Original Article

Identification of low birth weight babies by birth weight-independent anthropometric measures

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Received - 18 September 2018 Initial Review - 08 October 2018 Accepted - 03 November 2018

ABSTRACT

Introduction: Birth weight (BW) is the single most important factor that affects neonatal mortality and infant and childhood morbidity. Most of the deliveries in rural areas are conducted at home, often by traditional birth attendants and relatives, where the facility to weigh the baby is not possible. There is a constant search for simple and effective method to identify at-risk low BW (LBW) babies. **Objectives:** The objectives of this study were to identify a single or combination of anthropometric data that reliably identify LBW babies. **Materials and Methods:** This was a cross-sectional study conducted in neonatal care unit of a teaching hospital. The study subjects included 141 singleton newborns with gestational age of between 32 and 42 weeks and within 24 h of birth were included in the study. Newborns that were sick or having congenital anomalies were excluded from the study. In all newborns, gestational age assessment and anthropometric data measurement were done within 24 h of birth by trained residents. **Results:** Male (54.0%) and female babies (46.0%) were similar in proportion. The mean BW was 2.54±0.53 kg and 43.3% were LBW babies (<2.5 kg). Calf circumference (CC), chest circumference (CHC), midarm circumference (MAC), head circumference (HC), and crown-to-heel length (CHL) showed significant and high positive correlation of 0.887, 0.871, 0.807, 0.77, and 0.724, respectively, with BW. The cutoff values corresponding with a BW of <2.5 kg with high sensitivity were as follows: CC ≤10.5 cm, CHC ≤32 cm, MAC ≤10 cm, HC ≤33.8 cm, and CHL ≤50 cm. **Conclusions:** CC was the single most useful anthropometric measure to predict LBW. Its sensitivity of 100% with relatively higher specificity of 67.5% indicates its ability mainly to rule out LBW in a baby, if CC is >10.5 cm.

Key words: *Calf circumference, Chest circumference, Low birth weight babies, Midarm circumference*

In both developed and developing countries, birth weight (BW) is the single most important factor that affects neonatal mortality and infant and childhood morbidity. Thus, BW has been a subject of clinical and epidemiological investigation and target for public health intervention. BW is influenced by nutrition of mother, socioeconomic status, antenatal care, and others [1-4].

There is no indicator in human biology which tells us so much about the past events and future trajectory of life as the weight of infant at birth [1]. Low BW (LBW) incidence has been recommended by the WHO, as one of the numbers of global indicators with which to monitor the progress of its global strategy for "health for all by the year 2000 AD." Globally, the incidence of LBW babies ranges 30–40% [1,2,5]. In India, 80% of all the neonatal deaths occur among the LBW babies [1,6]. >80% of the deliveries are conducted at home in rural areas [6], often by traditional birth attendants and relatives, where the facility to weigh the baby is not possible. There is a constant search for a simple and effective method to identify at-risk LBW babies. Therefore, we planned this study to identify a single or combination of anthropometric data that reliably identify LBW babies.

MATERIALS AND METHODS

This was a cross-sectional study conducted in the neonatal intensive care unit (NICU) of a tertiary care hospital, Warangal, Telangana, from over a period of 3 months. Ethical approval was obtained from the institutional ethics committee. A total of 141 consecutively born singleton newborns admitted to the NICU were included in the study. All sick newborns such as respiratory distress syndrome, birth asphyxia, and congenital anomalies were excluded from the study. All the newborns were examined within 24 h of birth after taking consent from parents. One trained resident recorded the gestational age which was accurate in each baby, where available by the first-trimester ultrasound or last menstrual period if it was reliable or modified Ballard score. BW was recorded on an electronic weighing scale with an accuracy of ±5 g.

Another trained resident recorded all the anthropometric data following the WHO guidelines. Circumference of calf (CC), head (HC), midarm (MAC), and chest (CHC) were recorded to the nearest 0.1 cm, the first four with a non-stretchable fiberglass tape. Crown-heel length (CHL) was measured with an infantometer; CC was taken at the level of maximum girth with leg in semi-flexed position; HC was measured to give the maximum circumference of the head from supraorbital ridges to occipital prominence; CHC was measured at the level of xiphisternum and MAC was measured at the midpoint between acromion and olecranon process. Statistical analysis was done using Epi Info™ for Windows, version 7.2 and MedCalc Statistical Software version 18.2.1 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2018).

RESULTS

Of 141 singleton newborns studied, there was no significant difference between the proportion of male and female babies. A total of 76 (53.9%) newborns were male and 65 (46.0%) were female babies. Hence, the inferences from the observations are applicable to both male and female babies. Table 1 shows the summary of gestational age and anthropometric characteristics of the study cohort. The mean weight was 2.54±0.53 Kg (95% confidence interval [CI]: 2.45–2.63 Kg) with the range of 1–3.75 kg.

Of 141 newborns, 61 (43.26%, 95% CI 34.95%–51.86%) were LBW babies compared to normal BW babies 80 (56.74%, 95% CI 48.14%–65.05%). Clinically, the proportion of 43.26% of LBW is significant, though statistically not significant. The median gestational age is 40 weeks with a range of 32–42 weeks.

Table 2 shows that there was no difference between male and female babies in relation to gestational age, BW, and other anthropometric characteristics.

Table 3 shows a significant positive correlation between BW and HC, CHC, MAC, CC, and CHL. CC is having the highest positive correlation with BW, followed by CHC, MAC, HC, and CHL in descending order. Identifying LBW baby without missing is more important for timely referral to a pediatric service. A little overdiagnosis of LBW is less harmful than underdiagnosis so the lower 95% confidence limit of sensitivity, of a predictive or diagnostic test to identify LBW, must be as high as possible. Then, the test will be reliable to identify LBW at population level.

Receiver operating characteristic (ROC) curve analysis shows the CCs diagnostic power to identify LBW babies. At a cutoff value of ≤10.4, the CC has a sensitivity of 96.72% (95% CI: 88.7–99.6) and specificity of 81.25% (95% CI: 71%–89.1%). At cutoff value of ≤10.5, the sensitivity increases to 100% (95% CI: 94.1%–100%). Table 4 shows the diagnostic ability of various anthropometric characteristics with their cutoff values to identify LBW babies. Highest sensitivity (100%) with better specificity (67.5%) was observed with CC of ≤10.5, in comparison to any other anthropometric measure (Fig.1).

DISCUSSION

In both developed and developing countries, BW is probably the single most important factor that affects neonatal mortality and infant and childhood morbidity. The BW has been a subject of clinical and epidemiological investigation and target for public health intervention. There is no indicator in human biology which tells us so much about the past events and future trajectory of life as the weight of infant at birth. There is a constant search for simple and effective method as an alternative for measuring BW. To overcome this, the use of surrogate markers for BW with single anthropometric measurements was studied. In the present study, 141 newborns of various gestational ages were measured in an attempt to predict the LBW accurately with single anthropometric index.

In the present study, CC was 10.5 cm with the best correlation with BW of 2500 gm with sensitivity 100% and specificity 67.5%. Similar studies by Landicho *et al*. [7], Neela and Raman [8], Raman *et al*. [9], and Samal and Swain [10] have taken the cutoff of CC of 10.0 cm while it was 10.5 cm in a study by Nair *et al*. [11], which was similar to the present study. The correlation coefficient (r) was 0.880 in the present study while it was 0.776 in a study by Landicho *et al*. [7], 0.830 by Neela and Raman [8], 0.772 by Raman *et al*. [9], and 0.69 in a study by Nair *et al*. [11].

The cutoff value for CHC was 32 cm for predicting the BW 2500 gm with sensitivity and specificity 100 and 40, respectively, and correlation coefficient (r) of 0.879 (p=0.001). In the present study, the cutoff value for MAC was ≤10 cm for predicting BW 2500 gm with sensitivity and specificity of 98.36 and 40, respectively. The cutoff was taken as 9 cm in a study by Landicho *et al*. [7], 8.9 cm by Huque and Hussain [12], 8.7 cm by Bhargava [13], 9.3 cm by Neela and Raman [8], and 93 cm by Raman *et al*. [9]. In our study, the cutoff value for HC for predicting BW 2500 gm was 33.8 cm with r: 0.77,

Table 1: Anthropometric characteristics of neonates (n=141)

Characteristic	Range	Mean±SD (95% CI)	Median (95% CI)
Weight birth (Kg)	1.0–3.75	2.54±0.53 (2.45–2.63)	2.50 (2.41–2.63)
GA (weeks)	32.0–42.0	39.10±2.35 (38.71–39.5)	40.0 (40.0–40.0)
HC (cm)	27.0–36.0	32.70±1.75 (32.4–33.0)	33.0 (33.0–33.0)
MAC (cm)	7.0–12.0	9.42±1.20 (9.22–9.61)	9.50 (9.33–9.50)
CHC (cm)	22.0–36.5	30.35±2.64 (29.91–30.8)	30.5 (30.0–31.3)
CHL (cm)	35.0–53.0	47.7±2.74 (47.3–48.21)	48.0 (47.5–48.5)
CC (cm)	7.0–12.5	10.20±1.20 (10.0–10.4)	10.0 (10.0–10.5)
	1.5–3.8	2.28 (2.22–2.33)	2.31 (2.26–2.40)

SD: Standard deviation, CC: Calf circumference, CI: Confidence interval, HC: Head circumference, MAC: Midarm circumference, CHC: Chest circumference, CHL: Crown-heel length, GA: Gestational age, PI: Ponderal index

Table 2: Differences in characteristics between male and female neonates

Characteristic	Gender	n	Mean±SD (95% CI)	Median (95% CI)	p value
Weight birth (Kg)	Male	76	2.56±0.51 (2.45–2.70)	NA	0.532
	Female	65	2.51±0.54 (2.40–2.64)	NA	
GA (weeks)	Male	76	NA	40.0 (40.0–40.0)	0.568
	Female	65	NA	40.0 (38.0–40.0)	
HC (cm)	Male	76	NA	33.0 (32.6–33.0)	0.817
	Female	65	NA	33.0 (32.5–33.5)	
MAC (cm)	Male	76	9.41±1.20 (9.14–9.70)	NA	0.989
	Female	65	9.42±1.13 (9.12–9.70)	NA	
CHC (cm)	Male	76	NA	30.5 (30.0–31.5)	0.852
	Female	65	NA	31.0 (30.0–31.5)	
CHL (cm)	Male	76	NA	48.0 (47.5–49.0)	0.333
	Female	65	NA	47.9 (47.0–48.9)	
CC (cm)	Male	76	10.15±1.2 (9.90–10.43)	NA	0.930
	Female	65	10.2±1.15 (9.90–10.46)	NA	
PI	Male	76	2.26 (2.20–2.34)	NA	0.507
	Female	65	2.30 (2.22–2.40)	NA	

SD: Standard deviation, CC: Calf circumference, CHC: Chest Circumference, CHL: Crown-heel length, MAC: Midarm circumference, HC: Head circumference, GA: Gestational age, PI: Ponderal index

Table 3: Correlation table

Characteristics	GA (week)	BW (Kg)	HC (cm)	CHC (cm)	MAC (cm)	CC (cm)	CHL (cm)	PI
GA (weeks)								
r		0.488	0.513	0.507	0.426	0.429		0.117
P		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		0.1686
BW (Kg)								
r	0.488		0.77	0.871	0.807	0.887	0.724	0.627
P	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
HC (cm)								
r	0.513	0.77		0.739	0.648	0.694	0.678	0.351
P	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CHC (cm)								
r	0.507	0.871	0.739		0.779	0.835	0.685	0.51
P	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001
MAC (cm)								
r	0.426	0.807	0.648	0.779		0.867	0.546	0.551
P	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001
CC (cm)								
r	0.429	0.887	0.694	0.835	0.867		0.623	0.565
P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001
CHL (cm)								
r	0.521	0.724	0.678	0.685	0.546	0.623		0.044
P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		0.6007
PI								
r	0.117	0.627	0.351	0.51	0.551	0.565	0.044	
P	0.1686	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.6007	

GA: Gestational age, BW: Birth weight, HC: Head circumference, CHC: Chest circumference, MAC: Midarm circumference, CC: Calf circumference, CHL: Crown-heel length, PI: Ponderal index, r: Correlation coefficient (Spearman rank correlation), P: Significance value

sensitivity 98.36% and specificity of 40% (p=0.001). In a similar study by Landicho *et al.*, the cutoff value was 32.0 cm with r: 0.738.

CC with cutoff value of 10.5 cm was the single most sensitive variable to predict the BW of 2.5 kg and below; similar observation was found in other studies. CC will be useful on field level as the paramedical workers can be easily trained to use it to identify LBW babies where weighing scale is not available or not reliable. Using CC, they can identify LBW

Table 4: Diagnostic power of anthropometric characteristics to identify LBW

Anthropometric characteristic	Criterion value	Sensitivity	95% CI	Specificity	95% CI
CC	≤10.5	100.00	94.1–100.0	67.50	56.1–77.6
CHC	≤32	100.00	94.1–100.0	40.00	29.2–51.6
MAC	≤10	98.36	91.2–100.0	46.25	35.0–57.8
HC	≤33.8	98.36	91.2–100.0	40.00	29.2–51.6
CHL	≤50	98.36	91.2–100.0	22.50	13.9–33.2

CC: Calf circumference, LBW: Low BW, CI: Confidence interval, MAC: Midarm circumference, CHL: Crown-heel length, CHC: Chest circumference, HC: Head circumference

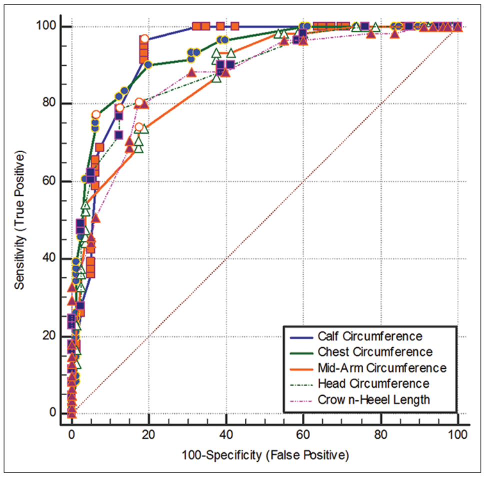

Figure 1: Diagnostic ability of anthropometric characteristics to identify low birth weight babies

babies and refer them for appropriate care. This is like using Shakir's tape in identifying particle environment monitor on field level. Further studies with larger samples are needed to confirm these findings.

CONCLUSIONS

CC with a cutoff value of ≤10.5 cm is the single most sensitive anthropometric measure to predict BW <2.5 kg. Its sensitivity of 100% with relatively higher specificity of 67.5% indicates its ability mainly to rule out LBW in a baby, if CC is >10.5 cm. The ROC analysis has clearly demonstrated the utility of CC as single measurement in identifying LBW and can further refer them for proper care.

ACKNOWLEDGMENT

We acknowledge the cooperation of NICU staff nurses, pediatric postgraduates, and mothers of all babies.

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Funding: None; Conflicts of Interest: None Stated.

How to cite this article: Kagithapu S, Gudur V, Ravikumar C. Identification of low birth weight babies by birth weight-independent anthropometric measures. Indian J Child Health. 2018; 5(11):682-685.

Doi: 10.32677/IJCH.2018.v05.i11.008