International Journal of Contemporary Pediatrics
Kumar S et al. Int J Contemp Pediatr. 2020 Mar;7(3):540-545
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20200677

Original Research Article

A comparative study of calf muscle circumference with other anthropometry measurement as a measure of low birth weight in neonates

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Received: 16 December 2019
Revised: 20 December 2019
Accepted: 27 January 2020

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ABSTRACT

Background: India having 3rd highest incidence of low birth weight (LBW) infants (28%) in the world. Majority of deliveries in our country are conducted at home by untrained traditional birth attendants or relatives, so it is not possible for untrained birth attenders to operate weighing machine in rural areas, therefore to find an alternative method for the estimation of low birth weight we used simple anthropometric indicators like calf circumference which is easily used by rural communities.

Methods: It was a Cross-sectional study done at tertiary care center, Udaipur, Rajasthan, India during 1 year period in 2018. 150 neonates without any congenital malformation delivered at hospital irrespective of gestational age were subjected to anthropometric measurements. The different anthropometric measurements like calf circumference, chest circumference were used and data was analyzed by using Receiver Operating Characteristic curve (ROC) to find out the cut-off values with the highest sensitivity and specificity for birth weight <2500gm and <1800gm. For comparison Pearson's Correlation coefficients was used.

Results: From different anthropometric measurements, calf circumference of 9.38 cm and 7.90cm had higher sensitivity and specificity in detecting birth weight babies of <2500gm, and <1800gm respectively. The best correlation was observed in calf circumference (r=0.989) and (r=0.990) for identifying babies with birth weight group 1.21-1.80kg and group 1.81-2.50kg.

Conclusions: In the absence of a weighing machine, simple measurements like calf circumference is the best indicator in identifying low birth weight babies.

Keywords: Anthropometry, Birth weight, Calf circumference, Low birth weight

INTRODUCTION

Birth weight is a strong indicator not only of a birth mother's health and nutritional status but also a newborn's chances for survival, growth, long-term health and psychosocial development.[1] Low birth weight infant is a major problem in developing countries. Globally about 22 million infants are born with birth weight of <2500gm every year with India having 3rd highest incidence of LBW infants (28%) in the world, Though these LBW infants constitute only about 14% of total live birth, they account for 60-80% of total neonatal deaths. Out of an estimated 22 million low birth weight babies born worldwide annually, India accounts for 7-8 million.[2]

Recording of birth weight is universal in developed countries and in regions where deliveries are conducted in hospitals. But in developing countries like India births which takes place at home are conducted by traditional birth attendants (TBA) or relatives, estimation of birth weight is a problem due to unavailability of weighing scales and trained personnel.[3] Also, because of sociocultural reasons, parents are reluctant to get their children weighed immediately after birth.[4] There is a constant search for an alternative, simple and reliable predictor of LBW babies that can be used by trained or untrained persons. Since identification of LBW infants is the highest priority to provide effective minimal perinatal care, a simple and sensitive parameter is needed. To achieve this, studies have been conducted to correlate the various anthropometric measurements of newborn with birth weight, which have different sensitivity and specificity.

In the background of facts most of the Indian workers recommend the use of <2000gm as a limit for identifying low birth weight babies. However, looking at the survival of the babies with birth weight >1800gm, the babies with birth weight <1800gm are considered at risk. This group of babies with birth weight <1800gm require specialized care for survival, hence many Indian neonatologist recommend tertiary institutional care to the babies <1800gm and observational domiciliary care for babies >1800gm birth weight.[5]

In light of above facts, the present study was designed to establish cut-off values for calf circumference and other anthropometric measurements for detection of birth weight <2500gm and <1800gm at community level. So that babies at risk can be referred to higher center for their appropriate management and survival.

The present study is an attempt to compare the feasibility of calf circumference with other indicators for detecting LBW babies at birth. The calf being prominent and easily identifiable even by untrained traditional birth attendant or community health worker with minimal training, needs minimal handling, no need to undress.[6]

Aim of this study was to compare calf circumference with length, head circumference, mid arm circumference, chest circumference and thigh circumference, as a reliable predictor of low birth weight babies.

METHODS

This was a cross sectional, observational, analytic study which include 150 consecutive neonates. The study was carried out at the tertiary care center in Rajasthan, India. Study was concluded during one year period after obtaining permission from ethical committee of institute.

Inclusion criteria

All the single newborns irrespective of gestational age were included and anthropometric measurements were carried out within 24 hours of birth.

Exclusion criteria

Babies with congenital anomalies were excluded from the study.

Method of collection of data (including sampling procedure)

All anthropometric measurements were carried out within 24 hours of birth by one investigator to avoid any interpersonal measurement error. All the anthropometric measurements were measured to the nearest 0.1cm using a non-stretchable tape. Standard anthropometric techniques were used to record the following measurements of these neonates. (i) New-born was weighed without clothes on an electronic type weighing scale to the nearest 1gm. The weighing scale was periodically checked by known standard weights. (ii) Head circumference was measured with a tape passing around the head over the most prominent part i.e. glabella anteriorly and posteriorly at the most prominent part of the occiput and laterally passing just above the ears. Care was taken to ensure that the tape was passed around the head at the same level on each side. (iii) Chest circumference was measured at the level of xiphoid process anteriorly and below the inferior angle of scapula posteriorly. The measurement was taken during quiet respiration with tape applied in such a manner as to permit contact without compression of underlying tissue. (iv) Mid arm circumference was taken mid-way between tip of acromion process and olecranon process of ulna in left upper limb. (v) Thigh circumference was recorded at the left thigh at the level of lowest fold in gluteal region. The tape was placed perpendicular to the long axis of the lower limb with its top edge just under the gluteal fold. (vi) Calf circumference was taken in most prominent point in semi flexed position of the left leg. (ⅶ) The foot length was measured from posterior most prominence of foot to the tip of the longest toe of the right foot.

Statistical analysis

Data was analysed by screening test parameters (sensitivity, specificity, positive and negative predictive value) and receiver operating characteristic curve. The correlation between LBW and indicators were estimated by multiple regression and Karl Pearson correlation co-efficient. The sensitivity and specificity value so achieved were used to find out the positive predictive value and negative predictive value of each anthropometric parameter. The collected data was analysed by using receiver operating characteristic curve (ROC) for calculating sensitivity and specificity of each anthropometric measurement.

RESULTS

Out of total 150 children enrolled in the study, total no. of males were 81 (54.0%) and female were 69 (46%). Indicating males were more common than females which is statistically significant (p-value<0.05). Study group was divided into 3 groups. In the weight group 1.2-1.8kg, there were 33 newborns with a mean weight and standard deviation of 2.18±0.245kg. Between 1.8-2.5kg weights group which consist of 84 newborn had a mean weight and standard deviation of 2.18±0.245kg, 33 newborns weighing more than 2.5kg had a mean weight and standard deviation of 2.83±0.249kg.

Table 1: Distribution of all anthropometry measurement with its means and standard deviation.

	Weight (1.21-1.80kg) Mean±SD	Weight (1.81-2.50kg) Mean±SD	Weight (>2.5kg) Mean±SD	p-value
Numbers of babies	**33**	**84**	**33**	
Weight (kg)	1.43±0.205	2.18±0.245	2.83±0.249	<0.05
Length (cm)	41.05±1.77	45.98±1.58	48.60±1.27	<0.05
Head circumference (cm)	28.78±1.27	31.42±1.05	34.46±0.912	<0.05
Chest circumference (cm)	27.08±0.938	29.46±1.37	32.34±1.05	<0.05
Mid-arm circumference (cm)	7.038±0.426	8.00±0.601	9.24±0.647	<0.05
Thigh circumference (cm)	11.5±0.648	13.03±0.918	14.16±1.076	<0.05
Calf circumference (cm)	7.43±0.389	8.57±0.431	9.54±0.345	<0.05
Foot length (cm)	6.27±0.759	6.68±0.482	7.33±0.476	<0.05

Table 1 shows distribution of all anthropometry measurements with its means and standard deviation in all age groups, which is statically significant p-value for weight, length, head circumference, chest circumference, mid arm circumference, thigh circumference, calf circumference, foot length.

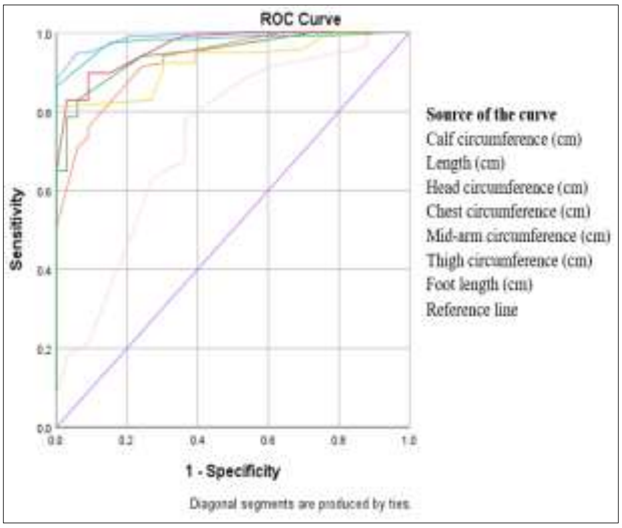

Figure 1: ROC for the babies weighing <1800gm and >1800gm.

In Figure 1 the calf circumference shows the maximum area under the curve (0.989), hence has the maximum sensitivity and specificity in identifying <1800gm babies. The area under the curve for other anthropometric measurements in descending order: length (0.979), head circumference (0.963), chest circumference (0.946), mid-arm circumference (0.928), thigh circumference (0.923), and foot length (0.735).

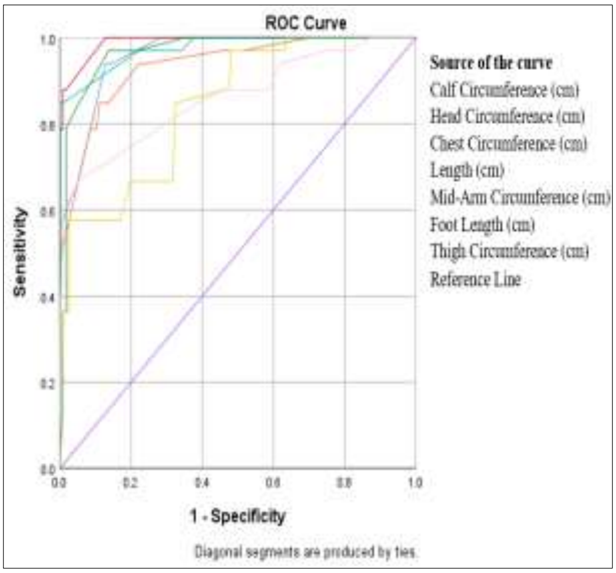

Figure 2: ROC for the babies weighing <2500gm and >2500gm.

In Figure 2 the calf circumference shows the maximum area under the curve (0.990), in identifying babies between 1800-2500gm. The area under curve for other anthropometric measurements in descending order: head circumference (0.975), chest circumference (0.968), length (0.959), mid-arm circumference (0.935), foot length (0.862) and thigh circumference (0.844).

In the Figure 3 and 4 scatter diagram, it was clearly made out that calf circumference at birth correlated positively with birth weight. Birth weight was significantly correlated with all other anthropometric measurements.

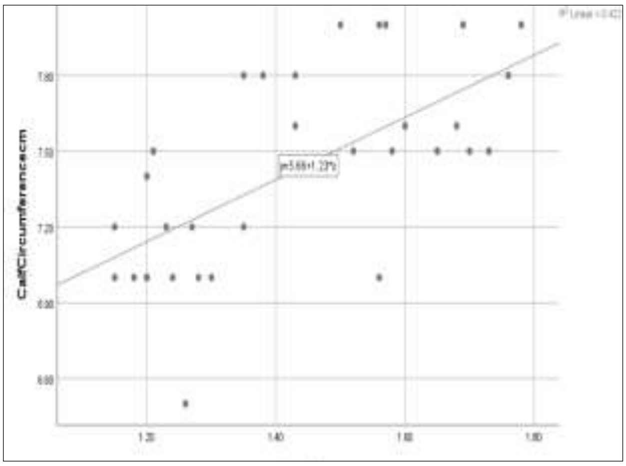

Figure 3: Scatter diagram for correlation between calf circumference weight groups between 1.21-1.80kg.

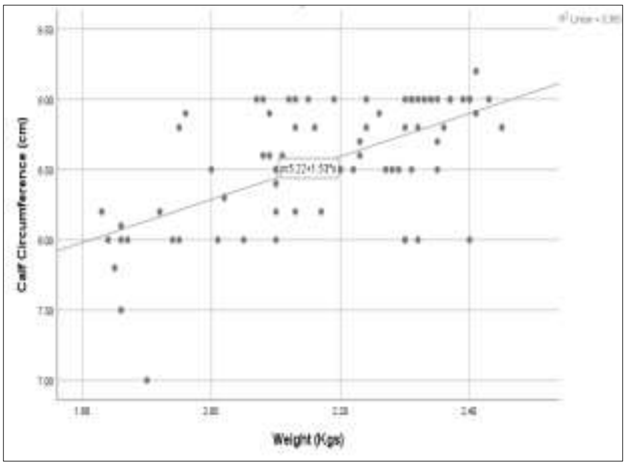

Figure 4: Scatter diagram for correlation between calf circumference and weight group 1.81-2.50kg.

Table 2: ROC for the babies weighing less than 1800gm.

Test result variable(s)	Area	Cut-off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p-value
Calf circumference (cm)	0.989	7.90	97.4	84.8	73.5	98.2	<0.001
Head circumference (cm)	0.963	30.15	89.7	90.9	68.4	94.5	<0.001
Chest circumference (cm)	0.946	28.10	82.9	93.9	66.3	94.3	<0.001
Mid-arm circumference (cm)	0.928	7.35	91.5	75.8	62.4	96.5	<0.001
Thigh circumference (cm)	0.923	12.1	76.1	69.7	61.5	97.5	<0.001
Length (cm)	0.979	43.75	94.9	90.9	69.5	98.6	<0.001
Foot length (cm)	0.735	6.55	77.8	63.6	77.8	96.2	<0.001

Table 3: ROC for the babies weighing less than 2500 gm

Test result variable(s)	Area	Cut-off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p-value
Calf circumference (cm)	0.990	9.38	92.6	89.2	69.9	80.5	<0.001
Head circumference (cm)	0.975	33.2	87.9	99.1	71.5	89.6	<0.001
Chest circumference (cm)	0.968	30.80	97.0	86.3	68.9	87.5	<0.001
Mid-arm circumference (cm)	0.935	8.35	93.9	77.8	67.6	86.3	<0.001
Thigh circumference (cm)	0.844	13.11	87.9	88.9	65.3	92.6	<0.001
Length (cm)	0.959	47.25	93.9	87.2	72.5	92.8	<0.001
Foot length (cm)	0.862	7.10	66.7	94.9	69.8	89.6	<0.001

Table 2 shows that for detection of baby's birth weight <1800gm calf circumference with cut off value of 7.90 cm had maximum sensitivity (97.4%) and specificity (84.8%) than any other anthropometric measurement. After that length with cut off of 43.75cm had higher sensitivity (94.9%) and specificity (90.9%) followed by mid-arm circumference with cut off value of 7.35cm with sensitivity (91.5%) and specificity (75.8%), head circumference with cut off value of 30.15cm had sensitivity (89.7%) and specificity (90.9%), chest circumference with cut off value of 28.10cm had sensitivity (82.9%) and specificity (93.9%), foot length with cut off value of 6.55cm had sensitivity (77.8%) and specificity (63.6%) and thigh circumference with cut off value of 12.1cm had sensitivity (76.1%) and specificity (69.7%).

Table 3 shows in babies' birth weight <2500gm calf circumference with cut off value of 9.38cm had sensitivity (92.6%) and specificity (89.2%), length with cut off value of 43.25cm had sensitivity (93.9%) and specificity (87.2%), mid arm circumference with cut of value of 8.35cm had sensitivity (93.9%) and specificity (77.8%), head circumference with cut off value of 33.20 cm had sensitivity (87.9%) and specificity (99.1%), thigh circumference with cut off value of 87.9% had sensitivity (87.9%) and specificity (88.9%), chest circumference with cut off 30.80cm had maximum sensitivity (97.0%) and specificity (86.3%) and foot length with cut off value of 7.10cm had sensitivity (66.7%) and specificity (94.9%).

DISCUSSION

In current study out of 150 neonates, 81 (54%) were male babies and 69 (46%) were female. Our data were comparable with studies done by Taksande et al, Mullany LC et al, Suneetha et al, where proportion of male babies was more than female babies.[6-8] This result is statistically significant p-value (<0.05).

The present study shows that in weight group 1.21-1.80kg, total number of baby enrolled were 33 with mean weight of 1.43±0.205kg. In group between 1.81-2.50kg, total number of baby enrolled were 84 with mean weight of 2.18±0.245kg and in group more than 2.51kg, total number of baby enrolled were 33 with mean weight of 2.83±0.249kg. Difference in weight in various group is statistically significant (p-value<0.05). Similarly in Mullany LC et al study shows mean weight for birth weight <2000gm was 1810±175gm and for birth weight <2500gm mean weight was 2.2±235gm and for birth weight >2500gm mean weight was 2914±270gm. Narendra K S et al observed the similar finding.[8,9]

The current study showed the mean calf circumference was 7.43±0.389 cm for birth weight group <1800gm which is comparable with the study of Kokku et al, showing mean calf circumference 7.83±0.45cm for birth weight of <2kg.[10]

The cut off value of calf circumference for predicting LBW babies by using ROC curve was 7.90cm with maximum sensitivity 97.4% and specificity 84.8%. It has PPV of 73.5% with NPV 98.2% for birth weight <1800gm, followed by length with cut off of 43.75cm and sensitivity (94.9%) and specificity (90.9%) followed by mid-arm circumference with cut off value of 7.35cm with sensitivity (91.5%) and specificity (75.8%), head circumference with cut off value of 30.15cm had sensitivity (89.7%) and specificity (90.9%), chest circumference with cut off value of 28.10cm had sensitivity (82.9%) and specificity (93.9%), foot length with cut off value of 6.55cm had sensitivity (77.8%) and specificity (63.6%) and thigh circumference with cut off value of 12.1cm had sensitivity (76.1%) and specificity (69.7%). Above cut off values of calf circumference is comparable with the study done by Kumar et al, showing 8.5cm as cut off value. Similar comparable value are seen in Samal GC et al and Neela J et al.[11-13]

All anthropometric parameters in relation to birth weight were analyzed using ROC curve shows in babies with weight cut off 1800gm, calf circumference showed maximum area under curve (0.989) means it has maximum sensitivity and specificity in identifying weight <1800gm, followed by length (0.979), head circumference (0.963), chest circumference (0.946), mid arm circumference (0.928), thigh circumference (0.821) and foot length (0.735).

The current study showed the mean calf circumference was 8.57±0.431 cm for birth weight group <2500gm which is comparable with the study of Kokku et al and Virdi VS et al showing mean calf circumference 9.13±0.399cm and 8.51cm for birth weight of <2.5kg respectively.[10,14]

The cut off value of calf circumference for predicting LBW babies by using ROC curve was 9.38cm with maximum sensitivity 92.6% and specificity 89.2%. It has PPV of 69.9% with NPV 80.5% for birth weight <2500gm, followed by length with cut off value of 43.25cm had sensitivity (93.9%) and specificity (87.2%), mid arm circumference with cut of value of 8.35cm had sensitivity (93.9%) and specificity (77.8%), head circumference with cut off value of 33.20cm had sensitivity (87.9%) and specificity (99.1%), thigh circumference with cut off value of 87.9% had sensitivity (87.9%) and specificity (88.9%), chest circumference with cut off 30.80cm had maximum sensitivity (97.0%) and specificity (86.3%) and foot length with cut off value of 7.10cm had sensitivity (66.7%) and specificity (94.9%). Above cut off values are comparable with the study of Kumar et al and Virdi VS et al showing 9.8cm and 8.5cm respectively as cut off for calf circumference.[11,14]

All other anthropometric parameters in relation to birth weight were analyzed using ROC curve showed that in babies <2500gm, calf circumference had maximum area under (0.990) means it has maximum sensitivity and specificity, followed by head circumference (0.975), chest circumference (0.968), length (0.959), thigh circumference (0.953), mid arm circumference (0.935) and foot length (0.862).

CONCLUSION

In the present study it is concluded that the calf circumference with cut-off value of 9.38cm, and 7.90cm which has maximum sensitivity and specificity compared to other anthropometric measurements can be used to assess birth weight of <2500gm, and <1800gm respectively in community by health workers. Calf circumference is readily accessible for measurement even during winter without disturbing the environment of warm neonate. In addition, it is a simple, need minimal handling cheap, quick and reliable indicator for detecting low birth weight babies at risk whenever weighing at birth is not feasible and such high risk babies can be referred to the appropriate health care facility for skilled management.

Funding: No funding sources
Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Kumar S, Jain H. A comparative study of calf muscle circumference with other anthropometry measurement as a measure of low birth weight in neonates. Int J Contemp Pediatr 2020;7:540-5.