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Receiver Operating Characteristics (ROC) Curve Estimation of Low Birth Weight Based on Maternal Early Third Trimester Weight among Bengalee Women of Kolkata, India

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A B S T R A C T

The cross-sectional hospital based study was undertaken to provide an efficient and useful cut off point of maternal early third trimester weight, for low birth weight (LBW), based on receiver operating characteristics (ROC) curve among Bengalee mothers of Kolkata, India. A total of 233 mother-baby pairs were included in the present analysis. The means for maternal age and weight were 23.44 (SD=3.88) years and 49.45 (7.19) kg, respectively. Means for gestational age and birth weight were 38.97 (1.12) week and 2664 (324) gm, respectively. The ROC curve analysis showed maternal weight ≤48.0 kg as the best cutoff point of LBW. Data showed maternal weight ≤48.0 kg had significantly higher OR (OR=2.92, 95% CI: 1.56–5.51) for delivering LBW baby. In conclusion, the cut-off point of maternal early third trimester weight ≤48.0 kg could be used for nutritional intervention programs in order to combat LBW among this population.

Key words: *India, Kolkata, third trimester, maternal weight, low birth weight, ROC*

Introduction

Low birth weight (LBW); babies weighing at birth less than 2.5 kg is a consequence of intrauterine growth retardation (IUGR) or preterm birth (born before 37 weeks), or both. LBW babies demonstrate significant growth retardation, as reflected by low body weights, heights and head circumference in comparison to normal weight peers. There is evidence of delayed skeletal growth and maturation in these children[1]. Growth-retarded girls become stunted and underweight adult women and are likely to give birth to LBW babies thereby perpetuating a vicious cycle through generation[2].

The incidence of LBW is higher in Asia than elsewhere[3], predominantly because of undernutrition of the mother before pregnancy, exacerbated by undernutrition during pregnancy. Approximately 60% of women in South Asia and 40% in South East Asia are underweight. In South Asia, 40% and more than 15% of mothers are thin and stunted, respectively[4]. In India, the prevalence of LBW is 30%[5]. Deprived populations of urban areas have consistently recorded very high prevalence of LBW. The weight of a neonate at birth is an important indicator of maternal health and nutrition during pregnancy. In developing countries with a higher incidence of LBW, IUGR is a major component of LBW compared to pre-maturity. Those IUGR components of LBW are related to nutritional parameter of the mother, such as weight during pregnancy[6].

It has now well established that women in both developed and developing countries, who are heavier before and during pregnancy, deliver heavier babies[7]. In contrast, undernourished women were more prone to have LBW babies[7,8] and complications during pregnancy[9]. A study from Bangladesh[10] has documented, by using the receiver operating characteristic (ROC) curve, the best cut-off point for predicting LBW infants as maternal weight at term (late third trimester) less then 50 kg. An earlier study[11] from Varanasi, India, reported low maternal weight in early third trimester was associated with a higher risk of being LBW. Another study by Shah[12] had found that a maternal third trimester (24 to 32 weeks) weight of less than 42 kg was related to higher risk of being LBW.

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In the Indian context, only mothers' weights are measured and recorded on a routine basis during antenatal checkup at Indian health institutions. Therefore, an efficient cut-off point is essential for screening pregnant women in different weights-for-gestational age. Therefore, antenatal caregivers at health institutions can then use the cut-off value as a screening tool for the identification of the high risk pregnancy. Thus, health worker could be provided advice for the weight gain required since maximum maternal weight increase occurs between second and third trimesters[13]. However, studies dealing with third trimester maternal weight among Bengalee Hindu women of Kolkata are lacking. Therefore, in view of broader context, the objective of the present study was to provide an efficient and useful cut off point of maternal weight of Bengalee Hindu women at early third trimester for LBW, based on ROC curve analyses.

Methods

This cross-sectional study was conducted over a period of six months from June 2004, in M. R. Bangur Hospital of South Kolkata, India, and is situated at 22°32'40''N, 88°24'30''E. As per latest census total population of Kolkata was 4580554, with a fertility rate of 3.2%. The literacy rate is 81.31%, which is higher than the national average of 59.5%. The present investigation deals with the Bengalee Hindu ethnic group.

There was homogeneity in the socio-economic status of the subjects in that all of them belonged to the lower social stratum. There were some screening criteria used for recruitment of the subjects. These were: women did not suffer from any severe medical disorder before pregnancy and they attended antenatal clinic for antenatal checkup during 24–28 weeks of pregnancy. Only singleton live born baby by normal delivery who did not suffer from any congenital malformation or sickness during the time of examination were considered.

Ethical approval and prior permission was obtained from Society for Applied Studies Ethics Committee for the study protocol, before commencement of study. Informed written consent was also obtained from those mothers willing to participate in the study.

The estimated sample size was calculated based on standard formula: $n=z^2pq/d^2$ (where $z=1.96$ and $q=p-1$, a prevalence (p) rate of 30% LBW in India[5], with a desired precision (d) of 6%). A minimum of 224 subjects would be required for the present investigation. Therefore, a total of 298 mothers were consecutively interviewed during the six months period those mothers attended at antenatal clinic for antenatal checkup during 24–28 weeks from the history of last menstrual period (LMP). Of these, 233 (78.2%) healthy mothers having term (delivered >36 weeks of gestation) and normal deliveries, who met all recruitment criteria were included in the present analyses.

Data were collected by one author (SB) by using pre-tested questionnaire following one to one interview of mothers for confirmation of age, ethnicity, history of LMP and medical disorder. Gestational age was calculated from the history of LMP. Mothers' weight was collected from antenatal case sheet which were earlier recorded by health workers using Salter bathroom scale to the nearest 1.0 kg. Birth weight was measured within 24 hours after delivery using triple beam balance to the nearest 1.0 g. Newborns were classified as LBW and NBW (normal birth weight) on the basis of weight at birth being <2.5 kg or ≥2.5 kg, respectively. The age range of mothers was 16.0–35.0 years.

Statistical method

Data entry and statistical analysis were done using the EPI-INFO, version 6.0 and MEDCALC Software[14]. Odds ratio was calculated to measure the risk between the groups. Sensitivity (SN), Specificity (SP), Positive predictive value (PPV) and negative predictive value (NPV) were calculated by standard statistical methods. Receiver operating characteristics (ROC) curve analyses was undertaken using MEDCALC software following the standard method[15]. A p value <0.05 was considered significant.

Results and Discussion

The mean (SD) for the total and percentile values of maternal age, weight, gestational age and newborn birth weights of study group are presented in Table 1. The mean monthly family income was Rs. 2365 (1491). The mean years of schooling of the subjects was 4.91 (3.86). Mean maternal weight was 49.45 (7.19) kg; 25th and 75th percentile maternal weights were 44.0 kg and 53.0 kg, respectively. Similarly, mean birth weight was 2664 (324) g; 25th and 75th percentile of newborn birth weight were 2447g and 2900g, respectively. The mean (SD) age of mother was 23.44 (3.89) years. The mean gestational age was 38.97 (1.12) weeks.

Three separate linear regression analyses were undertaken (results not shown) using maternal age, maternal weight and gestational age as independent variables. It was observed that maternal weight (F change=31.782)

TABLE 1
MATERNAL AND NEWBORN CHARACTERISTICS

Variables	Mean±SD	Percentile cutoff		
		25	50	75
Monthly Family Income (Rs.)	2365±1491	1500	2000	3000
Age (year)	23.44±3.88	20.0	23.0	25.0
Education (years)	4.91±3.86	0.0	5.0	8.0
Gestational age (week)	38.97±1.12	38.0	39.0	40.0
Maternal weight (kg)	49.45±7.19	44.0	50.0	53.0
Birth weight (g)	2664±324	2447	2646	2900

TABLE 2
SCREENING TEST FOR EFFICIENT CUTOFF POINT OF MATERNAL WEIGHT FOR LOW BIRTH WEIGHT

Weight (kg)	SN	SP	PPV	NPV	OR (95% CI)
≤47.0	52.3	71.4	41.5	79.5	2.74 (1.45–5.20)
≤48.0	60.0	66.1	40.6	81.0	2.92 (1.56–5.51)
≤49.0	63.1	61.3	38.7	81.1	2.71 (1.43–5.14)

SN = Sensitivity, SP = Specificity, OR = Odds ratio, CI = Confidence interval, PPV = Positive predictive value, NPV = Negative predictive value

and gestational age (F change=19.142) independently had strongest impact on birth weight. Maternal weight explained 12.1% (R-square change=0.121) variation in birth weight while gestational age explained 6.8% (R--square change=0.068) variation in birth weight. However, maternal age had no significant impact on birth weight (t=0.645).

A cut-off point was obtained by ROC curve analyses (Table 2, Figure 1). The ROC curve showed maternal weights ≤48.0 kg as the best cutoff point for being LBW. The area under the curve (AUC) was 0.679 (SE=0.037) and the difference of maternal weight by two groups (LBW Vs NBW) of mother was significant (p<0.0001). Data showed maternal weight ≤48.0 kg had significantly higher odds ratio (OR=2.92, 95% CI: 1.56–5.51) for delivering LBW baby. The comparative proportional screening test was evaluated for LBW using different maternal weight indicators. Maternal weight ≤48.0 kg had higher OR for LBW when compared to mothers' weight ≤47.0 kg and ≤49.0 kg. The NPV of this cutoff point (maternal weight ≤48.0 kg) was higher than maternal weight of ≤47.0 kg, and similar to cutoff point of maternal weight ≤49.0 kg for predicting LBW.

LBW is a major public health problem in South Asian countries including India. Over the last five decades there has been no significant decline in the prevalence of LBW in India. In the present study, the mean birth weight was 2664 g which is comparable to earlier studies from India[16–20]. However, it was higher[21,22] and lower[23–27] than those reported from other previous Indian studies. It was also lower than those reported from other developing countries[28,29].

The present study attempted to examine to what extent early third trimester maternal weight is a useful and efficient indicator for predicting LBW baby of pregnancy. The main objective of this study was to provide a cut-off point for LBW by maternal early third trimester weight among the women of Kolkata. The ROC curve showed maternal weights ≤48.0 kg best cutoff point for being LBW. Data showed maternal weight ≤48.0 kg had significantly higher odds ratio (OR = 2.92, 95% CI: 1.56–5.51) for delivering LBW baby. The SN, SP, PPV and NPV values were 60%, 66%, 41% and 81%, respectively. Some earlier published works have demonstrated similar results for predicting LBW babies by maternal weight indicator

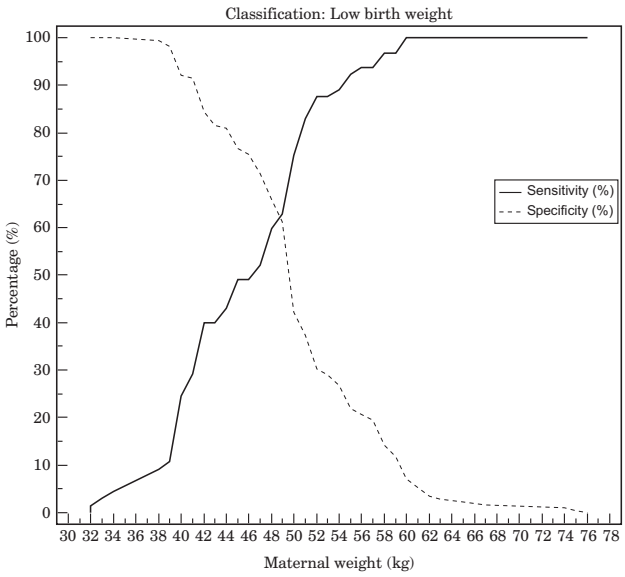

Fig. 1. Roc curve of third trimester maternal weight and birth weight.

at different gestational ages[10,30–32]. The main advantage of using a standard for attained weight at a specific point in pregnancy is that it requires a single measurement only[33]. Several cut-off points at different times of pregnancy have been recommended in the literature. Similar findings have been reported by an earlier study[11] from Varanasi, India. They suggested a cut-off of 45 kg at 13 weeks, increasing to 47 kg at 20 weeks, 49 kg at 25 weeks, 50 kg at 30 weeks, 51 kg at 35 weeks and 52 kg at 40 weeks. Similarly, other recommendations for cut-off values are maternal weight of less than 45 kg at first trimester and less than or equal to 43 kg in pregnancy month 3–5, based on work in India[32] and Bangladesh[33].

In conclusion, a cut-off point of maternal early third trimester weight ≤48.0 kg could be used for nutritional intervention programs in order to combat LBW among this population along with consideration of other biochemical and obstetric risk factors. However, it must be mentioned here that the sample size of the present study was small. This is a limitation of the study. Therefore, the findings need to be validated among a larger sample of Bengalee women before it can be applied for health promotion purpose among this ethnic group. Moreover, similar studies are needed in different tribal communities, since they are more socially and economically underprivileged population in India.

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SMANJENA TJELESNA TEŽINA NOVOROĐENČETA I MAJČINSKA TIJELESNA TEŽINA U RANOM TREĆEM TRIMESTRU TRUDNOĆE KOD BENGALSKIH ŽENA U KALKUTI, INDIJA

SAŽETAK

Provedena je presječna studija među bengalskim majkama u Kalkuti, Indija kako bi se dobila primjenljiva granična vrijednost majčinske tjelesne težine u ranom trećem trimestru koja je povezana uz smanjenom tjelesnom težinom djeteta pri porodu, uz uporabu operativne krivulje (engl. receiver operating characteristic curve – ROC). U analizu su uključena ukupno 233 para majka-dijete. Srednje vrijednosti za majčinsku dob i težinu bili su 23.44 (SD=3.88) godina i 49.45 (7.19) kg. Srednje vrijednosti za trajanje trudnoće i tjelesnu težinu pri porodu su 38.97 (1.12) tjedana i 2664 (324) g. Analiza ROC krivulje pokazala je kako je majčinska težina od 48.0 kg najbolja granična vrijednost za težinu novorođenčeta. Podaci su pokazali kako je majčinska težina od 48.9 kg imala značajno viši OR (OR=2.92, 95% CI: 1.56–5.51) za porod djeteta sa smanjenom tjelesnom težinom. U zaključku, granična vrijednost tjelesne težine majki u ranom trećem trimestru od 48.0 kg može se upotrijebiti u interventnim nutricionističkim programima kako bi se spriječila smanjena tjelesna težina novorođenčeta.