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A comparative study of calf circumference and chest circumference as a measure of low birth weight in neonates

Dr. Swati Jain[1], Dr. Prasanna Parashare [2], Dr. Monil Sarode[3], Dr. Vaibhav Rathod[4], Dr Girish Shakuntal [5]

[1]Associate Professor, Department of Pediatrics, SMBT Institute of Dental Sciences & Research centre, Dhamangaon, Igatpuri
[2]Assistant Professor, Department of Pediatrics, SMBT Institute of Dental Sciences & Research centre, Dhamangaon, Igatpuri
[3]Junior Resident, Department of Pediatrics, SMBT Institute of Dental Sciences & Research centre, Dhamangaon, Igatpuri
[4]Junior Resident, Department of Pediatrics, SMBT Institute of Dental Sciences & Research centre, Dhamangaon, Igatpuri
[5]Associate Professor, Department of Pediatrics, SMBT Institute of Dental Sciences & Research centre, Dhamangaon, Igatpuri

Corresponding author –**Dr. Swati Jain**

Abstract

Introduction-Birth weight is the single most important indicator of survival, growth and overall development of the child. New-borns with less than 2.5 kg birth weight are termed as low birth weight (LBW). Approximately 28% babies in India are LBW. LBW is associated with high neonatal morbidity and mortality. Early diagnosis of LBW and apt intervention can lead to favourable outcome. 70-80% of births take place either at home or at peripheral hospitals. Measuring birth weight is difficult in India due to resource limited set up. There is a need of alternative methods to detect LBW which should be simple, handy, quick and cost effective. Hence, we decided to do study of correlation of calf muscle circumference and chest circumference with birth weight to determine LBW in new-borns.

Aims-To study calf circumference and chest circumference in diagnosing low birth weight babies.

Objective-

1)To correlate above-said anthropometric parameters with birth weight

2) To decide indicator with better correlation with birth weight amongst calf circumference and chest circumference

Material & Method: Its a cross sectional study conducted in tertiary care centre in North Maharashtra. 162 New-borns (34- 42 weeks gestation) were included in Study. Birth weight, calf circumference and chest circumference were measured with appropriate scientific method. Results are analyzed with SPSS software & Microsoft excel.

Results-Cut-off value to detect LBW is 9.2 cm and 26cm for calf circumference and chest circumference respectively. Calf circumference had better correlation (r=0.85) as compared to chest circumference (r=0.58). Chest circumference has 92.2% sensitivity & 68.1% specificity as compare to Chest circumference which has 80.9% sensitivity & 59.6%.specificity respectively.

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Conclusion: Chest circumference and calf circumference can be used to determine LBW, though larger study with more number of patients is needed to establish precise correlation.

Key words- new-born, low birth weight, anthropometry, calf circumference, chest circumference

Introduction-

Birth weight is the single most important indicator of survival, future growth and overall development of the child. In India prevalence of low birth weight is very high and constitutes a major problem [1]. About 28% babies in India are LBW as opposed to about 5-7% of new-borns in the west. According to Indian new born action plan (INAP, Government of India, 2014) India accounts for more than 40% of the global burden of low-birth-weight babies with 7.5 million LBW babies (or 30% of the country's total annual live births) [2].

LBW is associated with high neonatal morbidity and mortality due to susceptibility to adverse environmental influences, predilection to infections and under nutrition. LBW is also associated with post neonatal mortality, infant and childhood morbidity. It also accounts for about 70% of perinatal and 50% of infant deaths in India [3,4]. LBW babies who survive have high risk of developmental disorders like mental retardation and also poor performance at school [5].

A weighing scale is the appropriate, accurate and standard equipment for the identification of birth weight [6]. However, this is difficult in developing countries like India where almost 70-80% births take place either at home or at peripheral hospitals where recording birth weight accurately is a problem due to unavailability of weighing scale and trained personnel. Even if we provide weighing scales at such places it has problems like carrying a heavy scale, as well as inability of traditional birth attendants to read them accurately as they are untrained [7].

Considering this problem, there is a need of alternative methods to identify birth weight from neonatal anthropometric parameters. Anthropometric measurements are easy to perform and manage. Therefore, finding an alternative method which is simple to use, quick and involving low-cost instruments is vital, especially in low-resource settings, so that low birth weight can be identified at the community level and referred to higher health care settings for further management. In India, there are outreach workers who can identify LBW using neonatal anthropometric measurements while they do home visits as the usual day-to-day activities.

Keeping above discussion in mind, present study aimed to determine the correlation between anthropometric parameters (calf circumference, chest circumference) and birth weight, to see if these parameters can be used as screening tool for detecting low birth weight new-borns. These parameters are easily measured using non stretchable measuring tape & it is simple, cheap, handy, reliable, quick method which can be easily performed by health workers and minimally skilled traditional birth attendants at rural centres

AIM-

To determine the efficiency of multiple neonatal anthropometric parameters in diagnosing low birth weight babies.

OBJECTIVES

1. To study various neonatal anthropometric parameters (calf circumference and chest circumference).
2. To correlate these anthropometric parameters with birth weight
3. To determine which single anthropometric parameter correlates best with birth weight.

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Material and Method-

A hospital based Cross sectional study was carried out in the Department of Paediatrics, SMBT hospital and research centre, Dhamangaon, Igatpuri Nashik on 162 live born LBW neonates who were born during one year period from July 2021 to august 2022. All the live born LBW neonates delivered at the hospital during one year were considered as the study population. All the anthropometric measurements are taken within 24 hours of birth by the investigator to avoid any interpersonal measurement error. Data was recorded in a pre-structured interview schedule and the findings were correlated with birth weight. Measurements of anthropometric parameters were done after washing hands and using sterile gloves. All anthropometric measurements are taken with the new-born lying down in supine position to the nearest 0.1 cm. Equipment's used during the study were of flexible, non-stretchable measuring tapes, electronic weighing machine, digital slide calliper.

Inclusion Criteria and Exclusion Criteria were used to record the following measurements are as follows:

Inclusion Criteria

1. Deliveries conducted at SMBT hospital.
2. All the live born normal neonates after 36 completed weeks and before 42 completed weeks in our tertiary care Centre
3. All live normal new-born born of singleton pregnancy

Exclusion Criteria

1. Neonates with congenital malformations
2. Sick new-born (to avoid excessive handling) excluded from the study.
3. Neonates born through multifetal pregnancy
4. Neonates born less than 36 weeks gestational age and more than 42 weeks of gestational age
5. Deliveries conducted outside our tertiary care Centre

Measurement taken were as follows-

Birth weight-Babies were weighed naked. Birth weight was recorded to the nearest of 5 g. Periodical checking of the scale was done using a set of standard weights. Birth weight less than 2500 g was defined as low birth weight.

The following anthropometric measurements were taken according to standard techniques described by Jellife.[8]

Chest circumference: Measured from at the level of mamillae/4th costo-sternal joint .

Calf circumference: Measured at the most prominent point in the semi-flexed position of the left leg with the measuring tape.

The study was initiated after obtaining approval of the institutional ethics committee. Data was entered, validated and analysed using Statistical Package for Social Sciences (SPSS) software version 28. Pearson's correlation was done to assess correlation of various anthropometric parameters with birth weight. Receiver operating characteristic (ROC) curves were used to evaluate the accuracy of different anthropometric measurements to predict LBW coded as dichotomous (1=yes; 0=no). For validity testing, the sensitivity and specificity values were calculated at serial cut-off points. To define the cut-off point which best discriminates between low birth weight. The value which yielded the highest accuracy, or percentage of correct classification was determined. $P<0.05$ was considered as significant and value $p<0.01$ was considered as highly significant

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Result-

Out of 162 live LBW neonates included in the study population, 73(45.1%) were male babies and 89 (54.9%) were female babies.76(46.9%) babies were born to primipara mothers and 86(53.1%) were born to multigravida mothers. 80(49.4%) were born through vaginal deliveries and 82(50.6%) were born through caesarean section.

Table1-Percentage of male and female babies

Gender	N	%
Female	89	54.9%
Male	73	45.1%
Total	162	100.0%

Table 2 -Percentage of mode of deliveries

Type of Delivery	N	%
Vaginal delivery	80	49.4%
LSCS	82	50.6%
Total	162	100.0%

Table 3 – Percentage of parity of mothers

Parity	N	%
Primipara	76	46.9%
Multigravida	86	53.1%
Total	162	100.0%

Table 4: Pearson's Correlation between birth weight & anthropometric measurements

Pearson co-relation		
Birth weight	**Pearson's Correlation coefficient (r) -value**	**Significance "P" value**
Calf circumference	0.85	**<0.01**
Chest circumference	0.58	**<0.01**

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Table 4 shows the correlation of birth weight to anthropometric measurements. The 'r' value of calf circumference is 0.85 for chest circumference is 0.58. All the co relations are statistically highly significant ($p<0.01$). The highest correlation among all measurements was observed between birth weight and calf circumference as compared to chest circumference

Table 5- Area under the curve values for ROC curves of various anthropometric measurements.

Area Under the Curve					
Test Result Variable(s)	Area	SE	p- value	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Calf circumference	0.906	0.029	<0.01	0.85	0.962
Chest circumference	0.774	0.043	<0.01	0.689	0.859

Table 5 shows that AUC value for ROC curves is highest for calf circumference (0.906) as compared to chest circumference (0.774) which shows that it is a better surrogate predictor of low birth weight (<2500 g) in our study as compared to chest circumference.

Table 6- Best cut-off points of anthropometric indicators for detecting neonates with birth weight less than 2500 g.

Parameter	Ideal Cut-off	Sensitivity	Specificity	Accuracy
Calf circumference	<9.2	92.2%	68.1%	80.2%
Chest circumference	<26	80.9%	59.6%	70.3%

Figure 1: Receiver operating characteristic curve for calf circumference and chest circumference

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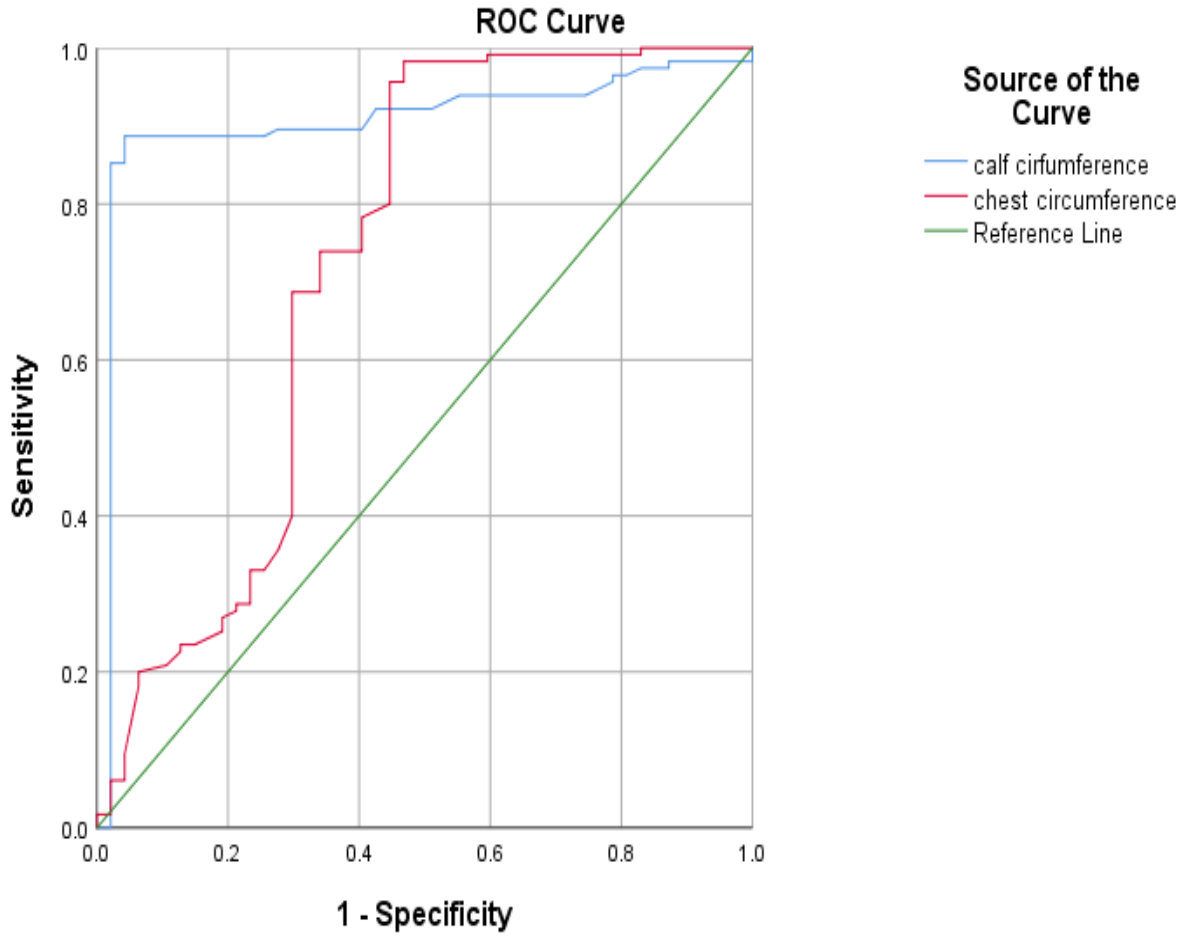

DISCUSSION

In countries like India, birth weight is often not recorded because of lack of knowledge about the importance of birth weight, non-availability of appropriate equipment, deliveries by untrained traditional birth attendants etc. There was many research done to identify appropriate alternative for birth weight; yet there is no unanimity in declaring an ideal anthropometric measurement. In the present study, effort has been made to compare the accuracy of head circumference and foot length in detecting low birth weight babies

In our study, there was no statistical difference in recordings of anthropometric measurements with respect to gender. calf circumference with cut off value of 9.2 cm had higher sensitivity and specificity of 92.2% and 68.1% respectively. While chest circumference length with cut off value of 26 cm, sensitivity of 80.9 % and specificity of 59.6%. Calf circumference had high area under curve (0.906) as compared to calf circumference (0.774) respectively. All the anthropometric measurements were statistically significant at 5% level of significance.
Many long-term duration studies have also been carried out in past between birth weight, and various anthropometric indices including foot length and head circumference. The numbers included for some of the studies is given below: Kulkarni ML et al., n= 817; Gowri S et al., n=600; Srinivasa S et al., n=500; Mukherjee S et al., n= 351; Amar MT et al., n=520; Ashish KC et al., n= 811; Mullany LC et al., n = 1640; Saroj AK et al., N=250; Sudhapriya P et al., n=1000; Akukwu DA et al., n=1000; Elizabeth N et al., n= 706. However, very few of these

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long-term studies have explicitly focussed on the association between birth weight and head circumference or foot length of the neonate, [9-19].
In par with the present study Taksende et al., found head circumference as better indicators in detecting low birth babies.

Other studies done by Elizabeth NL found foot length to have the highest predictive value for LBW with AUC of 0.94. The highest sensitivity and specificity were found with foot length (94%) respectively.[19] Similar results with high sensitivity (97.3%) and specificity (87.05%) with foot length was observed by Srinivas S. [11]
A study done by Geetha et al concluded foot length correlates well with birth weight of the neonate cut off taken as 7.59 cm. The cut-off values suggested through various studies is as follows. Mathur A et al., 7.2 cm; Saroj AK et al., 7.27 cm; Sudha Priya P et al., 7.3 cm; Srinivasa S Geetha Manivannan et al., 7.4 cm; Mullany LC et al., 7.4 cm; Kulkarni MI 7.5 cm; Hirve SS 7.6 cm; Mukherjee S et al., 7.9 cm; Marchant T et al., 8 cm [10-12,15-17,21-24].

Conclusion:

Low birth weight is a grave issue in both developing and under-developed nations and responsible for majority of neonatal morbidities and mortality. Anthropometric measurements are easy to perform and manage and can be used as proxy markers to identify low birth weight. In present study our results showed that, amongst both the anthropometric parameters, calf circumference was the best predictor for low birth weight as compared to chest circumference.

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Conflict of interest -None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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