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Original Research Article

Maternal nutritional status during pregnancy as a predictor of Ponderal index and body proportionality at birth, in term neonates

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ABSTRACT

Background: It is well established that maternal body mass index (BMI) and haemoglobin (Hb) level has an impact on foetal growth. Various studies have concluded that intrauterine growth as reflected by the Ponderal index (PI) is strongly influenced by various maternal factors. Therefore, we undertake this study to address the evidence gap to establish the strength of association between maternal nutritional status as indicated by her pre-pregnancy BMI and haemoglobin levels and neonatal PI.
Methods: A hospital based cross-sectional, observational study was conducted that included 236 normal newborns and their mothers. A predesigned questionnaire was used to collect relevant socio-demographic data and obstetric history. Details regarding the maternal pre-pregnancy weight were collected from antenatal records, maternal height was measured and BMI was calculated. Neonatal birth weight and recumbent length was measured. PI was calculated and co-related with the maternal BMI and haemoglobin values.
Results: 11.9% of the mothers were underweight and 51.3% had normal BMI. Majority of the mothers (62.7%) had normal Hb levels and 0.4% were found to have severe anemia (Hb <7 mg/dl). We saw a significant positive correlation ($p<0.05$) between BMI and birth weight, BMI and PI that is, with decrease in BMI there was a significant decrease in the birth weight and PI of the newborn. There was no significant correlation between haemoglobin level and PI.
Conclusions: Our study showed a positive association between maternal pre-pregnancy BMI and birth weight, BMI and PI. Therefore, interventions aimed at improving the nutritional status of the mother have a direct impact on the foetal growth outcomes.

Keywords: Maternal nutrition, Ponderal index, Anthropometry, Pre pregnancy BMI

INTRODUCTION

Rohrer's Ponderal index (PI) has been used to identify infants whose soft tissue mass is below normal for the stage of development. In particular, PI has been used widely in neonatology as a measure of foetal growth status and in particular to establish the symmetry of intra uterine growth retardation (IUGR). Studies have demonstrated the impact of altered PI on short term perinatal outcomes of acidosis, increased perinatal mortality and unfavourable neurological outcomes as well as long term impact on the BMI of young males, glucose tolerance in children, blood pressure and coronary heart disease in adults and its influence on the age of menopause in women.[1-4]

Previous studies have concluded that low birth weight and IUGR reoccurred in siblings and clustering of low PI in siblings even persisted after controlling for factors such as race, gender, maternal age, gravidity, year of birth, gestational age, pregnancy complications and poor maternal illnesses.[5] Thus, pointing to a possibility of genetic or maternal factors influencing the growth of term newborn infants. Various studies undertaken in the past have conclusively established the interrelationship of good maternal nutrition prior to pregnancy and favourable

newborn outcomes.[6,7] Pre-pregnancy BMI and haemoglobin levels are most often considered as simple yet precise indicators of maternal nutritional status.

Therefore, we undertook this study to address the evidence gap to establish the strength of association between maternal nutritional status as indicated by her pre-pregnancy BMI and haemoglobin levels and neonatal PI in south Indian women.

METHODS

A hospital based cross-sectional, observational study of normal newborns and their mothers was conducted in Rajarajeswari Medical College and Hospital, Bangalore. The study was conducted for a duration of three months from May 2019 to August 2019.

The study included all consenting mothers with singleton, full-term live births with a gestational age of ≥37 weeks. Women with any apparent pathological condition or risk factor which might impair the foetal intra-uterine development such as hypertension, diabetes or renal disease were excluded from the study.

All the mothers of the newborns included in the study were informed about the purpose and objectives of the study and their informed verbal consent was obtained. A total of 236 normal newborns and their mothers were included in the dataset. A predesigned simple questionnaire was used to collect relevant socio-demographic data and obstetric history. Details regarding maternal pre-pregnancy weight and haemoglobin level was collected from antenatal records at the first antenatal visit. Maternal height was measured to the nearest 0.1cm and weight was recorded to the nearest 0.1 kg. BMI was calculated using the formula BMI=weight (kg)/height^2 (m).

Neonatal birth weight was recorded within one hour of birth to the nearest 0.01 kg using an electronic scale. Recumbent length (crown heel length) was measured to the nearest 0.1 cm using an infantometer. PI was calculated using the formula PI=weight (gm)×100/length^3 (cm).

Data was entered into Microsoft (MS) excel data sheet and was analyzed using statistical package for the social sciences (SPSS) 22 version software. Categorical data was represented in the form of frequencies and proportions. Chi-square test was used as the test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Analysis of variance (ANOVA) was used as the test of significance to identify the mean difference between more than two groups for quantitative data. Graphical representation of data was done using MS Excel and MS word, which was also used to obtain various types of graphs such as bar diagram and pie diagram. A p value (probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

RESULTS

In the current study a total of 236 women and their newborns were included, of which 36.9% of the mothers had secondary level of education. Majority of the women (49.6%) were in the age group of 21 to 25 years, were multi-gravida (52.5%) and had normal vaginal delivery (56.4%). Among the newborns included in the study 25.8% had low birth weight (<2.5 kg), 73.3% had normal birth weight (2.5-4 kg) and 0.8% were found to have macrosomia (>4 kg) (Table 1). The average PI of the newborns was found to be 2.48 with a standard deviation of ±0.427, the maximum PI was found to be 4.37 and minimum was 1.53.

Table 1: Socio-demographic profile and anthropometric measures.

Particulars	Count	Percentage
Age (years)		
<20	39	16.5
21-25	117	49.6
26-30	64	27.1
>30	16	6.8
Education		
Illiterate	11	4.7
Primary	22	9.3
Secondary	87	36.9
PUC	80	33.9
Graduate	36	15.3
Obstetric score		
Primigravida	112	47.5
Multigravida	124	52.5
Mode of delivery		
Elective LSCS	72	30.5
Emergency LSCS	31	13.1
Vaginal	133	56.4
Birth weight (kg)		
<2.5	61	25.8
2.5-4	173	73.3
>4	2	0.8

A significant proportion of the mothers (62.7%) had normal haemoglobin levels and 0.4% were found to have severe anaemia with a haemoglobin level of <7 mg/dl (Figure 1). The mean pre pregnancy BMI of the study population was 24.10±5.4 kg/m^2. 51.3% of the mothers had normal pre-pregnancy BMI and 11.9% were found to be underweight (Figure 2).

In the study there was significant positive correlation ($p<0.05$) between BMI and birth weight and BMI with PI, indicating that with a decrease in maternal pre-pregnancy BMI there was significant decrease in the neonatal birth weight and PI and vice versa (Figure 3 and 4). There was no significant correlation between haemoglobin level and birth weight or length or PI (Table 2 and 3).

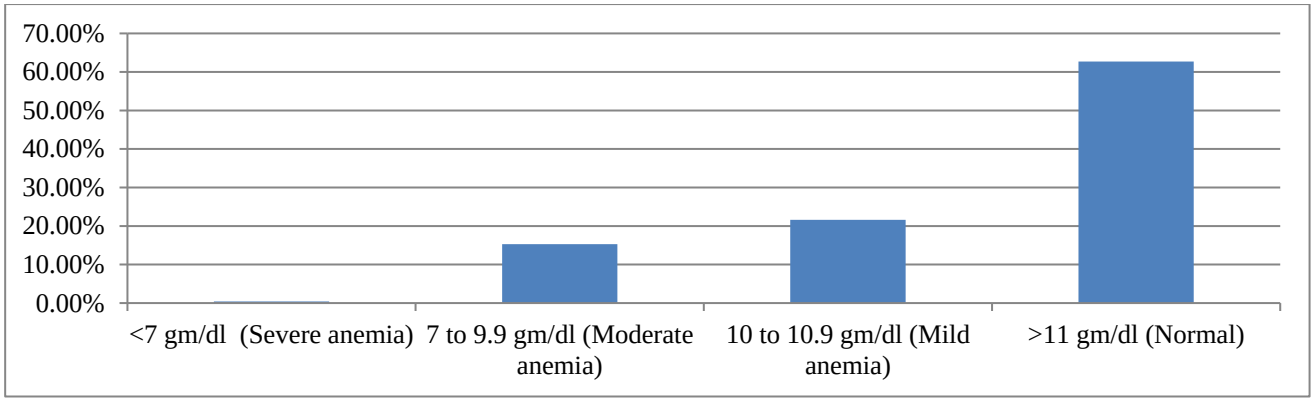

Figure 1: Bar diagram showing haemoglobin level distribution among the subjects.

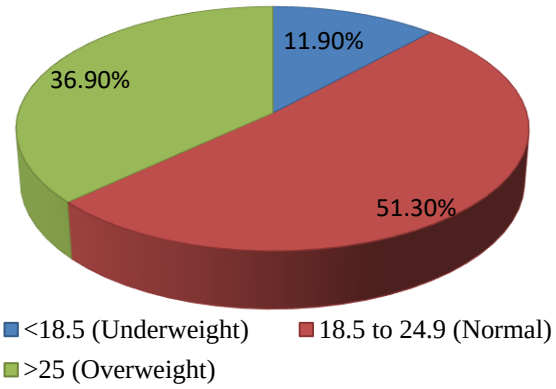

Figure 2: Pie chart showing BMI distribution among the subjects.

Table 2: Correlation between BMI and various parameters.

Parameters (BMI)	Birth weight	Length	Ponderal index
Pearson correlation	0.129	0.010	0.134
P value	0.047*	0.873	0.039*
N	236	236	236

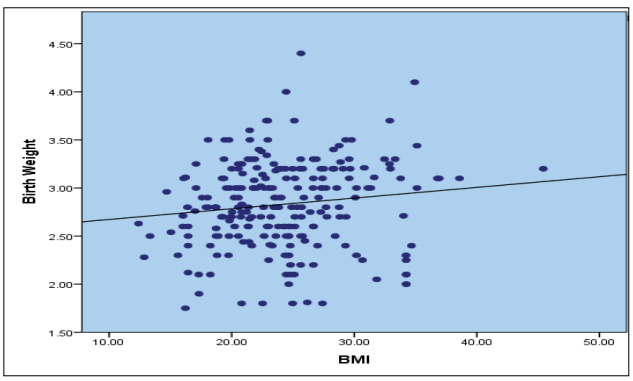

Figure 3: Scatter plot showing positive correlation between BMI and birth weight.

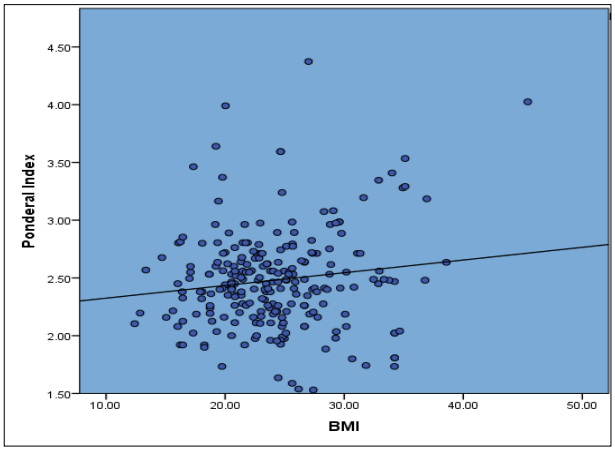

Figure 4: Scatter plot showing positive correlation between BMI and Ponderal index.

Table 3: Correlation between haemoglobin and various parameters.

Parameters (haemoglobin level)	Birth weight	Length	Ponderal index
Pearson correlation	0.070	0.038	0.014
P value	0.283	0.559	0.833
N	236	236	236

DISCUSSION

Human foetal development is characterized by sequential growth and maturation of various tissues and organs. Factors that influence growth vary based on the gestational age. During early gestation growth is determined by the genetic potential of the foetus whereas nutrition, environment and hormones are the determinants of foetal growth in late pregnancy.[8-9] Several factors such as the genetic potential, hormonal influence and gestational age are non-modifiable. Maternal nutritional status as determined by the pre-pregnancy BMI and haemoglobin level is a modifiable factor subjectable to preventive interventions. Therefore the present study examined the

maternal pre-pregnancy BMI, haemoglobin level and anthropometric measures of the new born.

Regional estimates of low birth weight by World Health Organization (WHO) shows a prevalence of 28% in South Asia similar to a prevalence of 25.8% found in our study.[10] The mean maternal pre pregnancy BMI of the study population was 24.10±5.4 kg/m^2 which was much lower than a value of 27.9±4.3 kg/m^2 found by a study conducted in Nigeria but nearer to a value of 24±4.3 kg/m^2 determined by a study conducted in Norway.[11,12] Our study found no significant correlation of maternal haemoglobin level with developmental outcomes of the infant, similar to a study conducted in Sri Lanka.[13] Contrary to some previous literature our study showed a positive correlation between BMI and PI.[14,15]

Our data indicate that infants of mothers with a low pre-pregnancy BMI were lighter and disproportionate in concordance with a similar study involving 2394 infants in West Indies.16 In the study there was significant positive correlation ($p<0.05$) between pre-pregnancy BMI of the mother and birth weight of the infant. Similar results were obtained in a study conducted in Norway that reported pre-pregnancy BMI alone to be an important predictor of birth weight. The study also reported that for every increase of 1 kg in pre-pregnancy BMI, there was an increase in birth weight of 25.9 g (95% CI, 25.0-26.9) and this increase was seen across all categories of pre-pregnancy BMI.[12] The study concluded that offspring birth weight increased with increasing pre-pregnancy maternal BMI, similar to the results obtained in our study.

Causes of low birth weight are complex and interdependent, but the anthropometry of the mother and her nutritional intake are thought to be among the most important.[17] WHO collaborative study on maternal anthropometry and pregnancy outcomes, using data from 111,000 women from across the world reported that mothers in the lowest quartile of pre-pregnancy weight, carried an elevated risk of intra uterine growth restriction and low birth weight of 2.55 (95% CI 2.3, 2.7) and 2.38 (95% CI 2.1, 2.5) respectively, compared to the upper quartile.[18]

CONCLUSION

Pre-pregnancy BMI has a strong and positive effect on foetal growth and body proportionality, suggesting energy balance to be an important determinant of birth outcome. The study brings to light the existence of malnourishment in the obstetric population dating back to poor nutrition in childhood and adolescence finally leading to poor neonatal growth outcomes. Thus, indicating a need to undertake public health interventions in the form of nutritional enhancement of girl child in childhood and adolescence and improved pre-conception care. The present study provides important information which can guide policy makers and behaviour change agents in planning and implementing maternal and child health services in the region.

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Ethical approval: The study was approved by the Institutional Ethics Committee of Rajarajeswari Medical College, Bangalore

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