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Original Article

Paediatrics Section

Surrogate Anthropometric Parameters for Assessment of Low Birth Weight Babies

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ABSTRACT

Introduction: Low Birth Weight (LBW) accounts for significant proportion of infants and under five mortality. Screening of LBW babies in peripheral areas with poor facilities, with surrogate anthropometric parameters is necessary to prevent morbidity.

Aim: To evaluate calf circumference and other anthropometric parameters as a measure of LBW.

Materials and Methods: A prospective observational study including consecutive live newborn admitted to tertiary hospital, Mumbai, from June 2014 to June 2015. All anthropometric measurements were carried out within 24 hours of birth. Birth weight was measured using digital weighing scale and calf circumference, thigh circumference, Head Circumference (HC), Chest Circumference (CC) and Mid Arm Circumference (MAC) measured according to standard guidelines.

Results: Overall prevalence of LBW was 6.8%. All anthropometric indicators had a statistically significant sensitivity, specificity and predictive value ($p<0.001$) for LBW babies. However, predictive accuracy of calf circumference was found to be the highest.

Conclusion: Calf circumference and other surrogate parameters can be employed as standard anthropometric parameter for identification of LBW babies especially in the peripheral health centers.

Keywords: Calf circumference, Chest circumference, Mid arm circumference, Thigh circumference

INTRODUCTION

Birth weight carries significant role in infant mortality, morbidity and future development of a child [1]. LBW accounts for 80% of neonatal death and 50% of infant deaths. Newborn deaths are accountable for 40% of all deaths in children under five years of age globally [2]. LBW is significant risk factor for infant morbidity and mortality. World Health Organisation estimates that the prevalence of LBW (birth weight <2.5 kg) is 15.5% across the world, and more than 95% of LBW infants are born in developing countries including India [3].

LBW babies, particularly high risk, even after surviving critical neonatal phase of life, often have multitude of physical, behavioural, learning and mental problems [4].

LBW babies poses major financial burden to families [5] particularly in country where approximately 80% of deliveries are conducted at home by traditional birth attendants or relatives. More than 70% of newborn babies are not weighed at birth as the deliveries are conducted in homes where weighing scale or skilled health workers are not available [6].

Finding a cost efficient way to meet such problem of significant magnitude in resource poor settings has always been a challenge.

Many authors have suggested use of alternate anthropometric parameters for assessment of LBW babies [7]. In our study we aim to utilise parameters such as calf circumference, thigh circumference, MAC, CC and HC which can readily be measured using measuring tape and which is invariably cheap, reliable, quick and can be easily used by health workers.

Objectives

1. Evaluation of calf circumference and other anthropometric parameters as a measure of LBW.

2. To compare calf circumference with other anthropometric indicators viz MAC, HC, thigh circumference and CC in detection of LBW babies at birth.

MATERIALS AND METHODS

This prospective observational study was carried out at Jagjivan Ram Railway Hospital Mumbai, India, which is a Tertiary Care Hospital catering to Indian Railway employees, at Mumbai,

Maharashtra. The study period was from June 2014 to June 2015. Institutional ethical committee approval was obtained. Total 310 consecutive live born normal neonates were included in study. Consent was obtained from parents prior to study.

Sample size: For calculation of sample size formula used is

$n = [Z^2 \times p (1-p)] / d^2$

Where: n-is the size of sample; Z-Standard variate for the desired level of confidence; p-Estimate of expected proportion with variable of interest in the population; d-Is the absolute error/desired precision.

In our study, we chose a 95% confidence level i.e., Z=1.96

As per previous study by Dhar B et al., the prevalence of the LBW in the study population was found to be 15% [7], i.e., p = 0.15. Precision or absolute error of 5% was taken i.e., d = 0.05.

All the live born normal neonates irrespective of gestational age were included and anthropometric assessment were done within 24 hours of birth.

Neonates with congenital malformations and sick babies (to avoid excessive handling) were excluded from the study.

All anthropometric measurements were carried out within 24 hours of birth by the investigator himself to avoid any interpersonal measurement error.

All the anthropometric measurements were taken with the newborn lying down in supine position. All the circumferences were measured to the nearest 0.1 cm using a flexible non stretchable tape. Standard anthropometric techniques were used to record the following measurements of these neonates. Newborn babies were subjected to thorough clinical examination and anthropometric measurements were recorded only for normal neonates.

Procedure

1. Measurement of weight: Babies were weighed naked on an electronic type weighing scale to the nearest 1 gm.

2. Chest circumference: It was measured at the level of xiphoid process anteriorly and below the inferior angle of scapula posteriorly. The measurement was taken during quiet respiration using non extendable measuring tape.

3. Mid arm circumference: Measurement was taken midway between tip of acromion process and olecranon process of ulna in left upper limb using non extendable measuring tape.

4. Thigh circumference: It was recorded in supine position using the left thigh at the level of lowest fold in gluteal region. Tape is placed perpendicular to long axis of the lower limb with its top edge just under gluteal fold using measuring tape.

5. Calf circumference: Most prominent point in semi flexed position of the left leg was measured using measuring tape.

6. Head circumference: HC was measured with a flexible non stretchable measuring 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.

STATISTICAL ANALYSIS

The Statistical software SPSS 15.0 was used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc. Descriptive and inferential statistical analysis were used in the current study. Results on continuous variables were tabulated on Mean±SD and results on categorical measurements were presented in number (%). Analysis of Variance (ANOVA) was used to compare multiple means of study parameters between three or more groups. Chi-square/Fisher's exact test was used to find the significant relationship of study parameters on categorical/nominal scale between two or more groups. Sensitivity, specificity, Positive Predictive Value (PPV), adn Negative Predictive Value (NPV), accuracy were calculated to estimate cut off point of anthropometric parameters for LBW babies. Pearson's correlation between study variables was performed to find the degree of relationship.

RESULTS

Our study population comprised of 310 consecutive live born babies. [Table/Fig-1,2] depicts gender and weight distribution. In present study, there were 164 males and 146 female new-borns the percentage of male to female is 52.9 % and 47.01% respectively. Male to female ratio was 1.12:1. Prevalence of LBW was 6.8%.

Comparison of study variables with calf circumference (cm) [Table/Fig-3]. The mean values and standard deviation of HC, CC,

Gender	No. of Patients	Percentage (%)
Male	164	52.9
Female	146	47.1
Total	310	100.0

[Table/Fig-1]: Gender distribution of subjects studie.

Weight (gm)	Gender		Total n(%)
	Male	Female	
<2500	11 (6.7%)	10 (6.8%)	21 (6.8%)
2500-3500	149 (90.9%)	132 (90.4%)	279 (90%)
3500+	4 (2.4%)	4 (2.7%)	8 (2.6%)
Total	164 (100%)	146 (100%)	310 (100%)

[Table/Fig-2]: Weight (gm) distribution.

Variables	Calf Circumference (cm)				All cases	p-value
	8.1-9 cm	9.1-10 cm	10.1-11 cm	11.1-12 cm		
Head Circumference (cm)	31.84±1.01	33.09±0.86	33.78±0.99	34.31±0.80	33.44±1.04	<0.001**
Chest Circumference (cm)	29.96±0.93	31.06±0.92	32.04±0.96	32.79±0.68	31.58±1.12	<0.001**
Mid Arm Circumference (cm)	8.71±0.75	9.72±0.34	9.90±0.35	10.30±0.25	9.81±0.44	<0.001**
Thigh Circumference (cm)	14.19±0.88	15.21±0.48	15.56±0.57	16.20±0.46	15.40±0.64	<0.001**

[Table/Fig-3]: Comparison of study variables according to calf circumference (cm).
ANOVA test

MAC and thigh circumference were 33.44±1.04, 31.58±1.12, 9.81±0.44 and 15.40±0.64 respectively among babies.

[Table/Fig-4] shows Pearson's correlation of all anthropometric variables with birth weight.

Pair	r value	p-value
Calf circumference (cm) vs Weight (gm)	0.747	<0.001**
Head Circumference (cm) vs Weight (gm)	0.510	<0.001**
Chest Circumference (cm) vs Weight (gm)	0.596	<0.001**
Mid Arm Circumference (cm) vs Weight (gm)	0.570	<0.001**
Thigh circumference (cm) vs Weight (gm)	0.595	<0.001**

[Table/Fig-4]: Pearson's correlation of birth weight with other anthropometric variables.

Head Circumference (cm)	Birth Weight (Kg)		Total
	>2500	<2500	
≤32.8	59 (20.4%)	15 (68.2%)	74 (23.8%)
>32.8	230 (79.6%)	7 (31.8%)	237 (76.2%)
Total	289 (100%)	22 (100%)	311 (100%)

[Table/Fig-5]: Head Circumference (cm) in relation to Birth weight.

Chest Circumference (cm)	Birth Weight (Kg)		Total
	>2500	<2500	
≤30.5	35 (12.1%)	16 (72.7%)	51 (16.4%)
>30.5	254 (87.9%)	6 (27.3%)	260 (83.6%)
Total	289 (100%)	22 (100%)	311 (100%)

[Table/Fig-6]: Chest Circumference (cm) in relation to Birth weight.

Mid Arm Circumference (cm)	Birth Weight (Kg)		Total
	>2500	<2500	
≤9.5	37 (12.8%)	15 (68.2%)	52 (16.7%)
>9.5	252 (87.2%)	7 (31.8%)	259 (83.3%)
Total	289 (100%)	22 (100%)	311 (100%)

[Table/Fig-7]: Mid arm circumference (cm) in relation to birth weight.

Thigh Circumference (cm)	Birth Weight (Kg)		Total
	>2500	<2500	
≤15	48 (16.6%)	18 (81.8%)	66 (21.2%)
>15	241 (83.4%)	4 (18.2%)	245 (78.8%)
Total	289 (100%)	22 (100%)	311 (100%)

[Table/Fig-8]: Thigh circumference (cm) in relation to birth weight.

The anthropometric measurements were correlated with birth weight with significant p-value, the maximum correlation with birth weight was observed for calf circumference (r=0.747) and a weak correlation was seen with head circumference (r=0.51).

HC (cm) in relation to birth weight: The cut off of HC at value of 32.8 cm was able to detect 15 (68.2%) of LBW babies [Table/Fig- 5].

Chest circumference (cm) in relation to birth weight: The cut off of chest circumference at value of 30.5 cm was able to detect 16 (72.7%) of LBW babies [Table/Fig-6].

MAC (cm) in relation to birth weight: The cut off of MAC value at <9.5 cm was able to detect 15 (68.2%) of LBW babies [Table/Fig-7].

Thigh circumference (cm) in relation to birth weight: The cut off of thigh circumference at value of 15 cm was able to detect 18 (81.8%) of LBW babies [Table/Fig- 8].

Calf circumference (cm) in relation to birth weight: The cut off of calf circumference at value of 9.8 cm was able to detect 19 (86.4%) of LBW babies [Table/Fig- 9].

Correlation of anthropometric variables with low birth weight: Predictive accuracy to screen LBW was the highest with calf circumference (87.5) and least with HC (78.8) [Table/Fig-10].

Calf Circumference (cm)	Birth Weight (kg)		Total
	>2500	<2500	
≤9.8	36 (12.5%)	19 (86.4%)	55 (17.7%)
>9.8	253 (87.5%)	3 (13.6%)	256 (82.3%)
Total	289 (100%)	22 (100%)	311 (100%)

[Table/Fig-9]: Calf circumference (cm)in relation to Birth weight.

DISCUSSION

Screening of LBW babies in the community is the highest priority to provide effective perinatal care to decrease morbidity and mortality. Search for a simple, reliable, inexpensive and quick method for screening such new-borns has always been felt in community. Health personnel posted at the peripheries are often supplied with limited facilities. They can screen high risk babies using surrogate parameters with the help of non-

Variables	Observation					Correlation					
	True Positive	False Positive	False Negative	True Negative	Total	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy	p-value
Head Circumference (cm)	15	59	7	230	311	68.10	79.6	20.3	97.1	78.8	<0.001**
Chest Circumference (cm)	16	35	6	254	311	72.7	87.9	31.4	97.8	86.8	<0.001**
Mid Arm Circumference (cm)	15	37	7	252	311	68.2	87.2	28.9	97.3	85.9	<0.001**
Thigh Circumference (cm)	18	48	4	241	311	81.8	83.3	27.3	98.4	83.3	<0.001**
Calf Circumference (cm)	19	36	3	253	311	86.6	87.5	34.6	98.8	87.5	<0.001**

[Table/Fig-10]: Correlation of anthropometric variables with low birth weight.

stretchable measuring tape, as done in our study.

Studies done by authors have compared various anthropometric parameters with birth weight. Our study is an attempt to know whether calf circumference and other surrogate parameters can be used for identification of LBW babies at birth and to establish cut off values of various anthropometric measurements for detection of LBW baby <2500 grams at community level.

We found the prevalence of LBW baby at our hospital to be 6.8%, however study done by Dhar B et al., on 316 babies found prevalence to be around 15.18% [7]. However, LBW prevalence depends on multitude of factors such as maternal health, antenatal care, nutrition and genetic profile of parents.

All the anthropometric measurements correlated well with the birth weight, but maximum correlation (r=0.747) was established between birth weight and calf circumference in our study. On comparison with other studies, the present study correlated well with Nur M et al., [8] and Viridi VS et al., [9].

Out of all the anthropometric measurements, in the present study the cut off value of ≤9.8 cm for calf circumference had the highest sensitivity (84.13%) and specificity (86.19%) for birth weight <2500 gm, the findings were similar to the one reported by Samal GC et al., [10].

The cut off value of MAC for detection of LBW was ≤9.5 cm but the sensitivity (82.06%) and specificity (85.91%) was less compared to calf circumference in our study.

Similarly, the cut off of CC value for detection LBW baby was found to be 30.5 cm with sensitivity of 72.7% and specificity of 87.9%. Similar findings were noted in other studies [7,11].

Moreover, the cut off of HC value for detection ofLBW baby was found to be 32.8 cm with sensitivity of 68.1% and specificity of 79.6%, and similarly for thigh circumference cut off value for detection of LBW was found to be 15 cm with sensitivity of 81.8% and specificity of 83.3%.

LIMITATION

Our study is single hospital based study, hence generalisation for entire community requires further study.

CONCLUSION

Our study found calf circumference to be a better surrogate anthropometric parameter for screening of LBW babies. Various surrogate parameters can be utilised to estimate LBW baby in remote areas, however calf circumference correlated strongly with birth weight and hence can be used reliably for screening such babies.

Recommendations

The calf circumference can be employed as standard anthropometric parameter for identification of LBW babies especially in the peripheral health centres.

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