Original Article

Maternal anthropometry in relation to birth weight of newborn: A prospective hospital based study

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Abstract

Background: Birth weight of neonate is probably the most important factor that affects the future survival and quality of life of the neonates. **Objective:** To study the maternal anthropometric parameters in relation to birth weight of neonate. **Methods:** This observational case-control study was conducted in a tertiary care teaching hospital in central India from March 2013 to September 2014. Low birth weight (LBW) neonates (<2.5 kg) and their mothers were taken as cases, and normal birth weight (NBW) neonates (≥2.5 kg) and their mothers were taken as controls. Data regarding demographic profile, maternal and neonatal anthropometry, antenatal, and natal events were recorded. **Results:** Of total 600 subjects, 300 neonates were LBW (cases) and 300 were NBW (controls). Mean birth weight was 2.05±0.252 kg (in cases) and 2.9±0.295 kg (in control). The weight of 59.3% mothers in the case group was below 50 kg (odds ratio [OR] - 3.4) and height was <150 cm (OR - 1.22). Mean maternal body mass index (BMI) in study and control group was 21.73±0.25 and 22.06±0.87, respectively (p<0.0677). BMI ranged from 21.5 to 22 in 85% of NBW and 19% of LBW neonates, and from 22.1 to 22.9 in 81% of LBW and 15% of NBW babies. Mean maternal mid-upper arm circumference (MUAC) in this study and control group were 20±2.13 cm and 25.5±1.36 cm, respectively (p<0.0001). Maternal MUAC was 19-23 cm in 81% of LBW babies and 23-27 cm in mothers of NBW babies (OR - 24). **Conclusion:** MUAC can be used as an easy cost-effective tool to identify mother at risk of delivering LBW babies so that they can be subjected appropriate care intervention at hospital and home to improve the perinatal outcome.

Key words: *Low birth weight, mid upper arm circumference, body mass index, maternal anthropometry*

Birth weight is the most sensitive and reliable indicator of health of the community [1]. Low birth weight (LBW) is defined as birth weight <2500 g irrespective of the period of gestation. These babies have a higher susceptibility for physical, neurological, and mental impairment than the normal birth weight (NBW) babies. Birth weight has been shown to be influenced by the length of gestation, parity, prenatal care, parental education, socio-economic status (SES), maternal malnutrition, maternal smoking, maternal and fetal medical problems, and exposure to environmental agents [2-6].

Many previous studies have investigated the role of maternal nutritional status, indicated by maternal anthropometry, to predict infant as well as maternal outcomes of pregnancy [5-8]. Indicators such as maternal height, pre-pregnancy weight, weight gain during pregnancy, body mass index (BMI), and mid-upper arm circumferences (MUACs) received considerable attention as proxy measures of current or past nutritional status of the mothers [5-8]. In 1995, the WHO Collaborative study on maternal anthropometry and pregnancy outcomes was published which is regarded as a milestone publication on this topic [9]. This meta-analysis of 25 studies of maternal anthropometry from 20 countries, involving over 111,000 births worldwide, revealed that attained weight during pregnancy was strongly associated with birth weight and intrauterine growth.

However, in developing countries, weight gain monitoring in pregnancy may not be feasible due to limited availability of the prenatal care and screening of mothers with anthropometric measurements that require single contact is more useful. Therefore, we planned this study to assess the relationship between maternal anthropometry in last trimester and birth weight of the neonates and to determine the sensitivity and specificity of these measurements in predicting LBW neonates. This sample screening may identify high-risk mother, and timely intervention can reduce the birth of LBW babies.

METHODS

This observational case-control study was conducted in the Department of Pediatrics and Obstetrics and Gynecology, Gandhi Medical College, Bhopal, from March 2013 to September 2014. Clearance from the Institutional Ethical Committee was obtained before starting the study. LBW neonates (<2.5 kg) and their mothers were taken as cases, and NBW neonates (≥2.5 kg) and their mothers were taken as controls. The study objective and procedures were clearly explained to mother and written consent was obtained from the mothers before recruitment.

Eligible subjects were women who were admitted for delivery in the Department of Obstetrics and Gynecology for planned delivery of a singleton at term (37-42 weeks of gestation) baby and who were willing to participate in the study. Mothers were excluded if they had physician diagnoses of any chronic illness such as renal, hepatic or cardiac disease; psychiatric illness; hemoglobinopathies; endocrine disorders, e.g., diabetes mellitus, or thyrotoxicosis; autoimmune diseases, e.g., Crohn's or coeliac disease; drug dependence or steroid intake during pregnancy; pregnancy complications such as antepartum hemorrhage, pre-eclampsia; placental abnormalities such as abruption placentae; multiple gestations or a fetus with congenital anomalies.

Assessment of potential risk factors was done by maternal interview, medical record review, and maternal anthropometric examination. A pre-tested Hindi translated questionnaire was used to collect the information. Maternal interview and measurements were conducted either before or within 24 h of delivery depending on the mother's condition. Information regarding socio-demographic factors such as maternal age, education, occupation, residence, and household income; obstetric history including parity, nutrition and antenatal visits during pregnancy, consumption of iron folic acid (IFA) tablets; medical or pregnancy induced morbidities such as anemia, physician-diagnosed hypertension, or diabetes were enquired and checked with the maternal case records.

Maternal anthropometry included mother weight, height, and MUAC. Mothers' weight was measured by a standard electronic weighing scale to the nearest 100 g. Maternal height was measured with a standard scale (stadiometer) to the nearest millimeter. BMI was calculated using the formula weight in kg/height in m^2. MUAC was measured by a non-stretchable tape at the mid-point of acromion and olecranon fossa on the non-dominant arm to the nearest millimeter. Newborns' weight was measured on a digital weighing scale to the nearest 10 g. The gestational age was calculated from the last menstrual period and by New Ballard's score within 24 h of the birth in completed weeks of gestation.

Statistical Analysis

Proportions were calculated for categorical variables and mean, standard deviation and median for continuous variables. The continuous variables were compared using t-test or ANOVA and categorical variables using χ^2 test and odds ratio (OR) were calculated.

RESULTS

A total of 600 mother-infant pairs were included in the study of which 300 were LBW (cases) and 300 were NBW (controls) as shown in Fig. 1. Mean birth weight was 2.165±0.342 kg in LBW and 2.912±0.465 kg in NBW babies with a male-female ratio of 1.3:1 and 0.923:1 in case and control group, respectively. The demographic profile of the mothers has been shown in Table 1. Most of the mothers belonged to age group of 20-35 years in both control (56%) and study (47.3%) group. Literacy status of mother and SES was comparable in both the groups. About 44.3% of the neonates of mothers belonging to SES I and II were LBW while 55.7% neonates were NBW (OR - 0.70, 95% CI 0.46-1.05). Interpregnancy interval <2 years, irregular antenatal checkups (i.e., <3 visits) maternal hemoglobin <8 g%, and IFA supplementation for short duration (<3 months) were other maternal factors shown to be associated with LBW in their neonates.

Around 70% mother had weight >50 kg in the control group in comparison to 40% in the study group. The mean BMI was 21.73±0.25 and 22.06±0.87 in study and control group, respectively, which was statistically not significant (p≤0.0677). The mean MUAC in the study and control group was 20±1.12 and 25.5±1.31 cm, respectively, which was statistically significant (p≤0.0001).

Table 2 shows that 19% of the study group and 85% of the control group had BMI between 21.50 and 22.10 and 81% of the study group, and 15% of the control group had BMI

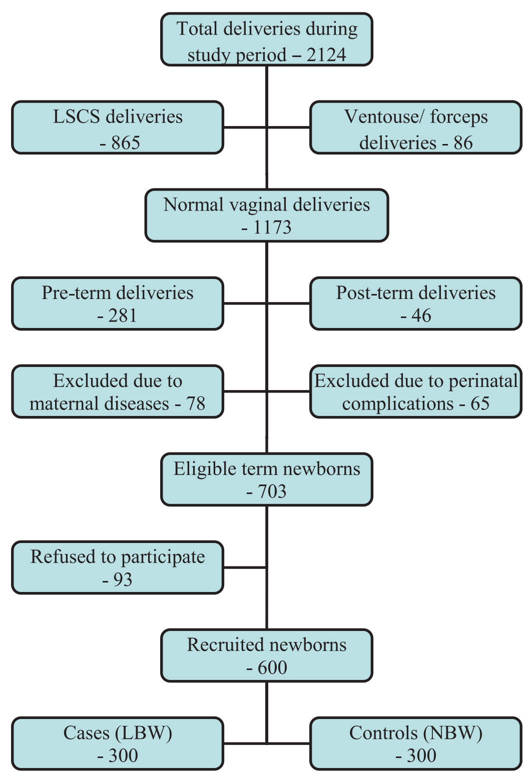

Figure 1: Study flow chart

Table 1: Demographic profile of mothers

Maternal factors	N (%)			OR (95% CI)
	LBW	NBW	Total	
Age of mother				
>20	95 (31.6)	75 (25.0)	170 (28.3)	1.39 (0.97-1.99)
20-35	142 (47.3)	168 (56.0)	310 (51.7)	0.71 (0.51-0.97)
>35	63 (21.1)	57 (19.0)	120 (20.0)	1.13 (0.76-1.69)
SES				
Class I/II	51 (44.3)	64 (55.7)	115 (19.2)	0.70 (0.46-1.05)
Class III/IV/V	259 (53.4)	226 (46.6)	485 (80.8)	
Inter-pregnancy interval				
<2 years	98 (64.5)	54 (35.5)	152 (46.3)	5.79 (3.58-9.36)
>2 years	42 (23.9)	134 (76.1)	176 (53.7)	
Parity				
1	142 (47.3)	130 (43.3)	272 (45.4)	1.89 (1.34-2.67)
2	66 (22.0)	62 (20.6)	128 (21.3)	1.08 (0.73-1.60)
3	92 (30.7)	108 (30.1)	200 (33.3)	0.81 (0.58-1.14)
Number of antenatal checkups				
<3 visits	243 (81.0)	140 (46.67)	383 (63.8)	4.87 (3.38-7.03)
>3 visits	57 (19.0)	160 (53.33)	217 (36.2)	
Maternal hemoglobin				
<8 g	168 (59.8)	113 (40.2)	281 (46.8)	2.11 (1.52-2.92)
>8 g	132 (41.4)	187 (58.6)	319 (53.2)	
Duration of iron supplementation				
<3 months	173 (62.7)	103 (37.3)	276 (46.1)	3.22 (2.31-4.51)
>3 months	111 (34.3)	213 (65.7)	324 (53.9)	

LBW: Low birth weight, NBW: Normal birth weight, SES: Socio-economic status, OR: Odds ratio, CI: Confidence interval

Table 2: Maternal anthropometry and birth weight of the neonates

Anthropometric parameter	N (%)		OR (95% CI)/ p value
	LBW	NBW	
Maternal weight			
<50 kg	178 (59.33)	90 (30)	3.43 (2.43-4.77)
>50 kg	122 (40.66)	210 (70)	
Maternal height			
<150 cm	155 (51.67)	140 (46.67)	1.22 (0.89-1.68)
>150 cm	145 (48.33)	160 (53.33)	
BMI			
21.50-22.10	55 (19)	255 (85)	0.041 (0.03-0.06)
22.11-22.90	243 (81)	47 (15)	
Mean	21.73±0.25	22.06±0.87	<0.0677
MUAC			
19-23 cm	221 (81)	79 (15)	9.73 (6.69-14.14)
23-27 cm	67 (19)	233 (85)	
Mean	20±1.12	25.5±1.31	<0.0001

MUAC: Maternal mid upper arm circumference, BMI: Body mass index, LBW: Low birth weight, NBW: Normal birth weight, OR: Odds ratio, CI: Confidence interval

22.10-22.90. 81% of mothers in study group, and 15% of the mothers in control group had MUAC between 19 and 23 cm while 85% of the mothers in control group and 19% of the mothers in study group had MUAC between 23 and 27 cm.

DISCUSSION

The prime concern of this study was to identify the best suitable surrogate parameter to assess the maternal nutrition to predict the birth weight of neonate. This should be able to detect the maximum number of at risk mothers when used by the health personal in the domiciliary outreach. In our study, we found that maternal MUAC was the best parameter to predict the birth weight of neonates. Maternal nutritional status can be assessed by stature, pre-pregnancy weight, and weight gain during pregnancy, BMI, height, skinfold thickness, and MUAC.

Maternal MUAC is a good indicator of the protein reserves of a body and is an important determinant of LBW of their newborn babies. The WHO Collaborative Study 1995 showed MUAC cutoff values of <21 to 23 cm as having significant risk for LBW (OR: 1.9, 95% CI: 1.7-2.1) [9]. Recently, another review was conducted to identify the anthropometric indicators to predict adverse birth outcomes and to screen acutely malnourished pregnant woman [10]. This review showed that a cutoff value of 21 cm might be too low and MUAC cutoff of <22 or <23 cm should be used to indicate risk of LBW. This seems more rationale as LBW has detrimental effects on a child's survival and a more inclusive approach with MUAC cutoff of <22 or <23 cm should be more appropriate in our setup. In our study, we have taken MUAC of 23 cm as cutoff and found that 81% mothers of LBW babies had MUAC < 23 cm while only 19% had MUAC of more than it. The mean MUAC in study and control group was 20±1.12 and 25.5±1.31 cm, respectively (p<0.0001).

Sen et al. showed maternal anthropometry and socio-economic variables have a significant association with birth weight of neonate, of which maternal weight and MUAC was found to be the best surrogate measure of LBW [6]. Mohanty et al. measured MUAC in 395 pregnant women in the first trimester and found MUAC ≤22.5 cm as the best cut-off value to predict adverse pregnancy outcome [7]. Similar observations were made by authors of other studies conducted in different developing countries [11-16]. Elshibly and Schmalisch studied 1000 Sudanese mother and neonates within 24 h of birth. The strongest association of birth weight was found (relative risk [RR] >5-6%) with MUAC, supine length and birth weight [14]. Sebayang et al. studied 14,040 births and found women with higher MUAC (≥23.5 cm) increases mean birth weight by 33 g (95% CI) and significantly reduced LBW by 21% (RR=0.79). The modifying effect of MUAC on mean birth weight, LBW and small for gestational age was significant [15].

Previous studies also showed association of LBW with maternal weight at <43.5 to <50 kg and weight <45 kg was indicative for high risk of LBW in Asian countries [10]. Similarly, significant association of maternal height and LBW was indicated by a maternal height ranging from <146 to <156 cm [10]. Our study also showed good correlation of LBW with maternal weight and height. Most of the previous studies from developing countries indicate cutoff values for BMI ranging from <18.5 to <20.5 kg/m^2 with statistical significance for LBW. BMI changes during pregnancy, and there is insufficient evidence from this to indicate one cutoff value for a specific gestational age for BMI [3-8]. However in our study, maternal BMI was not significantly associated with LBW in neonates. In this study, BMI was 21.50-22.10 in 19% mothers and 22.11-22.90 in 81% of mothers of LBW babies. The mean BMI in study and control group was 21.73±0.25 and 22.06±0.87, respectively (p<0.0677). Karim et al. found maternal weight at term as the best single predictor of LBW with a correlation coefficient of 0.49 [5].

Although previous studies have shown importance of maternal anthropometric measurements for prediction of LBW, recent meta-analysis could not prove its suitability for predicting LBW [17]. This meta-analysis included a large number of studies involving 309,419 mother-infant pairs. It included data on maternal height, weight, MUAC, BMI, and weight gain during pregnancy (n=85, 80, 23, 51, and 16, respectively). However, author could not found sufficiently high sensitivity - 0.46 (95% CI: 0.35-0.56) to 0.63 (95% CI: 0.54-0.71), specificity - 0.55 (95% CI: 0.42-0.67) to 0.71 (95% CI: 0.61-0.80), and diagnostic ORs - 2 (95% CI: 2-2) to 4 (95% CI: 3-5) for primary screening.

Various factors such as maternal nutrition, height, anemia, concurrent illnesses, low SES, behavioral habits, inter-pregnancy interval, antenatal care visits, and IFA supplementation are known determinants of LBW but all need technical expertise to predict at risk mothers. MUAC is rather insensitive to changes over the total duration of pregnancy, is easy to measure, and requires only one measurement. MUAC can be used as a simple predictor than BMI for assessment of maternal malnutrition and anticipating birth of LBW babies. It can also be used by peripheral health workers as it does not require expertise, training, or difficult calculations. More research is needed to evaluate whether the combined use of two or more easily measurable anthropometric indicators can have a high predictive value for adverse birth outcomes. Furthermore, research is needed to determine to what extent enrollment of pregnant women with MUAC <23 cm in various nutritional programs can decrease the risk of LBW deliveries.

CONCLUSION

This study reveals that MUAC can be a useful surrogate parameter to identify at risk mothers so that they can be given special attention at the hospital and home to improve the perinatal outcome of their babies. It does not need expertise or training like in assessment of BMI so it can be used by peripheral health workers as an easy objective tool to identify mothers at risk of delivering low births weight babies.

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