

## Original Research Article

# Calf circumference to detect low birth weight babies: a comparative study

Pradheep Kumar Kokku<sup>1</sup>, Himabindu Singh<sup>2</sup>, Rakesh Kotha<sup>2\*</sup>, Arjun Jadhavo<sup>3</sup>, Alimelu Maddireddi<sup>2</sup>, Nirmala Cherukuri<sup>1</sup>, Sadiqua Anjum<sup>2</sup>, Apoorva Tadury<sup>2</sup>

<sup>1</sup>Department of Pediatrics, <sup>2</sup>Department of Neonatology, Niloufer Hospital, Hyderabad, Telangana, India

<sup>3</sup>Fellow in Navodaya Hospitals, Hyderabad, Telangana, India

**Received:** 08 August 2019

**Revised:** 27 August 2019

**Accepted:** 30 August 2019

### \*Correspondence:

Dr. Rakesh Kotha,

E-mail: [dr.rakeshkotha@gmail.com](mailto:dr.rakeshkotha@gmail.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### ABSTRACT

**Background:** In developing countries 15 per cent of infants weigh less than 2,500 grams at birth. It is not possible to provide expensive weighing scales to the community members and families due to logistic (carrying a heavy scale) and operational (inability of Trained Birth Attenders to read) problems. Therefore it is essential to find out an alternative method for the estimation of birth weight. Almost 60 per cent of newborns in developing countries are not weighed. Which can lead to an underestimation of the incidence of low birth weight. That's why we done present study to know the simple indicators to detect low birth weight babies. Aim of this study to compare calf circumference with other Low birth weight indicators as a reliable predictor of low birth weight babies.

**Methods:** It is a cross-sectional study done during period 2018 January to 2018 October done at Niloufer Hospital Hyderabad. Statistical analysis is done using SPSS (version 17) statistical software. For comparison Pearson's Correlation coefficients used.

**Results:** The best correlation was observed with both calf circumference ( $r=0.818$ ) and head circumference ( $r=0.744$ ) for identifying babies with birth weight <2 kg. For babies with birth weight <2.5 kg, calf circumference had the highest order of correlation ( $r = 0.986$ ) followed closely by head circumference ( $r=0.886$ ).

**Conclusion:** In the absence of a weighing machine, simple measurements like calf circumference is the best indicator in identifying low birth weight babies (<2.5kg) at birth.

**Keywords:** Calf circumference, Community health, Head circumference, Low birth weight, Neonate, Trained birth attendants

### 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.<sup>1</sup> A low birth weight (less than 2,500 grams) raises grave health risks for children. Low birth weight is a public health problem in most

developing countries.<sup>2</sup> India, one of the countries with the highest incidence, has the highest number of low-birth weight babies each year: 7.5 million.<sup>3</sup> Recording of birth weight is universal in developed countries and in regions where deliveries are conducted in hospitals.<sup>4</sup> 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.<sup>4</sup> Also, because of socio cultural reasons, parents are reluctant to get their children weighed immediately after birth.<sup>5</sup> In addition, when infants are weighed at birth, the readings tend to cluster around multiples of 100 grams. This would further underestimate the incidence of low birth weight.<sup>1</sup> 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.<sup>5</sup> A number of studies have been done in this regard of finding suitable substitute measurements for birth weight, such as chest circumference, mid-arm circumference, thigh circumference etc. The present study is an attempt to compare the feasibility of calf circumference with other indicators for detecting LBW babies at birth why because it is easy for health workers to measure in field condition. 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.<sup>6</sup> Aim of this study 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

Institutional ethical committee's approval was obtained; informed consent of the mothers participating was taken in the study was taken. It is a cross-sectional study done during period 2018 January to 2018 October done at Niloufer Hospital Hyderabad. One hundred and forty-seven term newborn babies with birth weight less than 2500 g and 55 term newborns with birth weight more than 2500 g by computerized random sampling method. Neonates with congenital anomalies especially limb anomalies and twin pregnancy were excluded. Measurement of weight, length, head circumference, mid-arm circumference, chest circumference, thigh circumference, and calf circumference were done in all the babies. Relevant maternal data like, parity, age of the mother, mother's weight and height, nutrition was also collected.

All the measurements were taken after 24 hours of delivery except head circumference which was taken after 72hrs due to avoid molding effect and by third person who not involved in study. Length measured by infantometer. Head circumference measured at occipitofrontal prominence above the ears. Mid - Arm Circumference is measured at the mid-point between the tip of the acromion and the olecranon process of ulna in the left upper arm to the nearest 0.1 cm. Chest Circumference is measured to the nearest 0.1 cm at the level of xiphisternum anteriorly and immediately below the level of inferior angle of scapula posteriorly during quiet respiration. Thigh Circumference is recorded to the

nearest 0.1 cm at the level of the lowest furrow in the gluteal region, the tape being placed perpendicular to the long axis of lower limb. Calf Circumference is measured to the nearest 0.1cm at the most prominent point in the semi flexed position of the leg.

## Statistical method

The data is entered into MS Access database. Statistical analysis is done using SPSS (version 17) statistical software. Relation between continuous variables is estimated using Pearson's Correlation coefficient. P-value less than 0.05 are taken as significant level.

## RESULTS

Total number of cases=147. Total number of cases <2 kg=49. Total number of cases 2-2.5 kg=98. Total number of controls=55. There was female preponderance in all three groups, but it was not statistically significant (P=0.143). Study group was divided into 2 groups. Below 2 kg weight group consisted of 49 with a mean weight of 1.56 kg and standard deviation of 0.21 kg (range 1.0-1.9). In the weight group 2-2.5kg, there were 98 newborns with a mean weight of 2.21 kg and standard deviation of 0.12kg (range 2-2.45). In the control group, 55 newborns weighing more than 2.5 kg were taken with a mean weight of 2.87 kg and standard deviation of 0.29 kg (range 2.5-3.6) (Table1, 2).

The mean length of 43.36 cm in the weight group less than 2 kg with a standard deviation of 2.29 cm (range 28.5-45.5). In the group 2-2.5 kg, mean length was 46.63cm and standard deviation was 0.71 cm (range 45-48). In the study group mean length was 49.51 cm with a standard deviation of 1.07 cm (range 47.5-52). The comparison of length between 2 study groups and control group was very highly significant (P <0.005) (Table 3).

The mean head circumference in less than 2 kg weight group was 29.07 cm with a standard deviation of 0.79 cm (range 26-30). The mean head circumference in 2-2.5 kg group was 31.20 cm with a standard deviation of 0.85 cm (range 29.5-32.9). In the control group, the mean head circumference was 34.64 cm with a standard deviation of 1.23 cm (range 32-36.8). Comparison of head circumference with weight in study groups and control group was very highly significant (P <0.005)(Table 4).

The mean chest circumference in the study group less than 2 kg was 27.1 cm with a standard deviation 0.66 cm (range 26-28). In the 2-2.5kg group mean chest circumference was 29.74 with a standard deviation of 1.59 cm (range 26-41). In the control group (>2.5kg), the mean chest circumference was 32.25 cm with a standard deviation of 0.96 cm (range 30-34). From this table it can be seen that the comparison of chest circumference with weight between study groups and control group was statistically very highly significant (p<0.005)(Table 5).

**Table 1: Sex distribution of newborns.**

Wt. Category		Female	Male	Total
<2	Count	25	24	49
	% within Wt. Category	51.0%	49.0%	100.0%
>2.5	Count	32	23	55
	% within Wt. Category	58.2%	41.8%	100.0%
2-2.5	Count	66	32	98
	% within Wt. Category	67.3%	32.7%	100.0%
Total	Count	123	79	202
	% within Wt. Category	60.9%	39.1%	100.0%

**Table 2: Birth weight distribution of newborns.**

Wt Category	N	Mean	Std. Deviation	Minimum	Maximum
<2.00	49	1.5663	0.21588	1.00	1.90
2.00-2.5	98	2.2189	0.12611	2.00	2.45
>2.5	55	2.8764	0.29168	2.50	3.60
Total	202	2.2396	0.51315	1.00	3.60

**Table 3: Length of newborns in 3 groups.**

Wt. category	<2.00	2.00-2.5	>2.5	Total
N	49	98	55	202
Mean	43.3673	46.6388	49.5109	46.6272
Std. Deviation	2.29886	0.71647	1.07526	2.58582
Min	28.50	45.00	47.50	28.50
Max	45.50	48.00	52.00	52.00

**Table 4: Head circumference of newborns in 3 groups.**

Wt. category	<2.00	2.00-2.5	>2.5	Total
N	49	98	55	202
Mean	29.0714	31.2092	34.6491	31.6272
Std. Deviation	0.79136	0.85664	1.23376	2.25587
Min	26.00	29.50	32.00	26.00
Max	30.00	32.90	36.80	36.80

**Table 5: Chest circumference of newborns in study and control groups.**

Wt. category	<2.00	2.00-2.5	>2.5	Total
N	49	98	55	202
Mean	27.1061	29.7459	32.2509	29.7876
Std. Deviation	0.66596	1.59213	0.96107	2.23415
Min	26.00	26.00	30.00	26.00
Max	28.00	41.00	34.00	41.00

**Table 6: Mid-arm circumference of newborns in study and control groups.**

Wt. category	<2.00	2.00-2.5	>2.5	Total
N	49	98	55	202
Mean	6.9673	8.1878	9.8273	8.3381
Std. Deviation	0.27340	0.46557	0.54483	1.13053
Min	6.50	6.50	8.00	6.50
Max	7.50	9.00	11.00	11.00

In the study group of less than 2 kg, 49 babies had a mean mid-arm circumference of 6.96 cm with a standard deviation of 0.27 cm (range 6.5-7.5). The mean mid-arm circumference of 98 babies in 2-2.5kg group was 8.18 cm with a standard deviation of 0.46 cm (range 6.5-9). In the control group, mean mid-arm circumference was 9.82 cm with a standard deviation of 0.54cm (range 8-11).The mean difference of mid-arm circumference between the study groups and control group was statistically very highly significant (P<0.005) (Table 6).

The mean thigh circumference was 12.892 cm with a standard deviation of 0.53 cm (range 12-14) in the study group of less than 2 kg. In the group of 2-2.5 kg, the mean thigh circumference was 14.2 cm with a standard deviation of 0.42cm (range 12-15). In the control group, mean thigh circumference was 15.9 cm with a standard deviation of 0.61 cm (range 14-16.9).The mean difference of thigh circumference between the two study groups and control group was statistically very highly significant (P=<0.005) (Table 7).

**Table 7: Thigh circumference of newborns in study and control groups.**

Wt. category	<2.00	2.00-2.5	>2.5	Total
N	49	98	55	202
Mean	12.8939	14.2000	15.9036	14.3470
Std. Deviation	0.53128	0.42353	0.61342	1.20142
Min	12.00	12.00	14.00	12.00
Max	14.00	15.00	16.90	16.90

**Table 8: Calf circumference of newborns in study and control groups.**

Wt. category	<2.00	2.00-2.5	>2.5	Total
N	49	98	55	202
Mean	7.8306	9.1367	9.9945	9.0535
Std. Deviation	0.45926	0.39958	0.35456	0.87833
Min	7.00	8.40	9.30	7.00
Max	8.50	9.80	10.80	10.80

**Table 9: Comparison of calf circumference between study and control groups.**

Wt. Category	N	Sig (2 tailed )	Pearson correlation
<2	49	0.000	0.818
2-2.5	98	0.000	0.986
>2.5	55	0.000	0.861

**Table 10: Comparison of different indicators by Pearson Correlation.**

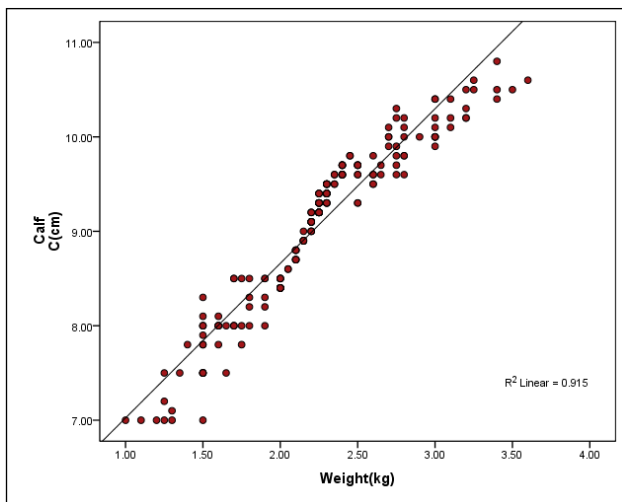
Wt Category		Length(cm)	HC (cm)	Chest C(cm)	MAC (cm)	TC (cm)	Calf C(cm)
<2.00	Weight(kg)	Pearson Correlation	0.412**	0.744**	0.638**	0.632**	0.595**
		Sig. (2-tailed)	0.003	0.000	0.000	0.000	0.000
		N	49	49	49	49	49
>2.5	Weight(kg)	Pearson Correlation	0.895**	0.913**	0.883**	0.855**	0.846**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
		N	55	55	55	55	55
2.00-2.5	Weight(kg)	Pearson Correlation	0.854**	0.886**	0.562**	0.844**	0.701**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
		N	98	98	98	98	98

The mean calf circumference in the study group with less than 2 kg was 7.83 cm with a standard deviation of 0.45 cm (range 7.00-8.5). In the group of 2-2.5 kg, the mean calf circumference was 9.13cm with a standard deviation

of 0.39cm (range 8.4-9.8). In the control group, the mean calf circumference was 9.99cm with a standard deviation of 0.35 cm (range 9.3-10.8) (Table 8).

The newborns in the two study groups had a statistically significant difference in calf circumference when compared to control group ( $P < 0.005$ ) (Table 9).

In the weight group less than 2 kg, all anthropometrical indicators had significant correlation with birth weight. Correlation of birth weight was highest with calf circumference ( $r=0.818$ ) and head circumference ( $r=0.744$ ) followed by chest circumference ( $r=0.638$ ), mid-arm circumference ( $r=0.632$ ), thigh circumference ( $r=0.595$ ) and length ( $r=0.412$ ). In the study group of 2-2.5 kg, correlation of birth weight was highest with calf circumference ( $r=0.986$ ) followed by head circumference ( $r=0.886$ ), length ( $r=0.854$ ), mid-arm circumference ( $r=0.844$ ), thigh circumference ( $r=0.701$ ) and chest circumference ( $r=0.562$ ). In the control group ( $>2.5$ kg), though all anthropometric indicators correlated significantly with weight, the highest order of correlation was with head circumference ( $r=0.913$ ) followed by length ( $r=0.895$ ), chest circumference ( $r=0.883$ ), calf circumference ( $r=0.861$ ), mid-arm circumference ( $r=0.855$ ) and thigh circumference ( $r=0.846$ ).



**Figure 1: Scatter diagram showing correlation between birth weight and calf circumference.**

Scatter diagram it is observed that calf circumference shows a good positive and significant correlation with birth weight in both study and control groups. (Figure 1).

## DISCUSSION

Identification of low birth weight babies in the community is the highest priority to provide effective minimal perinatal care to decrease mortality, there is a constant search for a simple and inexpensive method for screening such newborns. A number of studies have been done in this regard by comparing various anthropometric indicators with birth weight.

Our study showed a mean length of 46.63 cm for birth weight of 2-2.5 kg and 43.36 cm for birth weight of less

than 2 kg. Our study showed a better correlation for length with birth weight ( $r=0.41 < 2$ kg,  $r=0.85$ , 2-2.5kg) compared to control group ( $r=0.89$ ). In a study by Ezeaka VC et al, 136 LBW infants were studied and a mean length of 47.7 cm and 45.5 cm were the corresponding values for identifying babies with birth weights  $<2.5$  kg and  $<2$  kg respectively. The correlation matrix in this study was 0.86.<sup>7</sup> In a similar study by Samal GC et al, 620 LBW babies were studied and a mean length of 44.6 cm was obtained for identifying babies with birth weight  $<2.5$  kg. They have not studied babies with birth weight  $<2$ kg. The correlation coefficient for length in this study was 0.57.<sup>8</sup> Sharma JN et al, also reported similar observations in a hospital based study involving 1000 consecutive newborn babies. Length of 49cm and 46cm correlated well for birth weight of  $<2.5$ kg and  $<2.0$ kg respectively.<sup>9</sup> Neela J et al, in a hospital-based study of 256 newborns reported that a length of 47.7cm had a correlation of 0.55 with low sensitivity and specificity for identifying babies with birth weight  $<2500$ g.<sup>10</sup> The correlation of length with birth weight was better in our study compared to both of the above studies can be explained by the differences in geographical, racial and socioeconomic status and nutrition of the mothers.

Our study showed the mean head circumference of 31.2 cm and 29.07cm for birth weights  $<2.5$  kg and  $<2$ kg respectively. The correlation coefficient was 0.88 and 0.74 respectively for birth weights  $<2.5$  kg and  $<2$  kg. Even in the control group head circumference correlated well with birth weight ( $r=0.91$ ) compared to all other anthropometric indicators. In a study by Dhar B et al, 316 new born with birth weight  $<2.5$ kgs were studied and head circumference of  $<32$  cm correlated well ( $r=0.83$ ) with birth weight  $<2.5$  kg.<sup>11</sup> In a similar study by Bhatia BD et al, 341 term LBW newborns were studied and a mean head circumference of 31.9 cm and 29.9 cm corresponded to a birth weight of  $<2.5$ kgs and  $<2$ kgs respectively. The correlation matrix was 0.76 and they have concluded that head circumference can be used to estimate LBW babies as it will not be affected by variations compared to birth length.<sup>12</sup> Gupta et al, in a hospital-based study reported that head circumference of 32.2cm identifies 76.7% of low birth weight babies ( $<2500$ g).<sup>13</sup> In another study by Samal GC et al, head circumference of 33.9cm had a correlation of 0.5 to identify babies with birth weight  $<2500$ g. A similar study by Viridi VS et al, enrolled 254 newborns and observed that head circumference of 32.0cm had a correlation of 0.712 for birth weight of  $<2.5$ kg.<sup>14</sup> A study by Sharma JN et al, also reported similar results. Head circumference of 31cm and 30cm identified babies with birth weight of  $<2.5$ kg and  $<2.0$ kg respectively.<sup>9</sup> Head circumference also showed a better correlation with birth weight in our study compared to other studies.<sup>5</sup>

In our study the mean chest circumference was 29.74 cm and 27.1 cm for birth weight of  $<2.5$  kg and  $<2$  kg respectively which was similar to earlier studies. The correlation of chest circumference with birth weight in

our study was better in control group than study groups ( $r=0.63 < 2 \text{ kg}$ ,  $r = 0.56 < 2.5 \text{ kg}$ ,  $r = 0.88 > 2.5 \text{ kg}$ ).

In a study by Kapoor SK et al, 54 low birth weight newborns were studied and a mean chest circumference of 29.5 cm correlated well with birth weight. But when tested in field conditions the difference of 3 cm in chest circumference was noticed which reflected the difficulty in measuring chest circumference in field situations.<sup>5</sup> In a similar study by Fazlul Huque et al, 217 full term newborns with low birth weight were studied, mean chest circumference was 30.14 cm for predicting birth weight of  $< 2.5 \text{ kg}$  and 28.34 cm for babies  $< 2 \text{ kg}$ . The correlation coefficient was 0.867.<sup>3</sup> Correlation of chest circumference with birth weight was better in our study compared to Viridi VS et al, and Bhat IA et al, but less compared to Fazlul Huque et al.<sup>3,14,15</sup> The causes for differences in measurement and correlation with chest circumference are, difficulty for workers to measure in field situations, needs more handling of baby and need to be lifted from the bed and complete undressing of the infant is not permitted by the parents or relations owing to social customs, beliefs and taboos.<sup>5</sup>

In our study the mean mid arm circumference was  $< 8.18 \text{ cm}$  and  $< 6.96 \text{ cm}$  for birth weight of  $< 2.5 \text{ kg}$  and  $< 2 \text{ kg}$  respectively. However, mid-arm circumference correlated weakly with birth weight ( $r=0.63$ ,  $< 2 \text{ kg}$ ,  $r=0.84$ ,  $< 2.5 \text{ kg}$ ) as compared to control group ( $r=0.85$ ). In a study by Bhargava SK et al, 520 LBW babies were studied and a mean chest circumference of  $< 8.7 \text{ cm}$  and  $< 7.5 \text{ cm}$  correlated well ( $r=0.81$ ) with birth weights of  $< 2.5 \text{ kg}$  and  $< 2 \text{ kg}$  respectively.<sup>16</sup> In another study by Sharma JN et al, 244 babies with LBW were studied and mid-arm circumference of  $< 8.6 \text{ cm}$  and  $< 7.4 \text{ cm}$  correlated well ( $r=0.89$ ) with birth weight of  $< 2.5 \text{ kg}$  and  $< 2 \text{ kg}$  respectively.<sup>17</sup> In a community-based study by Kapoor SK et al, 660 consecutively born newborns were studied and 54 babies weighed  $< 2500 \text{ g}$ . Mid arm circumference of 8cm was more sensitive than chest circumference to identify babies with birth weight  $< 2500 \text{ g}$ .<sup>5</sup> Siddarth Ramji et al, in a hospital-based study of 216 newborns using discriminant analysis reported that mid arm circumference of 8.4cm and 8.0cm was less sensitive than thigh circumference in identifying  $< 2500 \text{ g}$  and  $< 2000 \text{ g}$  birth weight babies respectively.<sup>18</sup> Biswas AB et al, observed that mid arm circumference of 9.6cm correlated better ( $r=0.916$ ) with birth weight  $< 2.5 \text{ kg}$  than calf circumference and thigh circumference.<sup>19</sup>

The mean thigh circumference observed in our study was 14.20cm and 12.89 cm for birth weight of  $< 2.5 \text{ kg}$  and  $< 2 \text{ kg}$  respectively and the respective correlation coefficients are 0.70 and 0.59. Sharma JN et al, in his study of 1000 newborns has shown that the mean thigh circumference of  $< 14.5 \text{ cm}$  and  $< 13.5 \text{ cm}$  had the best correlation ( $r=0.92$ ) for identifying babies with birth weight of  $< 2500 \text{ g}$  and  $< 2000 \text{ g}$  respectively.<sup>9</sup> Siddarth Ramji et al, also reported similar observations in a hospital based study of 216 newborn infants using

discriminant analysis. He reported that a thigh circumference of  $< 14.7 \text{ cm}$  and  $< 13.9 \text{ cm}$  had the best correlation ( $r=0.91$ ) in identifying  $< 2500 \text{ g}$  and  $< 2000 \text{ g}$  birth weight babies respectively.<sup>18</sup>

In our study, the mean calf circumference of 9.13 cm correlated significantly ( $r=0.98$ ) with birth weight of  $< 2.5 \text{ kg}$  whereas for birth weight of  $< 2 \text{ kg}$  the mean calf circumference was 7.83 cm which had significant correlation ( $r=0.81$ ). In a hospital based study of 620 LBW babies by Samal GC et al, a mean calf circumference of 9.9 cm had the highest order of correlation ( $r=0.78$ ) in identifying LBW babies ( $< 2.5 \text{ kg}$ ).<sup>8</sup> In a study conducted at a peripheral health centre by Neela J et al, 256 term LBW babies were studied and a calf circumference of  $< 10 \text{ cm}$  had the best correlation ( $r = 0.83$ ) with birth weight of kg al.<sup>12</sup> In a similar study by Bhat IA et al, a calf circumference of 9.78cm correlated significantly with birth weight of  $< 2.5 \text{ kg}$  ( $r= 0.87$ ).<sup>15</sup> Biswas AB et al, also reported that a calf circumference of 9.6cm correlated well with birth weight of  $< 2500 \text{ g}$  ( $r=0.882$ ) and was more specific than mid arm circumference and thigh circumference.<sup>19</sup> In a hospital-based study by Viridi VS et al, 254 term newborns were enrolled out of which 47 babies were low birth weight. Calf circumference of 8.5cm had the best correlation ( $r=0.753$ ) compared to chest circumference and head circumference.<sup>14</sup> In a study by Gupta V et al, 1600 consecutively born newborns were involved and calf circumference of 10.8cm had the best correlation ( $r=0.98$ ), sensitivity and specificity when compared to length, head circumference, chest circumference, mid - arm circumference and thigh circumference, Calf circumference correlated well with birth weight in both study groups in our study.<sup>13</sup> Correlation was best with calf circumference in our study compared to all other studies. The differences in various indicators noticed in different studies can be explained on the basis of geographical, racial and socioeconomic status and nutrition of the mothers, which highly influence the capacity of the fetus to grow.<sup>14</sup> The observations in our study were similar to earlier studies. None of the earlier studies have used calf circumference for identifying babies with birth weight  $< 2 \text{ kg}$ . It is the first time we have observed that calf circumference has the best correlation in identifying babies with birth weight of  $< 2 \text{ kg}$  as compared to all other indicators.

## CONCLUSION

All the indicators correlated significantly with birth weight in both study groups and control group. The best correlation was observed with both calf circumference ( $r = 0.818$ ) and head circumference ( $r=0.744$ ) for identifying babies with birth weight  $< 2 \text{ kg}$ . For babies with birth weight  $< 2.5 \text{ kg}$ , calf circumference had the highest order of correlation ( $r=0.986$ ) followed closely by head circumference ( $r=0.886$ ). Our study shows that in the absence of a weighing machine, simple measurements

like calf circumference is the best indicator in identifying low birth weight babies (<2.5kg) at birth.

### Recommendations

This being a hospital based study; further studies are needed in the community to stress further its usefulness in field conditions.

*Funding: No funding sources*

*Conflict of interest: None declared*

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

### REFERENCES

1. Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. Bulletin of the world health organization. 1987;65(5):663-737.
2. Wilcox AJ. On the importance - and the unimportance - of birthweight. International journal of epidemiology. 2001 Dec 1;30(6):1233-41.
3. World Health Organization, Low Birth Weight: A tabulation of available information, WHO/MCH/92.2, World Health Organization, Geneva, and UNICEF, New York, 1992.
4. Huque F, Hussain Z. Detection of low birth-weight newborn babies by anthropometric measurements in Bangladesh. Ind J Pediatr. 1991 Mar 1;58(2):223-31.
5. Kapoor SK, Kumar G, Pandav CS, Anand K. Performance of surrogate markers of low birth weight at community level in rural India. J Epidemiology and Community Health. 2001 May 1;55(5):366-7.
6. Raman L, Neela J, Balakrishna N. Comparative evaluation of Calf, thigh and arm circumference in detecting low birth weight infants: Part II, Indian Paediatr – 1992;29(4):481-4.
7. Ezeaka VC, Egsi – Okwaji MT, Renner JK, Grange AO. Anthropometric measurements in the detection of low birth weight infants in Lagos, Nigerian Postgraduate Medical J. - 2003;10(3):168-72.
8. Samal GC, Swain AK. Calf circumference as an alternative to Birth weight for identification of low birth weight infant s, Indian Pediatr. 2001;38:275-7.
9. Sharma JN, Saxena S, Sharma V. Thigh circumference at birth as the best predictor of low birth weight babies, Indian Paediatr. 1989;26(1):18-20.
10. Neela J, Raman L, Balakrishna N, Rao KV. Usefulness of Calf circumference as a measure for screening low birth weight infants, Indian Pediatr. 1991;28(8):881-4.
11. Dhar B, Mowlah G, Nahar S, Islam N. Birth-weight status of newborns and its relationship with other anthropometric parameters in a public maternity. Hospital in Dhaka Bangladesh, Journal of Health, Population and Nutrition. 2002;20(1):36-41.
12. Bhatia BD, Tyagi NK. Birth weight: relationship with other fetal anthropometric parameters. Indian pediatrics. 1984 Nov;21(11):833-8.
13. Gupta V, Hatwal SK, Mathur S, Tripathi VN, Sharma SN, Saxena SC, et al. Calf circumference as a predictor of low birth weight babies. Indian pediatrics. 1996 Feb 1;33(2):119-21.
14. Viridi VS, Jain BK, Singh H. Calf circumference for identification of low birth weight babies. Indian pediatrics. 2001 Aug;38(8):934-5.
15. Bhat IA, Dhar GM, Shah GN, Neelofar K, Shehzada A. Efficiency of various anthropometric measurements in determining low birth weight babies. Indian Journal of Maternal and child Health. 1995;6(2):40-2.
16. Bhargava SK, Ramji S, Kumar A, Mohan MA, Marwah J, Sachdev HP. Mid-arm and chest circumferences at birth as predictors of low birth weight and neonatal mortality in the community. Br Med J (Clin Res Ed). 1985 Dec 7;291(6509):1617-9.
17. Sharma JN, Sharma BS, Gupta ML, Saxena S, Sharma V. Mid –arm Circumference at birth as a predictor of low birth weight babies and early Neonatal mortality, Indian Paediatr. 1986;23(11):915-9.
18. Ramji S, Marwah J, Satyanarayana L, Kapani V, Mohan M, Bhargava SK. Neonatal thigh circumference as an alternative indicator of low birth weight. The Indian J Medical Research. 1986 Jun;83:653.
19. Biswas AB, Sengupta B, Manna A, Mondal NC, Palodhi PK, Sarkar S. Comparative usefulness of arm thigh and calf circumference for screening low birth weight infants. J Tropical pediatrics. 1994 Oct 1;40(5):312.

**Cite this article as:** Kokku PK, Singh H, Kotha R, Jadhavo A, Maddireddi A, Cherukuri N, et al. Calf circumference to detect low birth weight babies: a comparative study. Int J Contemp Pediatr 2019;6:2302-8.