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Influence of Pre-Pregnancy Weight, Maternal Height and Weight Gain During Pregnancy on Birth Weight

Phaneendra Rao RS, MBBS, MD*
Prakash KP, MBBS**
Sreekumaran Nair N, MSc, PhD***

Objective: To study the effect of pre-pregnancy weight, maternal height and weight gain during pregnancy on birth weight.

Design: A community based longitudinal study.

Setting: The study was conducted in the rural field practice area of the Department of Community Medicine, Kasturba Medical College, Manipal, Karnataka State, India.

Study Period: Between 1st June 1996 to 31st January 1998.

Subjects: A total of 75 pregnancies were followed up till delivery.

Main outcome and measures: Pre-pregnancy weight, maternal height, weight gain during pregnancy and other baseline characteristics were collected using a pre-tested proforma. Weight of the baby was recorded immediately after birth.

Results: The mean pre-pregnancy weight and maternal height were 43.7 kg (SD=6.6) and 154.2 cm (SD=5.2) respectively. The mean weight gain during pregnancy was found to be 8.0 kg (SD=2.6). The mean birth weight was 2869.7 gm (SD=467.2) with a range of 1380-3800gm. A statistically significant correlation was observed between pre-pregnancy weight ($r = 0.4$, $p<0.001$), maternal height ($r=0.36$, $p=0.001$), weight gain during pregnancy ($r=0.52$, $p<0.001$) and birth weight.

Interpretation and conclusion: Multiple regression analysis revealed that pre-pregnancy weight, maternal height and weight gain during pregnancy were independently associated with birth weight.

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*Professor and Head & Director PG Studies
**Tutor cum Postgraduate
***Assistant Professor in Biostatistics
Department of Community Medicine
Kasturba Medical College
Manipal, Karnataka, India.

Birth weight is perhaps the most important and reliable indicator for neonatal and infant survival, its physical growth and mental development. As a universal indicator, it can be used to describe the health, nutrition and socio-economic status of population in both developed and developing countries. Currently, the incidence of low birth weight in India is 33 percent and as per National Health Policy efforts are being made to bring down the incidence to 10 percent by the year 2000 AD[1].

The causes of low birth weight are multifactorial. Since maternal anthropometry is an important determinant of birth weight[2], it is important to establish standards of maternal anthropometric variables according to region to suggest appropriate remedial measures. Further it is essential to have an estimate of the weight gain during pregnancy and its relationship with the weight of the newborn. Hence, it was decided to conduct a community based prospective study to find out the influence of pre-pregnancy weight, maternal height and weight gain during pregnancy on birth weight and to estimate the average weight gain during pregnancy.

METHODS

Study area: This longitudinal study was carried out in the rural field practice area of Department of Community Medicine, Kasturba Medical College (KMC), Manipal, South India during the period of 1st June 1996 to 31st January 1998. The field practice area covers an approximate population of 41,500 living in 6730 families spread out in 11 villages. The Maternal and Child Health services are provided through six Rural Maternity and Child Welfare (RMCW) homes, managed by Department of Community Medicine, KMC, Manipal.

Sample size: Sample size was determined by considering the objective of estimating the average weight gain during pregnancy. Various studies have shown that, for Indian women, the average weight gain during pregnancy varies from 5.33 to 8.12 kg with a standard deviation of 1.2 to 1.6 kg[3-6]. By assuming an average weight gain during pregnancy of 7.5 kg with SD of 3.2 kg in this area, the minimum sample size required for the study to give a true estimate of the weight gain with 10% allowable variation and at 95% level of confidence was estimated to be 70. Considering a maximum of 20% for lost to follow-up during the study, the sample size[7] was finally decided as 84.

Study population: Two of the six RMCW homes serving a population of 16985 were selected randomly for the study. Among 2368 eligible couples in the population, couples who were unlikely to become pregnant under different categories were excluded by using the data available from the Management Information System (MIS) developed by the Department of Community Medicine, KMC, Manipal. Thus, the study population consisted of 320 women who were fertile, non-pregnant, not practicing any family planning method and having 3 or less living children. These 320 women were registered and interviewed with the help of Auxiliary Nurse Midwife (ANM). Among the 320 women registered, all women who became pregnant and whose Expected Date of Delivery (EDD) was before 31st January 1998 were followed-up till delivery. During the follow-up period weight was recorded between 16-20 weeks, 27-29 weeks and 37 or more weeks of gestation. Birth weights were recorded immediately after birth.

Anthropometric measurement: The study subjects were weighed using **spring balance (Adult)** with minimum clothing after correcting zero error. The weighing machine was standardized frequently. The weight was recorded to the nearest 50 gm. Height was measured keeping the women standing on level ground, without footwear, against a wall, by using measuring tape to the nearest of 0.5 cm. Birth weight was recorded by using infant weighing machine - lever type (UNICEF) to the nearest 20 gm.

Working definitions:

Pre-pregnancy weight: Pre-pregnancy weight is the weight recorded before conception.

Body mass index: BMI was calculated by the formula:
[pre-pregnancy weight (kg)/height(mts)^2]x100.

Weight gain during pregnancy: Maternal weight gain during pregnancy was calculated by subtracting the pre-pregnancy weight from the recorded weight at term.

Gestational age: Period of gestation (POG) was calculated from the reported first day of the last menstrual cycle till the date of delivery.

Data analysis: The data was analyzed using statistical package for social sciences (SPSS PC) and EPI info version 6.0. One way Analysis of variance (ANOVA), multiple range test, correlation and stepwise multiple regression analysis were the different statistical methods applied for analyzing the data. P value less than 0.05 was considered as significant.

RESULTS

Out of the total 320 women registered, 84 women became pregnant with an EDD before 31st January 1998 constituted the study subjects. These 84 pregnant women were followed up until delivery. There were 3 abortions, 3 lost to follow-up, 1 twin delivery and 2 home deliveries with no record of birth weight and these were therefore excluded from the analysis. Thus, a total of 75 pregnant women who delivered live born singleton babies formed the basis of this analysis.

Majority of the study subjects were Hindus (81%), literate (94.8%), housewives (74%) and belonged to middle socio-economic status (63.6%). 44.1% of women were primiparae. The incidence of low birth weight was found to be 13.3 % and 3.9% of the babies were premature.

Table 1 summarizes the characteristics of the women studied. The mean period of gestation was 39.2 weeks (SD=1.9 weeks) and mean birth weight was 2869.7 gm (SD=467.2 gm). The mean weight gain during pregnancy was observed to be 8.0 kg (SD = 2.6 kg).

Table 1. **Characteristics of the study population (N=75)**

Characteristics	Mean	SD	Range
Age (years)	25.2	3.9	18.0 - 40.0

Age at menarche (years)	14.1	1.4	12.0 - 18.0
Age at marriage (years)	22.1	3.3	16.0 - 33.0
Age at first pregnancy (years)	23.0	3.7	17.0 - 38.0
Pre-pregnancy weight (kgs)	43.7	6.6	32.0 - 63.0
Maternal height (cms)	154.2	5.2	140.0 - 167.0
Body mass index	18.4	2.4	13.8 - 25.7
Period of gestation (weeks)	39.2	1.9	29.0 - 43.0
Weight gain during regnancy (Kgs)	8.0	2.6	1.0 - 15.0
Birth weight (gms)	2869.7	467.2	1380 - 3800
Sex of the baby- Male:Female =	1:1.08		

Table 2 shows the association between pre-pregnancy weight and birth weight. As the pre-pregnancy weight increased there was a corresponding increase in the mean birth weight. The mean birth weight of babies of women who had pre-pregnancy weight of 45-49.9 and ≥ 50.0 kg when compared with that of women with a pre-pregnancy weight less than 40 kg was found to be significantly higher ($p<0.05$).

Table 2. **Influence of pre-pregnancy weight on birth weight (N=75)**

Pre-pregnancy weight (kgs)	Number	Birth weight (gms)		
		Mean	SD	95% Confidence interval
<40.0	20	2609.0	455.2	2395.9 - 2822.0
40 - 44.9	23	2830.4	519.3	2605.8 - 3055.0
45 - 49.9	19	3073.6	369.4	2895.6 - 3251.7
≥50.0	13	3042.3	322.6	2847.3 - 3237.3

One way analysis of variance followed by Multiple range test results: Mean birth weight in pre-pregnancy weight categories 45-49.9 and ≥50 kgs were significantly higher than that of less than 40 kgs category ($p<0.05$).

Table 3 reveals the association between maternal height and birth weight. The mean birth weight increased steadily from 2550 gm in women with height less than 145 cm to 3145.4 gm in women with height more than or equal to 160 cm. There was a significant difference in the mean birth weight in different categories of maternal height except among those with maternal height between 150 to 160 cm when compared to women with height 160 cm or more.

Table 3. **Influence of maternal height on birth weight (N=75)**

Maternal height (cms)	Number	Birth weight (gms)		
		Mean	SD	95% confidence interval

<145	3	2550.0	327.8	1735.5 - 3364.5
145 - 149.9	11	2727.3	311.7	2517.8 - 2936.7
150 - 154.9	23	2768.7	501.5	2551.8 - 2985.6
155 - 159.9	27	2937.0	501.6	2738.6 - 3135.5
≥160	11	3145.4	340.9	2916.4 - 3374.5

One way analysis of variance followed by multiple range test results: Mean birth Weight in maternal height category ≥160 cms was significantly higher than that of Categories <145, 145-149.9 and 150-154.9 cms ($p<0.05$).

Table 4. **Influence of weight gain during pregnancy on birth weight (N=75)**

Groups	Weight gain during pregnancy (kgs)	Number	Birth weight (gms)		
			Mean	SD	95% Confidence interval
1	<5	5	2186.0	485.8	1582.8 - 2789.2
2	5 - 6.9	19	2665.8	393.7	2476.0 - 2855.5
3	7 - 8.9	24	2934.6	428.5	2753.6 - 3115.5
4	9 - 10.9	17	3015.9	418.7	2800.6 - 3231.1
5	≥11	10	3195.0	286.2	2990.2 - 3399.7

One way analysis of variance followed by multiple range test results: The mean birth weight in group 1 was significantly lower than all other groups. Mean birth weight of group 3, 4 and 5 were significantly higher than group 2 ($p<0.05$).

Table 4 reveals the influence of weight gain during pregnancy on birth weight. The mean weight gain during pregnancy of study subjects was found to be 8.0 kg (SD=2.6). Majority of them (68%) gained a weight of 7 kg or more and 13.3 % gained 11 kg or more. With an increase in weight gain during pregnancy from 5 to 11 kg or more, there was a corresponding increase in mean birth weight from 2186 to 3195 gm. This increase was statistically significant (($P < 0.05$). Figure 1 shows the scatter graph of relationship between weight gain during pregnancy and birth weight. The fitted regression could explain 27% ($R^2 = 0.27$) of the variation in the birth weight.

Figure 1. Influence of weight gain during pregnancy on birth weight

In an attempt to find out the independent effect of pre-pregnancy weight, maternal height and weight gain during pregnancy on birth weight, multiple regression analysis was carried out. The other significant correlates of birth weight were also included. These results are shown in Table 5. Weight gain during pregnancy, period of gestation, pre-pregnancy weight, maternal height and BMI were significantly associated with birth weight.

Table 5. **Multiple regression analysis for the influence of maternal variables on birth weight (N=75)**

Variables	Regression coefficient(B)	SE(B)	P - value
Pre-pregnancy weight	-227.1	112.2	0.04
Maternal height	143.6	60.9	0.02
Weight gain during pregnancy	62.3	17.1	0.0005
Body mass index	560.9	267.9	0.04
Period of gestation	90.9	21.2	0.0001
Socio-economic status	4.9	3.3	0.14
(constant)	-23981.5	9434.2	0.01

Coefficient of determination, R^2 (%) = 54.5 % , P< 0.00001

To assess the relative importance of independent variables, forward stepwise multiple regression analysis was carried out with birth weight as dependent variable. Table 6 shows the observations of the stepwise regression analysis.

Table 6. **Stepwise multiple regression analysis of maternal variables and birth weight (N=75)**

Steps	Variables	Coefficient of determination (R^2%)	F- Ratio	P-value
1.	Weight gain during pregnancy	28.0	28.4	< 0.0001
2.	Period of gestation	41.7	25.8	< 0.0001
3.	Maternal height	48.4	22.2	< 0.0001

Variables not selected by the model:- pre-pregnancy weight, body mass index and socio-economic status.

DISCUSSION

The observed mean birth weight in the present study is comparable to studies conducted by Prasad et al, in 1991[8] and Rodrigues et al, in 1992[9] who observed a mean birth weight of

2823.6 gm (SD=417.8 gm) and 2815.0 gm (SD=449.3 gm) respectively. The mean weight gain during pregnancy obtained in this study was also comparable to other studies carried out in India[5,6]. However, the studies conducted by Barbara Abrams[10], and Ekblad et al[11] found mean weight gains during pregnancy of 15.4 kg (SD=5.2 kg) and 13.0 kg (SD=3.0 kg) respectively which were higher than the findings of the present study.

Results in Table 2 point out that, as the pre-pregnancy weight increased there was a corresponding increase in the mean birth weight and this relationship was statistically significant. Many research workers have reported an increase in the mean birth weight as the pre-pregnancy weight increased[12,13]. Similarly the mean birth weight also increased steadily with maternal height (Table 3). Similar results were reported by Deshmukh JS et al[14]. However, Vijayalaxmi et al[5] reported that maternal height had no influence on birth weight.

Table 4 reveals that, with an increase in weight gain during pregnancy there was a corresponding increase in mean birth weight and this increase was statistically significant (($P < 0.05$). Many studies conducted in India[4,5] and in different parts of the world[12,15] have proved the positive relationship between weight gain during pregnancy and birth weight.

Results of multiple regression analysis as shown in table 5 further establish the fact that, apart from maternal anthropometry, period of gestation and weight gain during pregnancy have an independent role in determining birth weight. The fitted regression model explained 54.5% (R^2=0.545) of the total variation in birth weight. Further to assess the relative importance of independent variables, forward stepwise multiple regression analysis was carried out with birth weight as a dependent variable. The stepwise regression model could explain 48.4 % of the total variation in birth weight. Weight gain alone contributed to 28.0% of the variation in birth weight. This increased to 41.7 % and 48.4 % respectively when the variables such as period of gestation and maternal height were added to the equation in that order. This only suggests that weight gain during pregnancy is perhaps the most important variable irrespective of maternal height and period of gestation.

It is a well established fact that period of gestation has an independent effect on birth weight and hence stepwise regression analysis was carried out after removing this variable. The stepwise regression model explained 35.7% of the total variation in birth weight. Weight gain alone contributed 28% where as pre-pregnancy weight was responsible for only 7.7% of the variation in birth weight.

CONCLUSION

In conclusion, pre-pregnancy weight, weight gain during pregnancy, period of gestation and maternal height have emerged as maternal factors influencing the birth weight of the baby.

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