profile and family monthly income [12]. Nearly, 69.3% of them were in the upper lower socio-economic group (scores: 5-10) and 12.4% were in the lower middle socio-economic group (scores: 11-15) whereas the upper middle socio-economic group (scores: 16-25) constituted of about 6.4%. About 10.4% were in the lower socio-economic group (scores:  $<5$ ) whereas only 1% was in the upper socio-economic group (scores: 26-29).

In the study, an attempt was made to categorize the study group into women  $\leq 27$  years of age ( $n=160$ ) and  $\geq 28$  years of age ( $n=62$ ) as it is known that chances of pregnancy-related complications increase as the age increases. Hence, all comparisons are discussed based on this classification. The mean height of the mothers was  $153.13 \pm 10.39$ cm while mean pre-pregnancy weight was  $52.58 \pm 11.73$ kg. 105 mothers could remember their body weights at first visit (antenatal checkup). The mean weight at first visit was  $55.84 \pm 10.00$ kg while, postpartum weight was  $57.02 \pm 11.57$ kg and postpartum BMI was  $24.29 \pm 3.54$ kg/m<sup>2</sup>. The mean age at marriage of the study group was  $20.56 \pm 3.76$  years while the mean inter-pregnancy interval was  $2.93 \pm 2.25$  years.

Older mothers ( $\geq 28$  years) married later were taller ( $+2.05$ cm), had higher pre pregnancy weight ( $+4.62$ kgs) and post pregnancy BMI though not statistically significant. However, there was a significant difference ( $p<0.001$ ) in interpregnancy interval ( $+1.3$  years) and age at marriage ( $+2.46$  years). The weight at the first visit and post pregnancy weight were also significantly associated ( $p<0.05$ ).

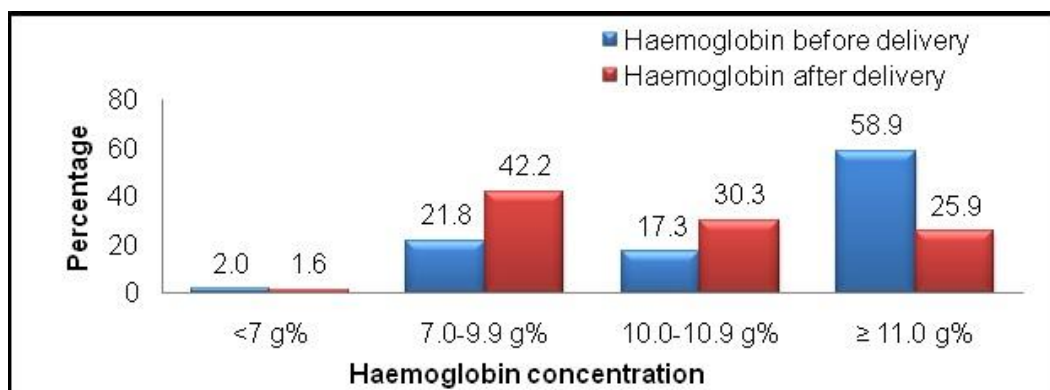
According to World Health Organization (WHO, 2004), classification of BMI for Asians [13] more than half of the subjects were normal prior to delivery, however, the percentage declined postpartum as the percentage of overweight and obesity increased (Figure 1). This could be because the mothers belonged to the lower socioeconomic status and also due to the weight gain during pregnancy but a

gradual weight loss occurs postpartum which can help them to reach the normal BMI range.



**Figure 1:** Maternal pre-pregnancy BMI (n=102) and postpartum BMI (n=202)

Furthermore, according to World Health Organization (WHO, 2011) classification for anaemia during pregnancy [14], majority of the mothers had a normal haemoglobin concentration prior to delivery which is in contrast to the study conducted in 2009 which said that nearly half the pregnant women suffer from varying degree of anaemia, with the highest prevalence in India and also has the highest number of maternal deaths in the Asian region [7]. However, this percentage reduced postpartum as the percentage for anaemia increased which could be due the pregnancy-related complications and/or excessive blood loss during delivery (Figure 2).



**Figure 2:** Maternal haemoglobin before delivery (n=202) and after delivery (n=185)

For 48.6% of the mothers who were ≤27 years of age, it was their primipara whereas, multipara (gravida 2-6) was seen in the majority (88.7%) of the older women (≥28 years) thereby showing a significant positive correlation ( $\chi^2=40.238$ ;  $p=0$ ) between maternal age and gravida.

From the total, 97% neonates were born alive and the remaining 3% were either stillborn or had intrauterine foetal death (IUFD). However, in a review article, the figures were used from government data after statistical extrapolation and it was found out that India tops half of the chart with 22 still births per 1,000 births as compared to the global rate of stillbirths at 19 for every 1,000 births [15]. From the 196 neonates born alive, only one had an early neonatal death. Out of the total 202 newborns, 112 (55.4%) were males and 90 (44.6%) were females. Furthermore, 78% of the pregnancies were term pregnancies while 21% were born pre-term with higher incidence (25.8%) among women ≥28 years as compared to women ≤27 years. Also, the incidence of C-section (78.7%)

was higher among the subjects as the study was conducted in a tertiary centre where 60% referral is for high risk or only for operative delivery.

The mean birth weight of the newborns ( $2.77 \pm 0.50$ kg) was within the normal range of the reference standard (2.7-2.9kg) [16] but had a lower mean neonatal length ( $45.72 \pm 1.14$ cm) when compared to reference (50cm) [16]. Of the total 202 newborns, 74.7% had normal birth weight while 22.3% had low birth weight ( $<2.5$ kg) and 3% had very low birth weight ( $<1.5$ kg). While globally, more than 20 million infants are born with low birth weight. According to UNICEF & WHO, 2004 the incidence of low birth weight in India alone accounts for 40 percent of the cases in the developing world and more than half of those in Asia [17]. The mean neonatal head circumference was  $33.45 \pm 1.53$ cm which was within the normal range of the reference standard (33-35cm) [16] and chest circumference was  $31.44 \pm 1.56$ cm. However with an increase in maternal age, birth weight, MUAC, ponderal index and MUAC/ head circumference also increased, though statistically not significant ( $p > 0.05$ ). According to BMI-for-age Z-score, 49.5% of the newborns were in the normal range whereas, 17.3% were mildly undernourished, 14.9% were slightly overweight and 4% were severely undernourished.

A study conducted in 2011 reported that the optimum cut-off point for MUAC/ head circumference ratio is 0.303 [18] which indicate wasting. However, in this study majority (62%) of the neonates had a ratio of  $\geq 0.303$ .

Furthermore, ponderal index (PI) of  $2.5 \text{ g/cm}^3$  is considered normal whereas PI  $< 2.0 \text{ g/cm}^3$  is classified as a low PI (malnourished) and PI between 2 to  $2.5 \text{ g/cm}^3$  is considered hypo-plastic [19]. However, the majority (86.6%) of the neonates had PI  $\geq 2.5 \text{ g/cm}^3$  whereas 10.4% were hypoplastic and the rest (2.5%) were malnourished.

As seen in Table 1, maternal anthropometric parameter such as height, weight and post-partum BMI significantly influences neonatal anthropometric indices and Z-scores. This is because when the maternal height and weight is appropriate the better is the growth of the foetus and better is the birth outcome.

**Table 1:** Association between maternal and neonatal anthropometric indices and neonatal Z-scores (n=202)

Neonatal Characteristics	Mothers height (cm)	Pre-pregnancy weight (kg)	Weight at the first visit (kg)	Post-partum weight (kg)	Post-partum BMI (kg/m <sup>2</sup> )
Birth weight (kg) (n=202)	0.119	0.238*	0.209*	0.283*	0.274*
Length (cm) (n=202)	-0.021	0.14	0.087	0.143*	0.210**
MUAC (cm) (n=195)	0.152*	0.152	0.132	0.202**	0.148*
Ponderal Index (n=202)	0.153*	0.236*	0.220*	0.288**	0.250**
MUAC/Head circumference (n=195)	0.146*	0.174	0.098	0.174*	0.129
Weight-for-length	0.184*	0.181	0.19	0.250**	0.191**
Length-for-age	0.013	0.147	0.134	0.167*	0.208**
Weight-for-age	0.119	0.240*	0.213*	0.286**	0.277**
BMI-for-age	0.124	0.237*	0.203*	0.281**	0.265**
Head circumference-for-age	0.078	0.016	0.138	0.141*	0.098

Data presented Pearson coefficient r value

\* indicate  $p < 0.05$  of significant correlation

\*\*indicate  $p < 0.01$  of significant correlation

According to the existing evidence low haemoglobin levels during pregnancy lead to reduced iron stores, causing infantile anaemia before the age of six months [20], reduce the oxygen supply to the foetus [21, 22] and can also adversely affect the immune system thereby increasing the host susceptibility to genital tract infections leading to poor pregnancy outcome [7]. Furthermore it is said that maternal anemia during pregnancy is associated with reduced birth weight, perinatal, maternal and infant mortality as well as higher risk of premature delivery [1]. However, in the study, mothers had a better haemoglobin level during pregnancy which greatly influenced the neonatal anthropometry especially the birth weight ( $p<0.05$ ) and length ( $p<0.01$ ) (Table 2). Also, the more the amount of time available for the growth of the foetus the better will be the growth and birth outcome. Hence, gestational age significantly influences the neonatal anthropometry and Z-scores ( $p<0.01$ ) (Table 2).

**Table 2:** Association of haemoglobin levels before delivery and gestational age with neonatal anthropometry and Z-scores ( $n=202$ )

Neonatal Characteristics	Haemoglobin before delivery (g/dl)	Gestational age (weeks)
Birth weight (kg)	0.149*	0.570**
Length (cm)	0.227**	0.607**
Head circumference (cm)	-0.019	0.253**
Chest circumference (cm)	0.022	0.266**
MUAC (cm)	-0.053	0.206**
Weight-for-length	0.005	0.252**
Length-for-age	0.205**	0.600**
Weight-for-age	0.157*	0.605**
BMI-for-age	0.136	0.578**
Head circumference-for-age	-0.019	0.269**

Data presented Pearson coefficient  $r$  value

\* indicate  $p<0.05$  of significant correlation

\*\*indicate  $p<0.01$  of significant correlation

Based on the 24-hour dietary recall taken prior to delivery, energy, macronutrients and selected micronutrient intake were calculated using values from Nutritive Value of Indian Foods (ICMR) [23] (Table 3). Though the mean maternal calcium intake was 75.1% of the recommended dietary allowance (RDA), it showed a positive significant correlation with neonatal length and Z-score for length-for-age and weight-for-age ( $p<0.05$ ). This is because calcium enhances foetal growth, improves neonatal bone density & prolongs gestation thereby better neonatal anthropometry. Furthermore, the mean maternal phosphorus intake was 85.7% of the RDA; it was positively correlated with neonatal length.

**Table 3:** Mean Maternal Nutrient Intake of the subjects ( $n=202$ )

Nutrients	Mean $\pm$ SD
Energy (kcal)	1578.10 $\pm$ 360.82
Carbohydrates (g)	192.08 $\pm$ 41.89
Protein (g)	45.11 $\pm$ 12.87
Fat (g)	42.11 $\pm$ 12.22
Calcium (mg)	901.23 $\pm$ 398.13
Phosphorus (mg)	1028.65 $\pm$ 283.05
Iron (mg)	16.52 $\pm$ 11.21
Dietary folate (mcg)	141.03 $\pm$ 101.85
Vitamin B12 (mcg)	0.56 $\pm$ 1.15
Vitamin C (mg)	68.15 $\pm$ 45.14
Zinc (mg)	4.23 $\pm$ 1.18



Moreover, vitamin C being an antioxidant, helps in the formation of collagen, connective tissue, cartilage, muscles and the lowest layer of skin thereby helps in the growth of the foetus and improves the pregnancy outcome. Thus, vitamin C was significantly positively correlated ( $p < 0.05$ ) with birth weight, neonatal length, Z-scores for weight-for-age, length-for-age, BMI-for-age. Furthermore, the positive significant association was observed between birth weight, neonatal length, length-for-age and weight-for-age with percentage RDA of calcium and vitamin C ( $p < 0.05$ ) whereas, BMI-for-age was significantly correlated with percentage RDA of vitamin C ( $p < 0.05$ ).

The neonatal length was also significantly positively correlated with percentage RDA of energy, and protein intake ( $p < 0.05$ ). However, due to low maternal protein and zinc intake as per the RDA, they were negatively correlated ( $p < 0.05$ ) with neonatal MUAC and MUAC/Head circumference.

#### 4. Conclusion

Maternal height, pre-pregnancy weight, post-partum weight and BMI were associated with neonatal anthropometry. The strong association with maternal height and post-partum weight with newer neonatal anthropometric indices like MUAC/Head circumference and ponderal index indicates that maternal anthropometry greatly influences neonatal anthropometry. Moreover, birth outcome was strongly influenced by maternal diet particularly energy and the maternal nutrient intake of protein, calcium and vitamin C. Also, maternal haemoglobin concentration prior to delivery and gestational age influenced birth outcomes. Hence, in order to reduce the adverse pregnancy outcomes awareness should be created among pregnant women and women of child bearing age about the factors that can improve the nutritional status of the women prior to conception and during pregnancy.

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