International Journal of Contemporary Pediatrics
Rathod VB et al. Int J Contemp Pediatr. 2023 Feb;10(2):158-162
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20230002

Original Research Article

A comparative study of head circumference and foot length as a measure of low birth weight in neonates

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Received: 19 December 2022
Accepted: 02 January 2023

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ABSTRACT

Background: 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. The 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. Aim of the study was to study head circumference and foot length in diagnosing LBW babies. Objectives were to correlate above-said anthropometric parameters with birth weight and to decide indicator with better correlation with birth weight amongst head circumference and foot length

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

Results: Cut-off value to detect LBW is 31cm and 8.2 cm for head circumference and foot length respectively. Head circumference had better correlation (r=0.73) as compared to foot length (r=0.30). Head circumference has 87% sensitivity and 68% specificity as compare to foot length which has 74.8% sensitivity and 46.8% specificity respectively.

Conclusions: Head circumference and foot length circumference can be used to determine LBW, though larger study with a greater number of patients is needed to establish precise correlation.

Keywords: New-born, LBW, Anthropometry, Head circumference, Foot length

INTRODUCTION

Birth weight is the single most important indicator of survival, future growth and overall development of the child. In India prevalence of LBW 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 LBW 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 (head circumference, foot length) and birth weight, to see if these parameters can be used as screening tool for detecting LBW new-borns. These parameters are easily measured using non stretchable measuring tape and 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

Aim of the study was to determine the efficiency of multiple neonatal anthropometric parameters in diagnosing LBW babies.

Objectives

Objectives were to study various neonatal anthropometric parameters (head circumference and foot length), to correlate these anthropometric parameters with birth weight and to determine which single anthropometric parameter correlates best with birth weight.

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

Deliveries conducted at SMBT hospital, all the live born normal neonates after 36 completed weeks and before 42 completed weeks in our tertiary care centre and all live normal new-born born of singleton pregnancy included in the study

Exclusion criteria

Neonates with congenital malformations, sick new-born (to avoid excessive handling) excluded from the study. Neonates born through multifetal pregnancy, neonates born less than 36 weeks gestational age and more than 42 weeks of gestational age, deliveries conducted outside our tertiary care centre also excluded from the study.

Measurement taken were as follows

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

The following anthropometric measurements were taken according to standard techniques described by Jellife.[7]

Head circumference: The head circumference was measured by using a flexible non-stretchable tape anteriorly at the glabella, posteriorly along the most prominent points.

Foot length: Foot length measured as the distance from the heel to the greater toe of the right foot by using digital slide calliper. Measurements were taken parallel to the long axis of the foot, and by the same observer to avoid the inter-observer bias.

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 LBW. 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

RESULTS

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

Table 1: Percentage of male and female babies.

Gender	N	Percentages (%)
Female	89	54.9
Male	73	45.1
Total	162	100

Table 2: Percentage of mode of deliveries.

Type of delivery	N	Percentages (%)
Vaginal delivery	80	49.4
LSCS	82	50.6
Total	162	100

Table 3: Percentage of parity of mothers.

Parity	N	Percentages (%)
Primipara	76	46.9
Multigravida	86	53.1
Total	162	100

Table 4: Correlation of birth weight to anthropometric measurements.

Pearson co-relation		
Birth weight	**R value**	**P value**
Head circumference	0.73	<0.01
Foot length	0.30	<0.01

The 'r' value of head circumference is 0.73 for foot length it is 0.30. All the co relations are statistically highly significant (p<0.01). The highest correlation among all measurements was observed between birth weight and head circumference as compared to foot length

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

Test result variable(s)	Area	SE	P value	Asymptotic 95% CI	
				Lower bound	Upper bound
Head circumference	0.821	0.045	<0.01	0.733	0.909
Foot length	0.626	0.052	<0.01	0.524	0.787

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

Parameters	Ideal cut-off	Sensitivity (%)	Specificity (%)	Accuracy (%)
Head circumference	<31	87.0	68.1	77.6
Foot length	<8.2	74.8	46.8	60.8

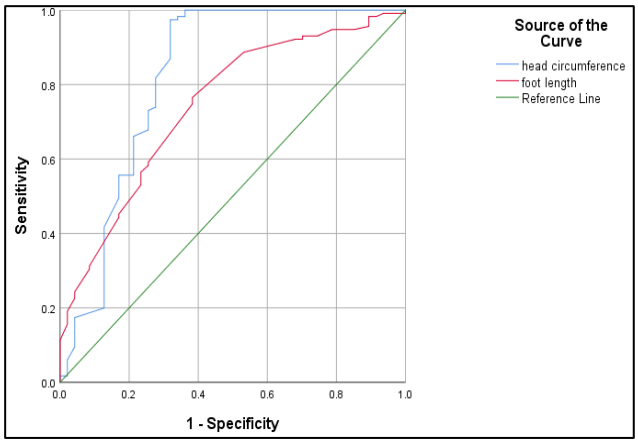

Figure 1: Receiver operating characteristic curve for head circumference and foot length.

It is evident that AUC value for ROC curves is highest for head circumference (0.827) as compared to foot length (0.62) which shows that it is a better surrogate predictor of LBW (<2500 gm) in our study as compared to foot length

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 LBW babies

In our study, there was no statistical difference in recordings of anthropometric measurements with respect to gender. Head circumference with cut off value of 31 cm had higher sensitivity and specificity of 87.1% and 68% respectively. While foot length with cut off value of 8.2 cm, sensitivity of 74.8% and specificity of 46.8%. head circumference had high area under curve (0.82) as compared to foot length (0.62) 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 et al n=817; Gowri et al n=600; Srinivasa et al n=500; Mukherjee et al n= 351; Amar et al n=520; Ashish et al n=811; Mullany LC et al n=1640; Saroj et al n=250; Sudhapriya et al n=1000; Akukwu et al n=1000; Elizabeth et al n=706. However, very few of these long-term studies have explicitly focussed on the association between birth weight as well as the 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 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.[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 et al., 7.2 cm; Saroj et al 7.27 cm; Sudhapriya et al 7.3 cm; Srinivasa et al 7.4 cm; Mullany et al 7.4 cm; Kulkarni 7.5 cm; Hirve 7.6 cm; Mukherjee et al 7.9 cm; Marchant et al 8 cm. [10-12,15-17,21-24]

CONCLUSION

LBW 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 LBW. In present study our results showed that, amongst both the anthropometric parameters, head circumference was the best predictor for LBW as compared to foot length.

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: Rathod VB, Mehkarkar NS, Gode VK. A comparative study of head circumference and foot length as a measure of low birth weight in neonates. Int J Contemp Pediatr 2023;10:158-62.