USEFULNESS OF CALF CIRCUMFERENCE AS A MEASURE FOR SCREENING LOW BIRTH WEIGHT INFANTS

J. Neela
L. Raman
N. Balakrishna
K.V. Rao

ABSTRACT

Usefulness of calf circumference (CC) for screening low birth weight (LBW) was assessed in comparison with other anthropometric measurements, crown heel and crown rump lengths (CHL, CRL), Chest (Ch C), head (HC) and arm (AC) circumferences in 256 infants within 24 hours of birth. Calf circumference showed highest degree of correlation (r = 0.83) with birth weight followed by arm and chest circumference and crown heel length. Step down multiple linear regression analysis of birth weight showed highest R^2 value with combination of calf, arm and crown heel length (82.1%). Addition of other measurements did not improve the predictive value of the model. Sensitivity of these parameters in screening LBW infants (<2500g) showed 95.7% critical limit for calf followed by 82.6% with arm circumference and 72.5% with crown heel length. False positive responses were similar (18-20%) with all the three parameters. Calf circumference being highly sensitive and easy to measure, is useful in screening most of the low birth weight infants in the communities where weighing scales are not available or cannot be used by peripheral workers.

Key words: *Calf circumference, Low birth weight, Predictive value, Sensitivity.*

Low birth weight accounts for more than 50% of perinatal deaths in India(1). Use of weighing scales with accuracy is difficult in rural and slum India due to non availability of simple reliable scales and because 70-80% of births take place at home and are conducted by trained or untrained birth attendants. There is a constant search for a simple and inexpensive indicator of low birth weight to predict neonatal well being in the community(2-4). Though calf circumference has been used as an indicator of protein energy malnutrition in preschool children(5), it has not been so far tried as one of the measurements in the assessment of the newborn or infant at risk. In the present study, feasibility of using calf circumference as a screening procedure for identification of low birth weight (LBW) assessed and compared with other anthropometric measurements.

Material and Methods

Data was collected from 256 consecutive newborns delivering at the local Government Maternity Hospital. All of them were full term, normal, singleton infants. In all cases birth weight, crown heel (CHL) and crown rump length (CRL), arm (AC), chest (CHC), head (HC) and calf circumference (CC) were obtained by one of the investigators within 24 hours of birth. In 20 infants inter and intra investigator

From the National Institute of Nutrition, Indian Council of Medical Research, Jamai Osmania P.O., Hyderabad 500 007.

Reprint requests: Dr. Leela Raman, Deputy Director, National Institute of Nutrition, Indian Council of Medical Research, Jamai Osmania P.O., Hyderabad 500 007.

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variations were tested for all the measurements by a team of two paramedical and one medical worker double blind in duplicates.

Calf circumference (CC) was measured at the most prominent point in semi flexed position of leg with a flexible fibre glass tape to the nearest 0.1 cm. Other measurements were done by standard techniques. Weight was recorded on a sensitive beam balance to the nearest 5 g.

Standard statistical methods of linear regression and correlation, step down multiple regression and best set analysis of variance were used for analysis of data(6). Assessment of the best suitable measurements useful in place of birth weight for identification of low birth weight infants was made by comparison of (*a*) coefficient of determination (R^2) and (*b*) sensitivity and specificity values.

Based on the simple regression model of birth weight, estimated values of CC, CHL and AC for given value of 2.5 kg were estimated. Sensitivity and specificity rates of each measurement were compared and tested for differences by normal curve test. Using stepwise discriminant function analysis, relative position of all measurements for differentiation of low birth weight from normal weight babies was assessed.

Results

Correlation matrix of all measurements including birth weight is given in *Table I*. Order of correlations of birth weight was calf circumference (0.83) followed by AC (0.81), CHC (0.80) and CHL (0.72).

As indicated by R^2, calf circumference showed highest contribution to the total variance (69.7%) observed in birth weight. Addition of crown heel length and arm circumference improved the R^2 to 78.9 and 82.1%, respectively (*Table II*). Other parameters did not improve the R^2 any further. Thus combination of calf with arm circumference and crown heel length could serve as useful parameters in place of birth weight. Step down discriminate function analysis of the various measurements to differentiate low birth weight from the normal neonates also established the superiority of calf circumference over and above all the other measurements (misclassification

TABLE I—*Correlation Matrix of Anthropometric Measurements*

Parameters	Crown heel length	Crown rump length	Head circumference	Chest circumference	Arm circumference	Calf circumference
Birth weight (kg)	0.72	0.53	0.68	0.80	0.81	0.83
Crown heel length		0.55	0.63	0.62	0.53	0.56
Crown rump length			0.44	0.45	0.46	0.42
Head circumference				0.53	0.57	0.60
Chest circumference					0.76	0.77
Arm circumference						0.81

All correlations are significant ($p < 0.001$).
All measurements in cm.

TABLE II—*Step Down Multiple Regression Models of Birth Weight with Anthropometric Measurements: Length, Calf and Arm Circumference*

	Constant	Calf circumference	Crown heel length	Arm circumference	R^2 (%)	R	df	'F' ratio
1.	-3.5833	+0.1961 (8.4)	+0.0580 (10.1)	+0.1554 (6.7)	82.1	0.906	3.252	383.93
2.	-3.5670	+0.3096 (18.1)	+0.064 (10.4)		78.9	0.888	2.253	471.69
3.	-1.4955	+0.4094 (24.2)			69.7	0.835	1.254	471.69

Note: Figures in parenthesis are 't' values of partial regression co-efficient ($p < 0.001$). All the 'F' values of the model are significant ($p < 0.001$); df = degrees of freedom.

probability 23.8%). Addition of other parameters especially CHL and chest circumference reduced the misclassification. However, analysis of data to derive the cut off values of CC, AC and CHL to predict birth weight indicated that for a birth weight of 2.5 kg critical limit of calf circumference was 10 cm (9.89 to 10.01, 95% confidence limit). Similar cut-off points were derived for CHL and AC.

Using these critical limits, sensitivity and specificity rates for each of the measurements were obtained and tested for differences between measurements. The sensitivity for calf circumference was 95.7% and for AC and CHL 82.6 and 72.5%, respectively (*Table III*). Specificity was almost similar with all measurements for newborns with birth weight above 2.5 kg. Variations in the measurements between investigators were lower for CHL and calf ($p < 0.05$) and higher for circumferences of arm, head and chest ($p < 0.05$).

Discussion

There is a constant search for simple and effective methods for identifying infants at risk in rural based society with poor literacy status and inadequate basic facilities for measuring birth weights. Most of the anthropometric measurements, though correlate well with birth weight are not sensitive enough to identify higher percentage of infants at risk(1,2). Since identification of low birth weight infants is the highest priority to provide effective minimal perinatal care in order to prevent perinatal deaths, a simple and sensitive parameter is the need of the day.

In the present study, various anthropometric measurements have been observed to correlate well with birth weight, similar to other studies(2,4). However, calf circumference which has not been used by many other workers except in the study of preschool children(5), has been used for the first time and seems to have the best correlation with the birth weight. With calf circumference of 10 cm used as cut off values, almost 96% of low birth weight infants with a fair degree of accuracy, it is logical that this may also be used to predict neonatal and perinatal mortality in the community by community health workers. Furthermore it is possible to train the traditional birth attendants to identify the risk group of infants by the use

TABLE III–*Sensitivity and Specificity Values of Circumference of Calf, Arm, Crown Heel Length*

S.No.	Measurement	Critical limit	Sensitivity	Specificity
1.	Calf circumference	≤ 10.0 cm	95.7[a]	79.7[A]
2.	Arm circumference	≤ 9.3 cm	82.6[b]	82.4[a]
3.	Crown heel length	≤ 47.7 cm	72.5[b]	82.9[a]
4.	Birth weight	≤ 2.5 kg	100.0[a]	100.0[b]

Note: Variation in superscripts indicate significance of difference between measurements ($p < 0.05$).

of simple tape marked with risk zones taking the cut off point of 10 cm. However, few earlier studies have identified thigh circumference as good indicator of LBW in the community. A comparison to evaluate the relative usefulness and validity of calf, thigh and arm circumferences in the identification of LBW infants will be the subject of a future communication.

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