

Original Research Article

Anthropometric surrogates to identify low birth weight babies: hospital based cross-sectional study

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ABSTRACT

Background: Birth weight acts as a crucial sensitive and reliable tool to prevent infant and child morbidity and mortality. There has been a considerable interest in recent years for using simple anthropometric measures as an alternative to birth weight. Objective of the study is to determine the cut off values of the anthropometric measurements and to assess the accuracy of the anthropometric surrogates to identify low birth weight babies

Methods: This is a cross sectional study conducted for a period of one year from 1st Dec 2011 to 31st Nov 2012 at Christian fellowship hospital, Oddanchatram, Dindigal, Tamilnadu. Study population included all the live newborns of term gestation at the hospital. A total of 500 newborns were included in the study during the period. Birth weight of the newborn was measured using spring scale to the nearest 25 grams. Head circumference, Chest circumference, Mid Upper Arm Circumference, Foot Length, Thigh circumference, Calf circumference, Crown-hell length were measured using proper guidelines to the nearest 0.1 cm.

Results: In the present study, low birth weight was present in 262 (52.4%) of the newborns. Thigh circumference with cut off value of 15 cm had higher sensitivity and specificity of 97.5% and 80.9% respectively. It was followed by Mid upper arm circumference with cut off value of 10 cm, sensitivity of 81.5% and specificity of 93.9%. Thigh circumference and mid upper arm circumference had high area under curve of 0.949 and 0.855 respectively. All the anthropometric measurements were statistically significant at 5% level of significance.

Conclusions: Thigh circumference with a cut off of 15 cm, followed by mid upper arm circumference of 10 cm were the better surrogate anthropometric measurements with better sensitivity, specificity to identify low birth weight babies.

Keywords: Anthropometric surrogates, Cut off values, Sensitivity, Specificity, Low birth weight

INTRODUCTION

The fetal and neonatal health can be determined by birth weight. It acts as a crucial sensitive and reliable tool to prevent infant and child morbidity and mortality. Size at birth is one of the important indicators for neonatal and fetal health, child's chance of survival, healthy growth and development in future. Thus, recognizing high risk

babies at the earliest is one of the crucial steps to reduce morbidity and mortality.^{1,2}

World Health Organization (WHO) defines Low birth weight as weight (LBW) at birth less than 2500 grams. Low birth weight is associated with a range of both short- and long term consequences and continues to be a significant public health problem globally. Overall, it is estimated that 15% to 20% of all births worldwide are

low birth weight, representing more than 20 million births a year.³ Thus, to provide proper care to the newborn and to avoid worse outcomes, low birth weight has to be detected as early as possible by surrogate markers like anthropometry where weighing is not possible due to unavailability of equipment, limited health facility, high delivery rate, rapid turnover rate of newborn care and limited staff of perinatal ward in the developing countries.^{4,5}

Anthropometry in newborns depends on racial, ethnic, environmental, age factors, biological, ecological and geographic factors and is essential to express the measurements of development of the human body.⁶

There has been a considerable interest in recent years for using simple anthropometric measures as an alternative to birth weight. Other anthropometric measurements like Crown heel length, mid upper arm circumference, head circumference, thigh circumference, chest circumference, calf circumference, foot length have been studied as surrogates for birth weight. With this concept, the present study was conducted to find a reliable, better and simple anthropometric measurement with its cut off values to identify low birth weight babies. Objective of the study is to determine the cut off values of the anthropometric measurements. And to assess the accuracy of the anthropometric surrogates to identify low birth weight babies.

METHODS

This is a cross sectional study conducted for a period of one year from 1st Dec 2011 to 31st Nov 2012 at Christian fellowship hospital, Oddanchatram, Dindigal, Tamilnadu. Study population included all the live newborns of term gestation at the hospital. A total of 500 newborns were included in the study during the period. Preterm babies

and/or asphyxiated/sick newborns under intensive care in the first 24 hours of birth were excluded from the study. Data was collected by interview of mother within 24 hours of child birth and through review of obstetric case sheets. New Ballard Score as described by Ballard J.L. et al was used to assess the gestational age.⁷ Birth weight of the newborn was measured using spring scale to the nearest 25 grams. Head circumference, Chest circumference, Mid Upper Arm Circumference, Foot Length, Thigh circumference, Calf circumference, Crown-heel length were measured using proper guidelines to the nearest 0.1 cm.

Statistical analysis

The data was entered into Microsoft excel sheet and analyzed using SPSS Version 20 software. The data was represented in the form of descriptive statistics like frequency, percentages for qualitative data and mean, standard deviation for quantitative data. Receiver Operating Characteristics (ROC) curves were drawn to assess the validity of the anthropometric measurements with area under curves. P<0.05 was considered statistically significant. Cut off values, sensitivity, specificity, Positive predictive value, Negative predictive value, Likelihood ratio positive and negative were also calculated for all the anthropometric measurements.

RESULTS

In the present study, of the 500 newborns, 286 (57.2%) were males and 214 (42.8%) were females. Low birth weight was present in 262 (52.4%) of the newborns Table 1. describes the relation between gender and the magnitude of the low birth weight.

Table 1: Gender and low birth weight of the newborns.

LBW (kg)	Present (n = 262, 52.4%)		Absent (n = 238, 47.4%)		Total
	<2	2.01-2.5	2.51-3	3.01-3.5	
Male	6 (2.1%)	142 (49.7%)	138 (48.3%)	0	286 (100%)
Female	10 (4.7%)	104 (48.6%)	99 (46.3%)	1 (0.5%)	214 (100%)
Total	16 (3.2%)	246 (49.2%)	237 (47.4%)	1 (0.2%)	500 (100%)

The anthropometric measurements of the total newborns classified as males and females are shown in Table 2. It was observed that weight and all the anthropometric measurements were almost equal in both genders.

Unpaired t test results showed that there was no statistical difference between gender and the anthropometric measurements.

The cut off values along with sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratio positive, likelihood ratio negative, false positive and false negative are noted in table 3. Thigh circumference with cut off value of 15 cm had higher sensitivity and specificity of 97.5% and 80.9% respectively. It was followed by Mid upper arm circumference with cut off value of 10 cm, sensitivity of 81.5% and specificity of 93.9%.

Table 2: Anthropometric measurements of the study population.

Anthropometric measurements	Gender	N	Mean	Std. Dev	t test	p value
Weight (kg)	Male	286	2.58	0.679	0.226	0.821
	Female	214	2.57	0.673		
Crown Heel length	Male	286	46.46	3.636	0.071	0.943
	Female	214	46.44	3.219		
Head circumference	Male	286	32.80	1.645	1.023	0.307
	Female	214	32.64	1.824		
MUAC	Male	286	9.51	1.136	-0.537	0.591
	Female	214	9.56	1.067		
Thigh circumference	Male	286	14.30	2.435	-1.432	0.153
	Female	214	14.62	2.536		
Chest circumference	Male	286	30.56	1.811	0.097	0.922
	Female	214	30.55	1.880		
Foot length	Male	286	7.45	0.651	0.041	0.967
	Female	214	7.45	0.668		
Calf circumference	Male	286	9.71	1.014	-1.477	0.140
	Female	214	9.85	1.025		

Table 3: Cut off values along with accuracy of the anthropometric measurements.

Anthropometric measurements	Cut off	Sen	Spe	PPV	FP	NPV	FN	LR+	LR-
Crown Heel length	45	91.6	54.6	63.5	36.46	37.15	62.84	1.74	1.69
Head circumference	33	78.6	75.2	51.9	48.07	48.7	51.2	1.07	1.05
Mid upper arm circumference	10	81.5	93.9	47.21	52.78	53.36	46.63	0.89	0.87
Thigh circumference	15	97.5	80.9	55.43	45.56	45.12	54.87	1.24	1.21
Chest circumference	31	74.4	77.9	49.65	50.34	51	48.99	0.98	0.96
Foot length	7.5	77.3	66.8	54.49	45.5	46.2	53.79	1.19	1.16
Calf circumference	10.2	51.7	99.2	34.92	65.07	65.74	34.25	0.53	0.52

Sen - Sensitivity, Spe - Specificity, PPV - Positive predictive value, FP - False positive, NPV-Negative predictive value, FN - False negative, LR+ and LR- - Likelihood ratio positive and Likelihood ratio negative.

Table 4: Area under curve of the anthropometric measurements of the newborns.

Anthropometric measurements	Area	p value	Asymptotic 95% CI	
			Lower Bound	Upper Bound
Crown Heel length	0.741	0.000	0.697	0.785
Head circumference	0.816	0.000	0.779	0.854
Mid upper arm circumference	0.855	0.000	0.823	0.887
Thigh circumference	0.949	0.000	0.931	0.966
Chest circumference	0.812	0.000	0.775	0.849
Foot length	0.740	0.000	0.697	0.784
Calf circumference	0.795	0.000	0.757	0.832

Receiver Operating Characteristic curve to depict area under curve was drawn for all the anthropometric measurements taken.

Birth weight of the newborns was taken as the reference line. Thigh circumference and mid upper arm circumference had high area under curve of 0.949 and 0.855 respectively. All the anthropometric measurements

were statistically significant at 5% level of significance (Table 4 and Figure 1).

DISCUSSION

In countries like India, recording of birth weight is often not made due to lack of knowledge about the importance of birth weight, unavailability of suitable equipment, deliveries by untrained attendants etc. There were many

studies conducted to identify a reliable alternative for birth weight; yet there is no unanimity in drawing an ideal anthropometric measurement. In the present study, attempt has been made to compare the accuracy of the anthropometric measurements in detecting low birth weight babies.

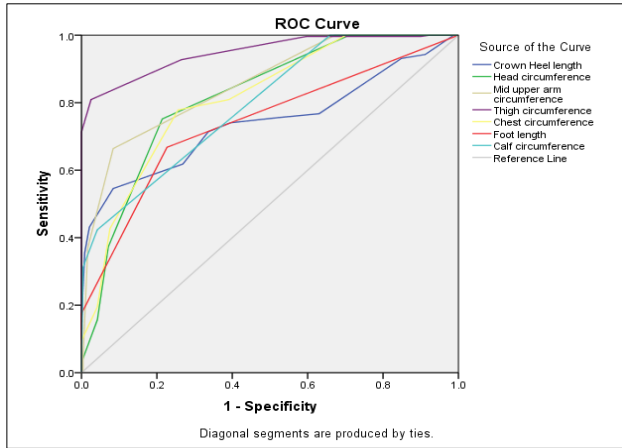


Figure 1: Receiver Operating Characteristic curve of the anthropometric measurements.

In our study, low birth weight was present in 262 (52.4%) of the newborns. There was no statistical difference in recordings of anthropometric measurements with respect to gender.

Thigh circumference with cut off value of 15 cm had higher sensitivity and specificity of 97.5% and 80.9% respectively. It was followed by Mid upper arm circumference with cut off value of 10 cm, sensitivity of 81.5% and specificity of 93.9%. Thigh circumference and mid upper arm circumference had high area under curve of 0.949 and 0.855 respectively. All the anthropometric measurements were statistically significant at 5% level of significance. A very few studies have found thigh circumference as one of the best anthropometric measurements to identify low birth weight babies.

Ahmed M et al., found chest circumference and thigh circumference to be the best surrogate parameters to identify low birth weight babies. The cut off value of thigh circumference was 13.6 cms and 13.8 cms in male and female neonates respectively.⁸ Similar observation was seen in the study done by Kumar S et al., where the highest sensitivity was found with calf circumference (98.4%), followed by thigh circumference (91.6%). But the specificity was seen to be high with thigh circumference (96.25%) than calf circumference (92%).⁹ Another study with the same observation which showed thigh circumference with high sensitivity and specificity was conducted by Oo WM et al., The study results showed that thigh circumference had sensitivity and specificity of 88.1% and 73.3% respectively, followed by calf and mid upper arm circumference.¹⁰ In par with the above results, Taksende et al., found head circumference

and thigh circumference as better indicators in detecting low birth babies. MUAC and calf circumference were found to be good in picking up very low birth weight babies.¹¹ But in many studies, chest circumference was found to be the best surrogate anthropometric measurement to identify low birth weight babies. Dhar B et al., in his study found chest circumference as the best anthropometric measurement with cut off value of < 29.5 cm, sensitivity and specificity of 83.3% and 83.6% respectively. It was followed by MUAC as the next better detector of low birth weight.¹² A meta-analysis report showed that chest circumference and arm circumference had areas under the curve >0.9 (0.95 for both) showing greater accuracy in predicting LBW, but thigh circumference and foot length were found to be less accurate.¹³ Other studies done by Kaur M et al., Nair BT et al., Otupiri E et al., Sajjadian N et al., Shastry CKR et al., have all found chest circumference to be the better surrogate compared to other anthropometric measurements in detecting low birth weight babies.^{1,6,14-16}

In contrast to chest circumference and thigh circumference, some other studies found foot length, calf circumference, MUAC as the good predictor. A Study 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%) and chest circumference (90%) respectively.¹⁷ Similar results with high sensitivity (97.3%) and specificity (87.05%) with foot length was observed by Srinivas S.¹⁸

Neeluri R et al., in his study concluded that mid upper arm circumference to be an easier, convenient anthropometric parameter in detection of low birth weight newborn babies.¹⁹ Shastry CKR et al., found chest circumference along with mid arm circumference to be the alternate parameters to identify low birth weight babies.²⁰ Calf circumference was suggested to be the surrogate parameter for early detection of low birth weight babies by Suneetha B et al.²¹

CONCLUSION

In our study, thigh circumference of 15 cm followed by mid upper arm circumference of 10 cm were the better surrogate anthropometric measurements to identify low birth weight babies. But comparing the results of our study and all the above-mentioned studies, it can be concluded that there is no single universal anthropometric measurement to act as a surrogate marker for detecting low birth weight babies. A large multicentric study involving babies from different ethnic group has to be conducted to identify a simple, accurate, reliable surrogate anthropometric measurement in picking up low birth weight babies to deliver proper treatment at the earliest and to reduce infant mortality.

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

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