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To estimate the impact of maternal and fetal outcomes on birth weight: A multivariate statistical approach

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ABSTRACT

Introduction: Birth weight is a critical indicator of neonatal health and development. Understanding the factors that influence birth weight is essential for improving maternal and fetal outcomes. In this study, we explore the impact of several maternal and fetal factors on birth weight. **Objective:** The primary objective of this study is to explore the impact of various maternal and fetal factors on birth weight. We employ multiple statistical approaches to comprehensively analyze these associations. **Material and Methods:** We collect data from a large cohort of pregnant women and their newborns. Variables included maternal age, gestational age, parity, maternal BMI, and socioeconomic factors. Bivariate statistical approaches tend to ignore the effect of other variables when examining the relationship between an independent variable and birthweight. **Result:** In the rural area, highly significant correlations were obtained with gender of the baby, maternal age, gravida, parity, birth interval, length of gestation and paternal anthropometric variables. Although the correlation coefficients with consanguinity and religion were low, still they were significant owing to large sample size. **Conclusion:** Our study provides valuable insights int the multifaceted determinants of birth weight. By employing diverse statistical methods, we enhance our understating of these factors and their implications for maternal and fetal health.

INTRODUCTION

Birth weight is a reliable outcome measure of the quality of pregnancy; it is the most important indicator of maturity of the neonate and health status of the mother. It is also important determinant of prenatal mortality.[1] A newborn's weight at birth is a vital indicator of maternal nutritional status and fetal health.[2] Birth weight is a critical indicator of neonatal health and development.[3] Understanding the factors that influence birth weight is essential for improving maternal and fetal outcomes.[4] Birth weight of a baby is measured within the first one hour of birth. It is categorized as low, normal and high. Less than 2.5 kg is considered as low birth weight (LBW). High birth weight or macrosomia is birth weight above 4kg.[5]

The majority of births occur in south-central Asia, with one-third of them weighing less than 2500 g.[6] Globally, more than 30 million newborns are delivered annually; of this almost one-quarter of them have low birth weight. The World Health Organization is set to reduce the burden

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of low birth weight by as little as 30% by 2025 through nutritional policies on getting affordable, accessible, and appropriate health care preventing and treating low birth weight.[7]

In developing countries like India, the consequence of LBW includes early childhood mortality and morbidity.[8] In the last decade, nationwide surveys in India have shown a marked reduction in neonatal mortality rate (39 in 2005-2006 to 30 in 2015-2016), infant mortality rate (57 in 2005-2006 to 41 in 2015-2016), stunting among under-5 children (48% in 2005-2006 to 38% in 2015-2016), and underweight among under-5 children (43% in 2005-2006 to 36% in 2015-2016).[9-10] A well known slogan stated by the World Health Organization (WHO): healthy child is the wealth of our nation/child's health is tomorrow's wealth. A healthy child is born when the mother is healthy which is interrelated.[11]

MATERIALS AND METHOD

Data were entered into the MS Excel 2019 version and exported to Statistical package for the social sciences (SPSS). The data was analyzed using SPSS version 24. Bivariate association between independent variables and low birth weight were analyzed using simple logistic regression, and crude odds ratios and confidence intervals were calculated. The joint influence of the independent variables, taking account of possible correlations among them, is investigated on birthweight using multiple regression analysis. In other words, multiple regression analysis enables us to obtain a quantitative estimate of the effect of each independent variable simultaneously.

RESULTS

The birthweight distribution of babies born during study period were analysed. The overall percentage of low birthweight babies (weighing less than 2500 gram) 27.3 percent. The percentages of low birthweight babies were 29.3 in rural and 17.4 in urban, the difference being statistically significant ($P < 0.001$).

About 60.5 percent (Rural 59.5%; Urban 61.6%) of newborn weighed between 2500 and 3250 grams. The overall percentage of birthweights of babies weighing 3250 gram and above was 15.7 (Rural 13.0%; Urban 19.2%).

Multiple regression analysis was carried out to find the independent effect of each of the maternal and related variables on birthweight using stepwise method. The birthweight of the newborn was as the explained variables and the maternal and its related characteristics as the explanatory variables. The classification of the explanatory variables used in the multiple regression analysis is given below.

Table No. 1: - Intercorrelations between selected explanatory variables

	Age	Sex	Parity	Birth interval	Length of gestation	Maternal weight	Maternal height	Paternal weight	Paternal height	Consanguinity	Earlier fetal deaths
Age	1.00	0.05	0.69	0.41	0.00	0.05	0.10	0.03	0.01	0.02	0.14
Sex		1.00	0.02	0.04	-0.01	-0.01	-0.01	0.02	-0.01	0.00	0.03
Parity			1.00	0.24	0.00	0.00	0.02	0.06	0.00	0.04	0.06
Birth interval				1.00	-0.02	0.03	0.02	0.01	-0.01	0.03	-0.28
Length of gestation					1.00	0.03	0.04	0.02	0.03	-0.02	0.00
Maternal weight						1.00	0.57	0.20	0.12	-0.02	0.01
Maternal height							1.00	0.15	0.30	-0.03	0.05
Paternal weight								1.00	0.47	-0.01	0.03
Paternal height									1.00	-0.02	0.02
Consanguinity										1.00	-0.01
Earlier fetal deaths											1.00

Before using this regression model the intercorrelations between the explanatory variables were examined in above table. Appropriate transformation was tried for the nonnormally distributed explanatory variables. None of these transformed variables improved the amount of explained variation of birthweight in regression model. All explanatory variables were included in the initial model. The variables that were not significantly contributing to the variability of birthweight were subsequently excluded.

The correlation coefficients between birthweight and the explanatory variables studied are given in table. In the rural area, highly significant correlations were obtained with gender of the baby, maternal age, gravida, parity, birth interval, length of gestation and paternal anthropometric variables. Although the correlation coefficients with consanguinity and religion were low, still they were significant owing to large sample size.

Table No. 03: - Results of multiple regression analysis of Birthweight- Rural

Entering Variables	B	SE (B)	BETA	T	Significance
Maternal weight	13.2824	1.9357	0.1689	5.564	P<0.001
Length of gestation	25.5753	4.4435	0.1563	6.09	P<0.001
Paternal height	6.4352	2.3746	0.0837	2.927	P<0.01
Gender of newborn	-87.1283	24.2321	-0.0863	-4.928	P<0.001

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Birth interval	1.8979	0.6757	0.0979	3.837	P<0.001
Paternal weight	5.4746	2.1221	0.9879	3.876	P<0.01
Parity	25.2432	5.343	0.2122	5.765	P<0.001
Consanguinity	-37.4516	2.7094	-0.0303	-2.307	P<0.05
Constant - 23.876					
R square- 12.43%					

The results of multiple regression analysis showed that birthweight was significantly related to, in order of importance, maternal weight, length of gestation, paternal height, gender of newborn interval, paternal weight, parity and consanguinity. However, all these eight variables together could explain only 12.43 percent of the total variation in birthweight. These variables showed the expected direction. Maternal weight was found to be the most important predictor of birthweight, explaining 4.03 percent of variation. The correlation coefficients of birthweight and its explanatory variables are given table. A highly significant correlation was observed with parity, length of gestation, fathers educational and occupational levels paternal weight and religion.

Table No. 04: - Results of Multiple regression analysis of birthweight - Urban

Entering weight	B	SE(B)	BETA	T	Significance
Maternal weight	15.2322	2.1323	0.3145	7.308	P<0.001
Length of gestation	35.8767	5.8690	0.3542	7.879	P<0.001
Paternal height	-90.3543	20.3534	-0.198	-3.567	P<0.001
Parity	18.3635	8.9890	0.132	3.251	P<0.01
Gender of newborn	-75.7583	29.8987	-0.0897	-2.555	P<0.01
Number of earlier fetal deaths	-79.4657	35.7564	-0.0576	-2.162	P<0.05
Constant - 1263.32					
R Square- 13.42%					

The results of multiple regression analysis are given in the above table. Of all the explanatory variables considered in their actual measurements maternal weight, length of gestation, paternal height, parity, gender of newborn and number of earlier fetal deaths were significantly contributing to the variation in birthweight. However, all these six variables together could explain only 13.42 percent variation in birthweight. Maternal weight again stood out as the single most important predictor of birthweight, explaining 5.01 percent of variation.

DISCUSSION

Research studies are in general expected to answer queries pertaining to various problems and to help decision makers in formulating public health and socioeconomic policies concerning the whole of the population. Birthweight of the newborn is an important variable which serves as an index to reflect the maternal health, socioeconomics statuses, as well as the effective health care utilizations available. Though accurate records of birthweights can be obtained for babies

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delivered in hospitals, such deliveries represent only a section of the population and hence are not representative in nature. Thus, there is a need for studies based on total communities or that based on appropriate sampling procedures.

The present investigation on birthweights is based on an adequately large samples from the rural and urban area of Amravati district, which are typical of other areas in the state of Maharashtra.

It is evident from this study that the gender of newborn had been found to have a significant independent effect on birthweight with male babies on an average 57 g heavier than the females. The gender differences in mean birthweight were statistically significant in the rural but not in the urban though male babies were heavier than female babies. In rural area the adjusted relative risk for low birthweight associated with female newborns was 1.25 ($P<0.05$). The fact that the male babies heavier at birth than females is in conformity with other studies.

The multiple regression analysis procedure also helped to establish a casual model to study the indirect effect of independent variables on birthweight. In this study especially, the socioeconomic variables like maternal education and paternal occupation needs some explanation on how they operate or the way in which they are associated with other variables in the path model, in turn contributes to the variability in birthweight. This study has failed to support the hypothesis that the direct effect of maternal education is less than the indirect effect on birthweight though there was no difference in the life style pattern between the illiterate and literate mothers especially in rural area.

CONCLUSIONS

The mean birthweight of all newborn was 2774 g with a standard deviation of 500g. The percentage of low birthweight less than 2500 g was 23.8 percent. The percentage of low birthweight babies are significantly higher ($p<0.001$) in rural (27.4%) than that in urban (19.3%)

The observed distribution of birthweight was approximately normal with no significant departure from normality. In rural, the multiple regression analysis showed that birthweight was significantly influenced by the maternal weight, length of gestation, paternal height, gender of newborn, birth interval, paternal weight, parity, and consanguinity. These variables together explained 11.64 percent of variation in birthweight. In urban, the multiple logistic regression showed that significant relative risks were obtained for mothers of preterm deliveries, fathers without occupation, fathers with no education and mothers of low weight.

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