COMPARATIVE EVALUATION OF CALF, THIGH AND ARM CIRCUMFERENCES IN DETECTING LOW BIRTH WEIGHT INFANTS – PART II

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ABSTRACT

In an earlier study usefulness and validity of calf circumference in the identification of low birth weight (LBW) infants was reported. To evolve a simple indicator in identifying LBW in community, comparative evaluation of three simple measurements, i.e., circumferences of calf (CC), thigh (TC) and arm (AC) was done with respect to their sensitivity and specificity. Though all the three measurements showed a high degree of correlation with the birth weight, calf circumference tended to be most sensitive in identifying almost 95% of LBW infants. Having established the superiority of CC, a two color tape demarcating LBW zone from normal birth weight using 10 cm CC as cut off point was tested by two independent investigators and two ANMs. It was observed that only 5% of cases were misclassified either as LBW or normal weight by the tape with hardly any inter individual variation. Measurement of calf circumference being simple and easy even in the hands of paramedics, it would be used as indicator of LBW and neonatal mortality in the community.

Key words: *Calf circumference, Thigh circumference, Arm circumference, Low birth weight, Simple indicator.*

An earlier study has established the usefulness and validity of calf circumference in identifying low birth weight (LBW) infant in a hospital set up in comparison to other anthropometric measurements(1). However, there are studies, where arm circumference has been used in predicting LBW and early neonatal mortality(2,3). Recent studies have also indicated the usefulness of thigh circumference as best predictor of LBW(4,5). A comparative evaluation of various indicators of low birth weight is important to select the simple and most sensitive parameter for application in the community. In this study, the three measurements calf, thigh and arm circumferences (CC, TC, AC) were carried out and compared for their sensitivity and specificity in identifying LBW. The validity of using a two color tape in identifying LBW infant was also evaluated.

Material and Methods

Measurements of CC, AC and TC were carried out in 255 singleton full term new born infants by standard techniques described earlier(6). Birth weight was taken within 24 hours on a beam balance with 5 gm accuracy. All measurements were recorded to the nearest 0.1 cm with a non-stretch fibre glass tape. The data was analysed using correlation and multiple linear regression analysis.

Results

The regression lines of birth weight

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with CC, TC and AC are shown in *Fig.* The highest degree of correlation (r = 0.772) (p <0.001) was seen between the birth weight and CC followed by TC (r = 0.754) and AC (r = 0.689). The CC also correlated well with the AC (r = 0.8541) and TC (r = 0.758).

Multiple linear regression analysis of birth weight with these parameters in order of importance indicated that CC was superior to arm followed by thigh circumference (*Table I*). Sixty six per cent of the variation in birth weight was explained by the combination of the three variables of which calf circumference alone contributed to 60% of the variation. Addition of thigh circumference increased the variation only upto 66%, whereas addition of AC contributed very little in the prediction of low birth weight.

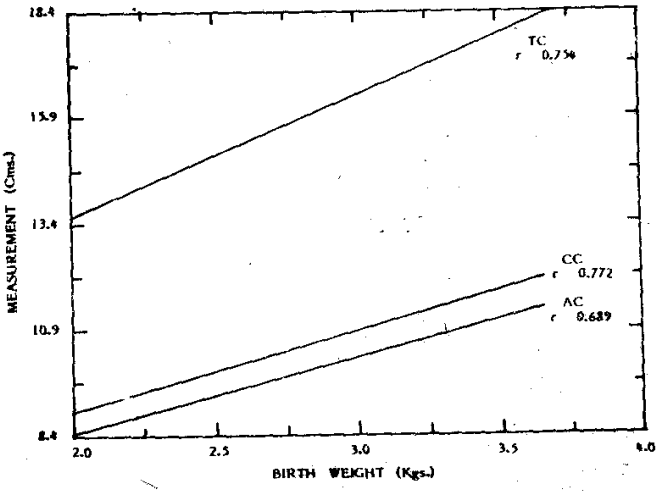

Fig. Regression lines depicting the relation between circumferences of calf (CC), arm (AC), thigh (TC) and birth weight.

Analysis of data to derive the cut off values of CC, AC and TC to predict low birth weight indicated that for birth weight of 2.5 kg and below, critical limit and 95% confidence limit for CC was 10 cm, for AC 9.3 cm and for TC 14.9 cm. Using these critical limits of each measurement, sensitivity and specificity analysis was done. This indicated that CC of ≤10 cm could predict 94% of low birth weight infants, whereas with thigh and arm circumference, the prediction was 76 and 71%, respectively (*Table II*). On the other hand specificity was of highest order with TC (93.6%) followed by CC and AC (around 85%).

Since superiority of CC over AC and TC was established beyond doubt by the two different studies, the evaluation of a

TABLE I—*Step Down Multiple Regression Model of Birth Weight with Circumferences of Calf, Thigh and Arm*

S.No.	Constant	Circumferences			R^2(%)	df	F
		Calf	Thigh	Arm			
1	–0.954	+0.182 (5.60)	+0.105 (6.91)	+0.016 (0.56)	66.3	3,251	164.44
2	–0.953	+0.195 (8.39)	+0.106 (7.06)		66.2	2,252	247.16
3	–0.586	+0.320 (19.30)			59.6	1,253	372.60

Note: Figures in parentheses are 't' values of partial regression coefficients (p<0.001). All the 'F' values of the model are significant (p<0.001). DF: Degrees of freedom.

two colored tape was carried out in identifying LBW infants. Accordingly, a two color (red/green) tape with a cut off point of 10 cm (red zone indicating LBW infants) was prepared and tested by two investigators and two ANMs by using both color identification and actual measurement of LBW in 70 new born infants. It was observed that the classification of LBW infants on the basis of color zones and actual birth weight was accurate in 95.5% of infants (*Table III*). Only one infant weighing 2.45 kg was misclassified as normal weight and one infant above 2.5 kg (2.6 kg) as LBW.

Discussion

The results of this study clearly establish the superiority of calf circumference as an indicator of low birth weight as compared to all other simple measurements. Though both AC and TC correlated well with birth weight, the sensitivity of these two measurements was far below that of CC and thus there was a possibility of missing 25-30% of LBW infants, whereas with CC only 5-6% of LBW infants could be missed. A highly sensitive parameter is essential in community studies to identify maximum number of LBW infants for appropriate and timely intervention. Though possibility of over estimation to the extent of 15-20% does exist with CC as was observed even in the earlier study, the high sensitivity makes it the most appropriate method which can be applied with greater ease in the community.

TABLE II—*Sensitivity and Specificity Values of Circumferences of Calf, Arm and Thigh*

Circumferences	Critical limit	Sensitivity (%)	Specificity (%)
Calf	≤10	94.0[a]	84.3[a]
Arm	<9.3	71.1[b]	85.5[a]
Thigh	<14.9	75.9[b]	93.6[b]

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

TABLE III—*Classification of Newborn with Weights in Relation to Color Zones of the Tape*

Birth weight	Red zone	Green zone	Total
1. ≤2.5	21 (95.5)	1 (4.5)*	22 (100)
2. >2.5	1 (2.1)*	47 (97.9)	48 (100)

* Misclassification.
Figures in parentheses indicate percentage.

The use of color zone by two independent investigators (both paramedics) have clearly shown that chances of misclassification is minimal (only 5%) in both over or under estimation. This makes it possible to utilize the color tape in the community even by CHWs and TBAs for identifying LBW infants especially in places where balances are not available, similar to the use of bangles in the identification of malnutrition(7).

Also, its usefulness even when used by paramedics has been established beyond doubt by the validity of two color tape, thus having great possibilities in field situation. The calf being prominent and easily identifiable even by untrained TBA or CHW, with minimal training, it could form a simple, inexpensive and reliable method of identifying LBW infants in the community. Also, since validity of using AC and TC in identifying infant mortality has already been established, the same functional parameters can be applied with CC also. The studies are already underway in the rural

community to stress further its usefulness in field conditions.

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