ORIGINAL

Determinants of Birth Weight
A Study of Selected Maternal Variables

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ABSTRACT

Case records of 216 mothers were analysed retrospectively to study the influence of prepregnancy weight, maternal height, haemoglobin, age and parity, and period of gestation on birth weight. Prepregnancy weight, maternal height and period of gestation were found to be significantly correlated with birth weight. The fitted regression model explained 29.88% of the total variation in birth weight with R^2 for period of gestation being 14.37%, and R^2 change being 11.85% and 3.66% when maternal weight and height were added respectively in the stepwise multiple linear regression analysis.

A vast amount of research on birth weight and its determinants carried out globally over the last few decades has revealed the multifactorial aetiology of low birth weight. However, the independent effect of each determinant is still controversial[1]. Reports from developed countries[2,3] and some developing countries[4,5] have established relationships between maternal variables and birth weight, though the statistical techniques used were different[6].

The prevalence of low birth weight (LBW) ranges from 30-40% in India to 4-8% in North America and Western Europe[1]. The problem of LBW is magnified by the fact that, besides determining the risk of morbidity and mortality, the birth weight is a significant factor determining the growth and development of a child[7].

The present study was planned to find out the proportion of LBW infants in a rural community of South India, and to study the independent effects of selected maternal variables on birth weight.

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METHODS

The study was carried out in the field practice area of the Department of Community Medicine, Kasturba Medical College (KMC) Manipal which covers a population of 65,000 spread out in 13 villages in the coastal area of Udupi taluk, Karnataka.

Maternal and child health (MCH) services are provided through a network of 7 Rural Maternity and Child Welfare (RMCW) Homes. These centres are well equipped with a labour room, postnatal ward, minor operation theatre, a laboratory and telephone facilities.

Each RMCW Home is staffed by a well trained and experienced Auxilliary Nurse, Midwife and attender. While most of the normal deliveries are conducted at the centre, complicated cases are referred to the KMC at Manipal.

Besides providing maternity services, weekly MCH clinics are held at the centres (on a predetermined schedule) by a team of faculty members and interns from the departments of Community Medicine, Paediatrics and Obstetrics and Gynaecology.

A total of 232 mothers who had their first antenatal checkup prior to 16 weeks of gestation during a 3 year period (January 1990 to December 1992) and delivered singleton live born infants were considered as study subjects.

The study was retrospective in nature. Case records of all 237 mothers enrolled in the study were reviewed. Mothers suffering from diseases like diabetes, hypertension and chronic infections were excluded from the study. A few mothers whose records were incomplete and untraceable were also excluded. Analysis was based on the data related to the remaining 216 mother - child pairs.

Information on maternal age, parity, haemoglobin, weight and height at the time of first antenatal check up were obtained from case records. Period of gestation (POG) was calculated from the first day of the last menstrual cycle till the date of delivery. Haemoglobin was estimated by Sahli's method. Birth weight was recorded by using a lever balance (UNICEF) to the nearest 20 grams within 30 minutes of birth. The weight of the mother at the time of first visit in the present study was used as a surrogate of her prepregnancy weight, since the weight gain during the early weeks of pregnancy is presumed to be negligible. Information on height of the mother was available only for 148 mothers and this data was analysed separately.

No attempt was made to study the characteristics of the mothers whose first antenatal visit was after 16 weeks of gestation. The generalisability of the study results was compromised for the sake of internal validity.

STATISTICAL ANALYSIS

Data analysis was carried out using the SPSS/PC+ statistical software package. The study variables were described using univariate analysis. The zero order correlation coefficients between birth weight and various maternal variables were studied. Stepwise multiple linear regression analysis was employed to estimate the relationship between birth weight and maternal factors under study.

RESULTS

The characteristics of the study subjects (n = 216) are shown in Table 1. The mean birth weight was found to be 2815.05 grams (SD=449.26). Low birth weight babies accounted for 18.98%, while prematurity accounted for 9.26%. Out of the study subjects 45.83% were primiparae and the average age of the mothers were 24.8 years. Data on height was analysed for the 148 cases where it was available.

Table 1
Characteristics of study subjects

Variable	*Mean*	*SD*	*Range*	*N*
Haemoglobin (gm/dl)	9.52	1.54	5.8 to 14.0	216
Weight (Kg)	43.92	5.78	32.7 to 64.0	216
Age (years)	24.78	3.91	16.0 to 39.0	216
POG (weeks)	38.80	1.76	30.0 to 42.0	216
Birth Weight (gm)	2815.05	449.26	1570.0 to 4090.0	216
Height (cm)	150.43	7.16	130.0 to 170.0	148

Table 2
Zero order correlation matrix (n = 216)

	Hb	*Weight*	*Age*	*Parity*	*POG*	*Birth-Weight*
Hb	1.00	-0.01	-0.03	-0.06	0.06	-0.03
Weight		1.00	0.06	-0.03	0.05	0.34*
Age			1.00	0.42*	0.08	0.04
Parity				1.00	-0.04	0.07
POG					1.00	0.40*
Birth weight						1.00

* $p < 0.001$

Table 3
Change in birth weight per unit change in maternal variable (n=148)

Variables	*B*	*SE (B)*	*P value*
Haemoglobin	-6.62	20.60	NS
Weight	17.95	6.45	<0.01
Age	1.39	8.69	NS
POG	94.21	19.37	<0.001
Parity	-2.77	39.73	NS
Height	13.67	5.30	<0.05
Constant	-3675.35	1071.44	S

NS = Not significant

The correlation matrix (Table 2, n=216) shows the zero order correlation coefficients between birth weight and six study variables. Period of gestation was found to be highly correlated with birth weight (r = 0.40,p<0.001) followed by weight of the mother (r = 0.34,p<0.001). None of the other variables showed a significant correlation with birth weight.

A separate analysis carried out on the data of the 148 mothers where height records were available revealed a significant correaltion between height and birth weight (r = 0.36, p<0.001).

Table 3 shows the partial regression coefficients (B) in multiple linear regression analysis for the maternal variables under study. These were significant only for POG, maternal weight and height.

The regression equation that relates the predicted birth weight (Yp) to the independent maternal variables is:

$$Yp = -3675.35 + 94.21(POG) + 17.95(WEIGHT) + 13.67(HEIGHT).$$

This equation can be used to predict birth weight (Yp) of an infant if the above 3 maternal variables are known.

To assess the relative importance of independent variables, stepwise multiple linear regression was carried out (Table 4) with birth weight as the dependent variable (n = 148).

The fitted model explains 29.88% (R^2) of the total variation in birth weight. The POG alone explained

Table 4
Stepwise multiple linear regression of independent variables on birth weight

Steps	*Variables*	*R^2 x 100*	*F ratio*	*P value*
1	POG	14.37	24.51	0.0000
2	Maternal weight	26.22	25.76	0.0000
3	Maternal height	29.88	20.45	0.0000

Variables not in equation - age, parity, haemoglobin

14.37% of the variation in birth weight. This increased to 26.22% and 29.88% when the variables weight and height were added to the equation respectively ie. R^2 change of 11.85% and 3.66% for weight and height respectively. The contribution to the variation in birth weight by the other three study varibales was not significant.

Prepregnancy weight and maternal height were significantly associated with birth weight (Table 5). Mean birth weight was significantly higher in taller and heavier mothers.

Table 5
Distribution of birth weights according to maternal variables

Maternal variable	*No*	*<2500g No*	*%*	*>2500g No*	*%*	*Mean*	*SD*
Weight (kg)							
<40	53	20	37.7	33	62.3	2564.91	392.68
40 - 44	76	10	13.2	66	86.8	2847.89	408.39
45 - 49	53	7	13.2	46	86.8	2918.11	474.58
>=50	34	4	11.8	30	88.2	2970.88	439.32
Total	216	41	19.0	175	81.0	2815.05	449.26
Chi square = 16.10, p = 0.0011							
Height (cm)							
<145	27	11	40.7	16	59.3	2547.78	357.56
145-149	25	8	32.0	17	68.0	2662.00	478.77
150-154	54	10	18.5	44	81.5	2814.26	405.98
>=155	42	4	9.5	38	90.5	2965.24	452.08
Total	148	33	22.3	115	77.7	2782.77	446.05
Chi square = 11.06, p = 0.0114							

DISCUSSION

The mean birth weirght was 2815 gm (SD = 449.26) which is marginally higher than that reported by some other Indian authors[4,5] though it is much lower than that reported from developed countries[1]. In our sample, the percentage of LBW babies was 18.98%. Other studies have reported figures of 24.6%[4] and 27%[5].

Multivariate analysis revealed a statistically significant relationship between maternal prepregnancy weight, maternal height and period of gestation and birth weight of the baby. These findings are supported by previous studies[4,5,8]. Age and parity did not show a significant association with birth weight in our study. Some authors[1,5,6] reported similar findings though others[4,9] found age and parity to be related to birth weight. Prepregnant haemoglobin status of the mothers did not seem to have any effect on birth weight. It is probably the haemoglobin status at term that is more closely related to birth weight.

Our entire model explained 29.88% (R^2 x 100) of the variation in birth weight in our sample even though only three varibales were taken in the equation. Singh[5] demonstrated R^2 value of 34% using 6 significantly related variables, which in addition to the above three included antenatal care, literacy and haemoglobin whereas Abrams[2] found R^2 of 24% though they used several other variables in their model.

The regression equation suggested in this study includes parameters routinely recorded in any antenatal clinic. It can therefore be utilised for the purpose of predicting LBW as a risk outcome early in pregnancy (POG can be taken as 40 weeks)[8]. We can therefore identify mothers who need special attention during the antenatal and intranatal period and monitor them closely for a favourable outcome.

Prepregnancy weight and maternal height were significantly associated with birth weight and the cut-off points for the risk of low birth weight have been established as 40Kg and 150cm respectively, Chadha, et al[7] also reported a cut-off point of 150cm for maternal height. Singh, et al[5] established 40Kgs as the cut-off point of maternal weight in their study. The lower cut-off point in our study could be because of the lower mean weight of our study subjects.

For the risk approach to be effective, one of the major prerequisities is the early identification of pregnant mothers. If the first visit to an antenatal clinic is prior to 16 weeks of gestation (when hardly any weight gain could have occurred) her weight at that visit can be recorded as a surrogate for prepregnant weight. Using the regression equation derived, it is therefore possible to identify potential candidates at risk of delivering LBW babies and direct appropriate intervention measures towards them.

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