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Pattern and Determinants of Birth Weight in a Rural Population of Punjab, India

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ABSTRACT

Introduction: Birth weight is a strong predictor for ensuring healthy life of a newborn and is affected by various maternal and social determinants. The study was planned to analyze the pattern of birth weight of newborns and to identify possible factors affecting birth weight.

Materials and Methods: A community based retrospective cohort study was conducted by identifying a birth cohort of 332 live born between 1st January 2014 to 31st December, 2014 under Rural Health Training Centre, Department of Community Medicine, Dayanand Medical College & Hospital, Ludhiana, Punjab. Data on birth weight and socio-demographic characteristics was collected from the records maintained at the centre by health workers through regular house to house visits.

Results: Mean birth weight was 2.69±0.57kg. Lower mean birth weight was significantly associated with younger maternal age, lower socio-economic status, lower maternal height and pre-pregnancy underweight mothers. The incidence of low birth weight (<2.5 kg) was 18.1%. Among all live births, 23.8% were delivered prior to 37 weeks of gestation (preterm). Multiple regression analysis identified younger maternal age, low maternal height and underweight mothers as significant determinants associated with lower mean birth weight.

Conclusion: The study identifies certain determinants for lower birth weight for which appropriate interventions need to be planned to ensure a healthy ageing.

Keywords: Mean birth weight, low birth weight, determinants, India

INTRODUCTION

Birth weight (BW) is the most important predictor of healthy life of a new born. Neonatal and infant survival is largely dependent on BW in resource poor countries. Birth weight is also one variable that is easiest to record and interpret statistically. The smaller the baby, the more crucial it becomes to monitor his or her growth after birth[1]. Low birth weight (LBW) continues to be a major public health problem worldwide especially in low and middle income countries[2,3]. In 2013, an estimated 16 per cent of all babies born globally had low birth weight. Among regions, South Asia has the highest incidence of LBW, with one in four newborns weighing less than 2,500 grams[3]. India alone accounts for one third of the global burden and more than one-fifth of children had LBW[4]. India is also among five countries where incidence of LBW exceeds 20 percent[5]. The World Health Assembly has set a new target to reduce LBW by 30 per cent between 2010 and 2025[6].

Factors associated with BW relate to socio-demographic and prenatal conditions in mother[2]. Birth weight is affected to a great extent by mater-

nal health and nutritional status before and during pregnancy[1]. Maternal malnutrition leads to poor foetal growth and lower BW, which affects survival of the child in early months of life. Those who survive tend to have increased risk of disease and are likely to remain undernourished. As adults, they suffer a higher incidence of diabetes and heart disease[3].

Mothers in deprived socio-economic conditions often have adverse BW. Women of short stature and young women have smaller babies[1]. In both developed and developing countries alike, LBW is frequently associated with adolescents who give birth when their own bodies have not yet fully developed[2]. Birth weight is strongly influenced by gestation period. For the same gestational age, girls weigh less than boys; firstborn infants are lighter than subsequent infants[1].

Albeit the pattern of determinants for lower BW may be similar, still the relative contribution of each determinant may vary from one setting to another[7].In community settings analysis of BW gives us an opportunity to observe its status in terms of mean birth weight, as well as to identify various determinants of BW of newborn. Therefore, this study was planned to overview the pattern of BW and to identify determinants of birth weight and the incidence of LBW in rural Punjab using population-based longitudinal data.

MATERIAL AND METHODS

A community based retrospective cohort study was carried out in 15 villages comprising a population of 31,756 under the Rural Health Training Centre of Department of Community Medicine, Dayanand Medical College and Hospital, Ludhiana, Punjab, India. A total of 376singletons live born in these fifteen villages from 1st January 2014 to 31st December, 2014 were identified. However birth weight measurements were missing for 44 (11.7%) live births and so were excluded from the study. Therefore a birth cohort of 332 live births was analyzed. Registration of pregnancy is hundred percent and detailed outcome of pregnancy is recorded by health workers by regular house to house visits. Information regarding maternal socio-demographic characteristics, obstetric and reproductive health parameters including birth history, pregnancy outcome and birth weight of newborn babies was collected from the registers maintained at the centre. Information on birth weight was recorded from Mother and Child Health Card (MCHC) which is issued to all mothers upon delivery or discharge. Ethics clearance for the study was duly obtained from the institutional ethics committee.

Operational definitions

The variables studied were maternal age, education, occupation, nutritional status, gestational order and birth interval. Maternal age was defined as age of mother at the time of delivery. Education of mothers as self-reported was considered in classifying them into educational groups. Primary occupation of mothers was considered in classifying them into occupational groups. Nutritional status of mothers was assessed by recording pre-pregnancy weight in kilograms (kg) and height of mothers in centimeters (cm) during the first trimester or first antenatal visit. Body Mass Index (BMI) of mothers was calculated from the ratio of Weight (kg)/ Height in meters $(m)^2$. Gestational age at birth was assessed from the difference between the date of child birth and the date of first day of last menstruation period (LMP) recorded at enrolment in the maternity records. Gravida was defined as the number of all previous pregnancies including abortions and stillbirths. Birth interval was defined as the period between previous delivery and recent conception. Preterm birth was defined as babies born alive before 37 completed weeks of gestation[1]. Birth weight was measured in kilograms (kg). Low birth weight was defined as birth weight less than 2.5 kg[1]

Statistical Analysis

Analysis was performed using Statistical Package for Social Sciences (SPSS package), version 20 (IBM SPSS, Chicago, Illinois, USA). Descriptive statistics are presented in percentages and mean ± standard deviation. One way ANOVA was used to determine the difference between the means of two and more than two independent groups respectively. All tests were two-tailed and $p<0.05$ was considered to be statistically significant. The associations between each explanatory variable and birth weight were explored at univariate level and those significant at $p<0.05$ were entered together into a multiple linear regression model with birth weight as outcome variable to quantify the adjusted association between explanatory and outcome variables.

RESULTS

The study included 332 live births. Table1 and 2 provide the descriptive information on socio-demographic characteristics of the mothers and birth weight of the newborns. The socio-demographic characteristics show that about 46% of the infants were born to mothers aged 20-24 years and 11.4% to mothers aged 30 years and above. The mean age of mother was 25.08±3.96 years. About 12% of infants were born to mothers with nil or primary education and 43.7% to moth

Table 1: Socio-demographic characteristics of mothers

Maternal Characteristics	Frequency (N=332) (%)
Age in years	
15-19	11 (3.3)
20-24	151 (45.5)
25-29	132 (39.8)
30+	38 (11.4)
Years of schooling completed	
No education	11 (3.3)
Up to 5	28 (8.4)
06-Oct	148 (44.6)
11-Dec	91 (27.4)
12+	54 (16.3)
Occupation	
Homemaker	310 (93.4)
Service	22 (6.6)
Socio-economic status	
Low & low middle	206 (62)
High & high middle	126 (38)
Type of family	
Nuclear	55 (16.6)
Joint	277 (83.4)
Gender of newborn	
Male	171 (51.5)
Female	161 (48.5)

Table 2: Distribution of births

Characteristics	Subjects (%)	Mean BW ±SD (kg)	Range (kg)
Mean BW (kg)	332	2.69±0.57	0.7-4.5
Birth weight (kg)			
<1.5	13 (3.9)	1.21±0.20	0.7-1.4
1.5-2.499	47 (14.2)	1.96±0.27	1.5-2.4
≥2.5	272 (81.9)	2.89±0.39	2.5-4.5
Low BW (<2.5kg)	60 (18.1)	2.30±0.58	0.7-2.43
Preterm births	79 (23.8)	2.57±0.53	0.7-2.8

BW=Birth Weight

Table 3: Maternal socio-demographic determinants of mean birth weight

Maternal characteristics	Subjects (%)	Mean BW ±SD (kg)	*p value
Total	332	2.69±0.57	
Age (Years)			
15-19	11(3.3)	2.43±0.57	0.040
20-24	151(45.5)	2.62±0.57	
25 -29	132 (39.8)	2.77±0.54	
30 and above	38 (11.4)	2.80±0.67	
Education			
Primary	39 (11.7)	2.57±0.70	0.291
Upto matric	148 (44.6)	2.69±0.53	
Matric+	145 (43.7)	2.73±0.58	
Occupation			
Homemaker	310 (93.4)	2.79±0.50	0.094
Service	22 (6.6)	2.93±0.49	
Socio-economic status			
Low & low middle	206 (62.0)	2.63±0.58	0.008
High & high middle	126 (38.0)	2.80±0.55	
Type of family			
Nuclear	55 (16.6)	2.62±0.57	0.307
Joint	277 (83.4)	2.71±0.58	

*p-value corresponds to F ratio of ANOVA; BW=Birth Weight

ers who had more than ten years of schooling. Mean year of schooling of mothers was 10.28±3.64 years. Majority of the mothers of newborns followed Sikh religion (93.7%), were residing in joint families (83.4%) and were home makers (93.4%). In the present study 51.5% of the infants were males and sex ratio at birth was 940 females per 1000 males. Mean gestational age at birth was 38.17±2.38 weeks. About 32% of new born were born by caesarian section. Birth weights ranged from 0.7 to 4.5 kilograms. The mean birth weight was 2.69 kilograms with a standard deviation of 0.57 kilograms. Proportion of very low birth weight (<1.5 kg) and low birth weight (<2.5kg) was 3.9% and 18.1% respectively. About one-fifth of the live births were preterm births and half of them were LBW babies. Nearly 8% of term births were low birth weight.

The pattern of mean birth weight by socio-demographic characteristics of mothers is shown in Table 3. It was observed that mean birth weight increased significantly with the increase in age of mothers. Adolescents had lower average birth weight (2.43±0.57kg) in comparison to mothers aged 30 years and above (2.80±0.67kg). (p=0.040). Mean birth weight also increased with increase in the education of mothers from primary (2.57± 0.70kg) to high school and above (2.73± 0.58kg) (p=0.291). Infants born to mothers who were home makers had lower average birth weight as compared to mothers who were in service (2.79± 0.50 vs. 2.93± 0.49 kg) (p=0.094).Nearly two thirds of the mothers belonged to low and lower middle socio-economic status as per Modified Udai Pareek (MUP) scale[8] for rural area. Mean birth weight increased from low & lower middle (2.63±0.58 kg) to upper middle and high socio-economic status (2.80±0.55 kg) of mothers (p=0.008). Mothers living in nuclear families had lighter babies (2.62±0.57 kg) than those living in joint families (2.71±0.58 kg) (p=0.307).

Regarding the association of birth weight of newborns by obstetric characteristics of their mothers (Table 4), compared to mothers having second birth order, primigravida and third birth order or higher had slightly lower mean birth weight (p=0.081). Birth interval showed no significant effect on birth weight although infants born to mothers having birth interval of less than 36 months had lower mean birth weight compared to birth interval of 36 months and above (2.65±0.62kg vs. 2.81±0.56kg) (p=0.107). The maternal heights at the 25th, 50th and 70th percentiles were 155, 157.5 and 160 cm respectively. Mean maternal height was 156.87± 4.67 cm. When analyzed as per height quartiles of mothers, it was observed that mean birth weight significantly increased from 2.62±0.63 to 2.89±0.56 kg with the increase in maternal height from ≤155cm to more than 160 cm. (p=0.018).

Table 4: Maternal Obstetric determinants of mean birth weight

Maternal characteristics	Subjects (%)	Mean BW ±SD (kg)	*p value
Total	332	2.69±0.57	
Gestational order			
First	151 (45.5)	2.68±0.54	0.081
Second	122(36.7)	2.71±0.57	
Third and higher	59 (17.8)	2.69±0.66	
Birth interval			
<36 months	122 (67.4)	2.65±0.62	0.107
≥36 months	59 (32.6)	2.81±0.56	
Height quartile			
≤25% (155.0 cm)	144 (43.4)	2.62±0.63	0.018
26-50% (157.5 cm)	84 (25.3)	2.66±0.48	
51-75% (160.0 cm)	51 (15.3)	2.78±0.53	
>75% (>160 cm)	53 (16.0)	2.89±0.56	
Pre-pregnancy BMI			
Underweight	90 (27.1)	2.51±0.56	0.001
Normal	164 (49.4)	2.78±0.52	
Overweight	78 (24.5)	2.74±0.65	
Gestational age			
Preterm births	79 (23.8)	2.57±0.53	0.001
Term Births	253 (76.2)	2.87±0.46	
Gender of newborn			
Male	171 (51.5)	2.75±0.58	0.073
Female	161 (48.5)	2.64±0.57	

*p-value corresponds to F ratio of ANOVA; BW=Birth Weight

Table 5: Multiple linear regression model predicting differences in birth weight of newborn babies

Parameter	aOR (95% CI)	p value
Intercept	3.182 (3.028, 3.337)	0
Age (Years)		
15-19	-0.234 (-0.524, 0.057)	0.115
20-24	-0.134 (-0.245, -0.022)	0.019
25 -29	Ref	
30 and above	0.029 (-0.143, 0.201)	0.741
Socio-economic status		
Low & low middle	-0.095 (-0.204, 0.015)	0.09
High & high middle	Ref	
Height quartile		
≤25% (155.0 cm)	-0.156 (-0.307, -0.004)	0.045
26-50% (157.5 cm)	-0.212 (-0.374, -0.051)	0.01
51-75% (160.0 cm)	-0.12 (-0.302, 0.061)	0.193
>75% (>160 cm)	Ref	
BMI		
Underweight	-0.162 (-0.284, -0.040)	0.01
Normal	Ref	
Overweight/obese	-0.027 (-0.157, 0.103)	0.685
Gestational age		
Preterm	-0.728 (-0.847, -0.609)	0
Term	Ref	

aOR=Adjusted Odds Ratio

Mean maternal weight was 51.5±10.51 kg and mean BMI of mothers was 20.89±4.01 kg/m^2. It was also observed that about 27.1% mothers were underweight whereas nearly one fifth of mothers were overweight or obese asper Asian adaptations of World Health Organization (WHO) criteria for categorization of BMI[9]. Infants born to mothers who were underweight had lower mean birth weight (2.51±0.56 kg) than mothers who had normal BMI (2.78±0.52 kg). Mean birth weight was 2.74±0.65 kg in overweight or obese mothers. The difference observed was found to be statistically highly significant. (p=0.001). Mean birth weight was found to be significantly lower among preterm births than term births (2.57±0.53 vs. 2.87±0.46 kg) (p<0.001). Male infants were heavier than female infants (2.75±0.58 vs. 2.64±0.57 kg) (p=0.073).

Factors which were significant in univariate analysis such as maternal age, socio-economic status, gestation period, pre-pregnancy BMI and height were used in a standard regression analysis to predict birth weight. Birth weight was primarily predicted by preterm births (β= -0.728, 95% CI = [-0.847, -0.609], p<0.001), underweight mothers (β= -0.162, 95% CI = [-0.264, -0.040], p=0.010), maternal height at 50th percentile i.e. ≤157.5 cm (β= -0.212, 95% CI = [-0.374, -0.051], p=0.010) and to a lesser extent by maternal age <25 years (β= -0.134, 95% CI = [-0.245, -0.022], p=0.019) and maternal height at 25th percentile i.e. ≤155 cm. (β= -0.156, 95% CI = [-0.307, -0.004], p=0.045) (Table 5).

DISCUSSION

This study was done to find out the pattern and determinants of birth weight in a rural area of Punjab, India. Mean birth weight in the present study was 2.69±0.57 kg, which is in consensus with the range observed for a rural community based study conducted in rural Wardha, by Gosavi et al (birth weight 2.67±0.42 kg)[10]. However, the observed birth weight in the present study is lower than the birth weight observed in a community based study done in rural Haryana by Rao et al (mean birth weight 2.786±.426 kg) for newborns[11]. Studies done by Ashtekar et al in rural Maharashtra[12] and Choudhary et al in urban slum community in Madhya Pradesh[13] observed mean birth weight of 2.81±0.40kg and 2.57±0.36 kg respectively. New born babies of Oman[7] and rural Portugal[14] were 400 gm and 503 gm heavier at birth than newborn babies in the current study.

Health and family welfare statistics in 2017 observed that, as per Health Management Information System (HMIS) data, out of 20.51 million live births occurred during the year 2016-17 in India, 2.32 million (11.9%) were found to be low birth weight as compared to 14.5% during 2013-14[15]. Incidence of LBW babies in the present study was 18.1%, which was lower than that observed in studies conducted in other parts of India[10,11,13,16,17], but higher than that of developing countries[2,18] and developed countries[7,14].

Gestational age plays significant role in determining infants' birth weight. Mean birth weight is generally influenced by proportion of preterm babies in addition to other predictors. Proportion of preterm births was 23.8% in the present study and average birth weight was significantly lower in preterm than term births. (p<0.001). Incidence of preterm was higher than that of other studies conducted by Raoet al[11] and Ashtekar et al[12] in India and Njim et al in Cameroon[20]and Sultan et al in Malaysia[21]. Infants who are delivered prematurely are at higher risk to have low birth weight. The present study revealed that two thirds of low birth weight infants were born before 37 weeks of gestation (preterm). With the advanced technology and improvement in mother and child health services, the chances of preterm live births are increasing which may affect the birth weight of the infants.

The present study revealed that maternal age, socio-economic status, pre-pregnancy BMI, height and preterm births were significant determinants of birth weight. The association between maternal socio-economic status indicators such as low level of education and low income with birth weight is controversial in developing countries[20]. Our study revealed that mothers' age and socio-economic status were significant determinants of birth weight. Adolescent mothers being still in the process of biological growth may not be physically and emotionally fully grown to know the significance of child bearing, self-care and adequate nutrition during pregnancy[2]. As observed in other studies[12,16,20], mothers aged below 20 years had significant lowest mean birth weight babies. Average birth weight of babies was highest for mothers aged 30 years and above. Other studies done in India[11] and abroad[2,7,14,20,21] also observed similar association.

The results also indicated that average birth weight increased significantly with increase in socio-economic status from low to high which is consistent with other studies[2,7]. Our study did not observe any significant association between maternal education and type of family with birth weight which is consistent with other studies conducted in India[13,16,22] and abroad[7,20]. In comparison to the significant association observed between birth weight and occupation by Choudhary et al[13], the present study did not find any significant association. This could be due to the fact that majority of mothers in the present study were homemakers (93.4%) and those employed were also not engaged in any kind of hard work. Similar results were also observed by Kadamet al[22].

Multiple linear regression analysis indicated that preterm births, underweight mothers, maternal age <25 years, maternal height at ≤157.5 cm were independent predictors of birth weight. The role of preterm birth as a strong predictor of birth weight is undeniable as preterm babies have not thrived enough to reach their target term weight and average birth weight was significantly lower in preterm than term births (p<0.001), which is in accordance with the estimates of Nijim etal[20]. Pre gestational BMI of mother, a reflection of gestational weight gain can act as biomarker for infant birth weight[23]. The current study observed a strong association between mothers who were underweight and infant birth weight. This finding is in agreement with the reports of other studies[20,21].

The study also revealed that there was a strong association between maternal height and infant birth weight. In many studies[20,23] conducted previously, significant birth weight differences were found among mothers of variable heights. A few possible mechanisms have been proposed for this association between maternal short stature and birth weight. Lao et al in a study conducted in mothers aged <19 years observed that gestational age and birth weight in the newborns increased with the higher quartiles of maternal height[24]. Further research in this area is needed to explore and explain the association between maternal height and gestational age and hence affecting birth weight. It was also observed in present study that gender of infants, gravidity and birth interval was not significantly associated with birth weight. Female infants had lower average birth weight than males. Similar findings have been reported in other studies[2,13,22]. The association between gravidity and birth interval has been established by other studies[2,22], however, in current study it was found to be non significant.

LIMITATIONS

A few important variables such as maternal weight gain during pregnancy and maternal history of disease were not available in the records used for the present study. These factors and including babies not weighed at birth could have provided additional information about determinants of birth weight.

CONCLUSION

This study reveals two important facts about birth weight of newborns in this rural community of Punjab. Incidence of low birth weight in newborns is 18.1%, which is lower than national figure of 22%[4]. However the incidence of preterm births is higher in the current study. Only 8% of LBW babies were born at term. The number of preterm babies contributed significantly in proportion of LBW newborns. Amongst factors mother's age, gesta-

tional age, maternal nutritional status and stature appear to be significant determinants of lower birth weight. Appropriate social and health promotion interventions targeting high-risk women need to be planned and implemented to ensure a healthy beginning.

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