Original Article

Identifying low birth weight babies using calf circumference among neonates in a semi-urban area

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ABSTRACT

Background: Low birth weight (LBW) still persists as a public health problem in low- and middle-income countries. There is a constant search to find newer methods to detect LBW babies so that early interventions can be taken. **Objective:** The objective of this study was to determine the critical limit and to assess the reliability of calf circumference (CaC) measurement in detecting LBW babies. **Materials and Methods:** This cross-sectional study was conducted in a tertiary care hospital between April 2018 and September 2018. In this study, a total of 185 newborns were included in the study. Anthropometric measurements (Calf Circumference [CaC], birth weight, head circumference, crown-rump length, chest circumference, and thigh circumference) were taken as per standard guidelines. Collected data were analyzed for determining the mean, standard deviation, critical limit, receiver operating characteristic curve, Pearson correlation coefficient, and regression analysis of the anthropometric measurements at birth in relation to birth weight. **Results:** The mean CaC of LBW babies was 9.16±0.11 cm and in normal weight babies, it was 10.86±0.09 cm. The mean values of CaC were significantly lower in LBW babies (p<0.0001). The mean cutoff value of CaC of LBW babies is found to be 9.90 cm, with a sensitivity of 85.6% and specificity of 82.2%. **Conclusions:** In our study, measuring CaC is found to be a good method in identifying LBW neonates. Hence, measuring CaC can be used as an alternative method to identify LBW babies in remote areas.

Key words: *Calf circumference, Low birth weight, Healthy newborns*

In spite of the interventions being taken, low birth weight (LBW) still persists as a public health problem in low- and middle-income countries [1]. The World Health Organization (WHO) defines LBW as birth weight <2500 g. According to the UNICEF estimates, institutional delivery rates are 90.9% and 9.1% delivered at home [2]. Identifying LBW neonates require an accurate weighing scale and trained staff. In remote areas where these facilities are often lacking, there is a need to find alternate methods to detect LBW babies.

Several other studies have equated calf circumference (CaC) with other anthropometric measurements such as thigh circumference (TC) and head circumference (HC). Majority of the studies show CaC measurement as a more reliable indicator. However, there is no standardized cutoff value for this. Determining the critical limit of CaC will help community health workers to identify and refer low birth babies using a simple color-coded measuring tape. There is no standard cutoff value as we see in literature. Hence, this study was done to arrive at a cutoff value of CaC in our population for identifying LBW. We conducted this study with an objective to determine the critical limit and assess the reliability of CaC measurement in detecting LBW babies.

MATERIALS AND METHODS

This cross-sectional study was conducted at a medical college, between April 2018 and September 2018 and was approved by the institutional ethics committee. Informed consent was obtained from the mother/father. A total of 185 newborn babies delivered during the study period were included by consecutive sampling method. Sample size was calculated using the formula: $n=4PQ/D^2$.

The inclusion criteria for this study were the healthy newborns in the postnatal ward. Those with congenital anomalies, NICU babies, and those with serious illnesses were excluded from the study. Detailed history regarding age of the mother, maternal illness, per capita income of the family, type of delivery, and gender of baby was recorded, and anthropometric measurements were taken after delivery. Postnatal ward staff nurses were trained to measure anthropometric parameters and were blinded to study. A standard measuring tape was used in the postnatal ward. Random supervision was made to assess the correct technique of measurement to reduce the variations.

Birth weight for all newborns in nude state was recorded, using a digital electronic weighing scale to the nearest 5 g. The recumbent crown heel-length was taken using an infantometer to the nearest 1.0 mm. The other measurements were taken using a non-elastic, flexible cloth-measuring tape to the nearest 1.0 mm. The CaC was measured at the most prominent point in a semi-flexed position of the leg. The HC was measured between the glabella anteriorly and along the most prominent point of occiput posteriorly by cross-over technique, over the parietal eminence. Chest circumference was measured by placing the tape at the level of nipples and encircling the body. Birth weight was classified using the WHO guidelines into LBW and normal birth weight [2].

Data were collected and compiled using MS Office Excel 2008. Qualitative variables were expressed in percentages. Continuous variables were expressed in mean and standard deviation. The difference between two means was computed using unpaired t-test. Box and whisker plots were used to depict the CaC in both LBW and normal weight babies. SPSS version 19.0 was used to analyze the data. Pearson's correlation coefficient was used to correlate CaC and birth weight. Receiver operating characteristic (ROC) curves were constructed to find out the critical value of CaC. Further, sensitivity and specificity were calculated for the best cutoff point of CaC.

RESULTS

Our study objective was to find the critical limit of Calf Circumference and its reliability in identifying Low Birth weight babies. Other measurements were taken as a part of routine newborn examination. Table 1 shows the sociodemographic characteristics of the study subjects. Of 185 neonates included in our study, 95 (51.35%) were male and 90 (48.65%) were female babies. Among 185 neonates, 25% were LBW (<2.5 kg). Lower segment cesarean section accounted for 54% and normal delivery constituted 45.9% in the study subjects.

In the present study, the Pearson's correlation coefficient between CaC and birth weight was 0.722 (p<0.0001). The mean CaC of LBW babies was 9.16±0.11 cm and was 10.86±0.09 cm in normal weight babies. The mean values of CaC were significantly lower in LBW babies (p<0.0001).

Fig. 1 shows the ROC curve for CaC. The area under a curve is 0.909 and the best cutoff is 9.90 cm of CaC. The sensitivity and specificity for the best cutoff for CaC are found to be 85.6% and 82.2%, respectively. A CaC cutoff value of 9.90 was found to be a good predictor for LBW babies, with an area under the curve in ROC of 0.909. The sensitivity was determined to be 85.6% and specificity 82.2%. Fig. 2 shows a CaC cutoff value of 9.90 which was found to be a good predictor among LBW male babies, with an area under the curve in ROC of 0.917. The sensitivity was determined to be 85.7% and specificity 83.3%.

Table 1: Sociodemographic characteristics of the study population

Demographic characteristics	n=185 (%)
Male	95 (51.35)
Female	90 (48.65)
Birth weight <2.5 kg	46 (25)
Birth weight >2.5 kg	139 (75)
Normal delivery	85 (45.9)
LSCS	100 (54.1)

LSCS: Lower segment cesarean section

A CaC cutoff value of 9.90 was found to be a good predictor among LBW female babies, with an area under the curve in ROC of 0.905. The sensitivity was determined to be 85.5% and specificity 81.5% (Fig. 3). There was a strong positive correlation between CaC and birth weight, and this was found to be statistically significant with p<0.0001 (Fig. 4). Fig. 5 shows the mean CaC values for normal birth weight babies as 10.86±0.09 cm and LBW babies as 9.16±0.11 cm.

DISCUSSION

One of the high-risk groups among under 5 children is LBW babies since they have significantly higher chances of morbidity and mortality. In the present study, 25% of the study subjects were LBW category. On ROC curve analysis, CaC was found to be a good tool to identify LBW. A cutoff point of 9.90 cm CaC

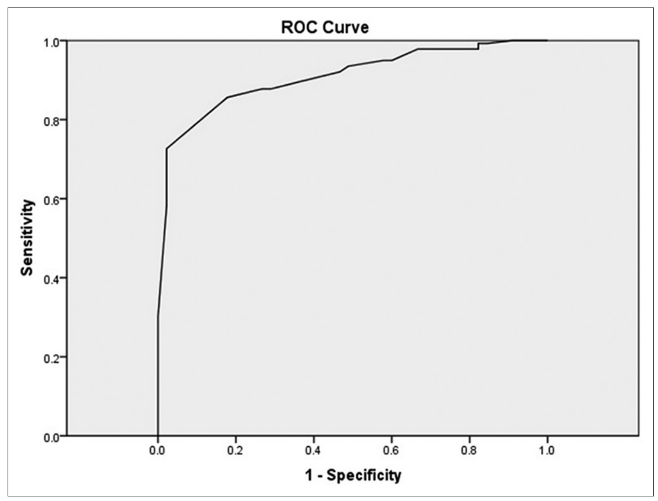

Figure 1: Receiver operating characteristic curve of calf circumference to determine low birth weight babies

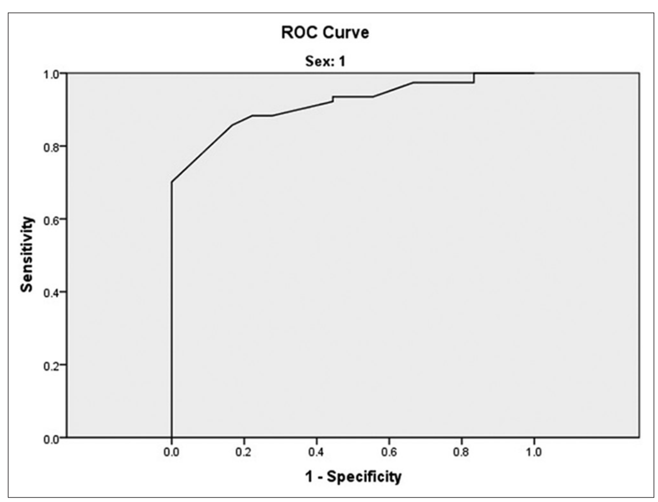

Figure 2: Receiver operating characteristic curve of calf circumference to determine low birth weight among male babies

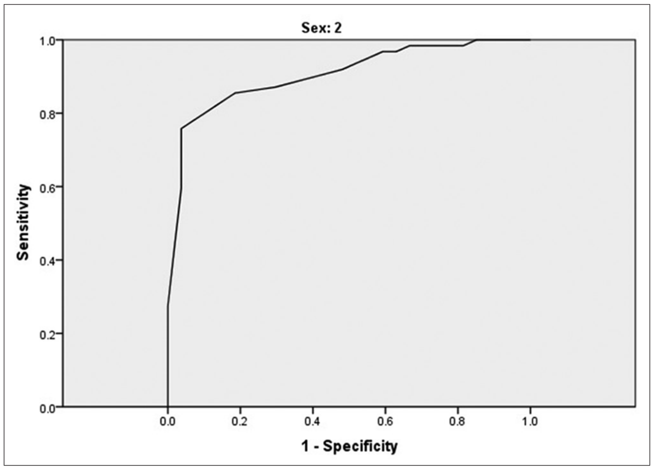

Figure 3: Receiver operating characteristic curve of calf circumference to determine low birth weight among female babies

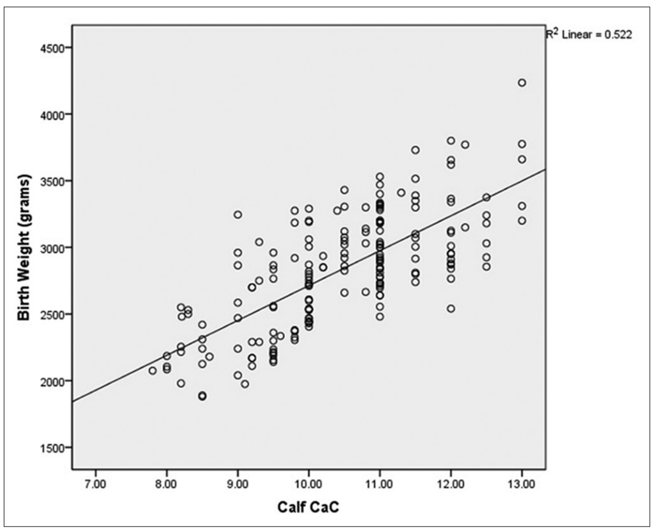

Figure 4: Scatter diagram showing correlation between calf circumference and birth weight of the study subjects

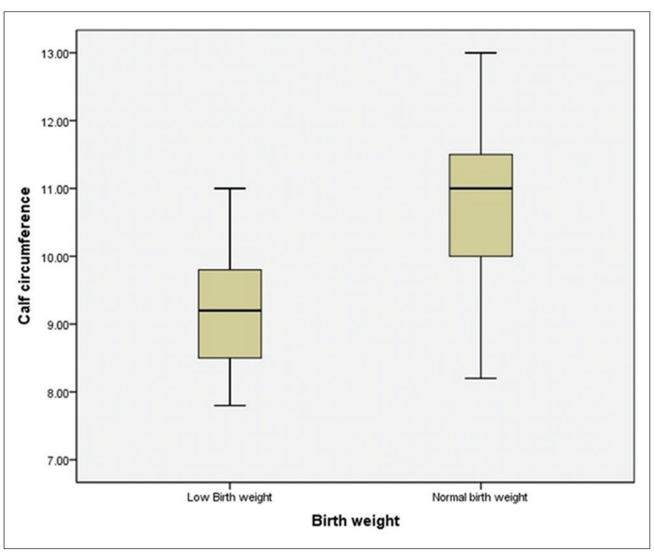

Figure 5: Box and whisker plots of calf circumference among low birth weight and normal birth weight babies

yielded 85.6% sensitivity and 82.2% specificity. Gupta *et al*. [3] reported that a CaC of <10.8 cm as the cutoff limit, almost 98% of LBW babies were screened with a fair degree of accuracy with a sensitivity and specificity of 98.4% and 90%, respectively. Kumar *et al*. [4] have shown in his study that with CaC <10.8 cm as cutoff limit, almost 98% of LBW babies can be identified with fair degree of accuracy.

Higher coefficients were reported by Sunilkumar *et al*., Kulkarni *et al*., and Alia *et al.* [5-7]. Higher cutoff points were reported by Kumar *et al.* and Das *et al*. [4,8]. A study by Kulkarni found the best cutoff of CaC to be 9.6 cm [6]. Similar studies by Taksande *et al*. [9] reported 9.75 cm with a sensitivity and specificity of 64% and 75.6%, respectively, as their best cutoff to screen the infants Suneetha *et al*. [10] also reported similar results where CaC was 9.7 cm, with a sensitivity and specificity of 86% and 88%, respectively. Our study shows 9.90 cm as cutoff value with a sensitivity and specificity of 85.6% and 82.2%, respectively.

A study by Kakrani *et al*. [11] and Suneetha *et al*. [10] found the Pearson's correlation coefficient between CaC and birth weight to be 0.72 (p<0.001) and 0.70 (p<0.001), respectively. These studies were in accordance with the present study (correlation coefficient=0.722, p=0.0001). Sheikh *et al*. [12] study showed a cutoff point of 9.75 cm CaC with 89.97% sensitivity and 42.86% specificity.

A simple color-coded tape could be recommended for measuring CaC to facilitate early identification of LBW newborns. Traditional birth attendants and community health workers could be easily trained by this simple method of color-coded measurement of CaC which could help in early identification and prompt referral of LBW babies.

The limitation of this study is that the data obtained were from one hospital in one geographical location. Hence, further study is needed in larger population of different regions to have a common average. Despite these limitations, CaC is an easy and feasible tool to screen for LBW babies born in remote areas. Further multicentric study is required for the overall population. There is no standard cutoff value as of now as we see in literature.

CONCLUSIONS

Measurement of CaC is easier and convenient as compared to measuring TC or HC since this does not require full undressing of baby and calf can be exposed and measured more easily. Furthermore, CaC, unlike HC, does not get altered by the process of difficult labor. All these factors have implications for the use of CaC measurement by community health workers.

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