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Birth-weight Status of Newborns and Its Relationship with Other Anthropometric Parameters in a Public Maternity Hospital in Dhaka, Bangladesh

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ABSTRACT

According to the World Health Organization, birth-weight of less than 2,500 g is considered low birth-weight since below this value birth-specific infant mortality begins to rise rapidly. In Bangladesh, the prevalence of low birth-weight is unacceptably high. To screen low-birth-weight babies, simple anthropometric parameters can be used in rural areas where 80-90% of deliveries take place. A sample of 316 newborn singleton babies were studied in a government maternity hospital in Dhaka city to examine the birth-weight status of newborns and to identity the relationship between birth-weight and other anthropometric parameters of newborns. The mean birth-weight was 2,889±468 g, and 15.18% were low-birth-weight (<2,500 g) babies. All key anthropometric parameters of the newborns significantly correlated with one another (p<0.001). The best cut-offs for detecting low-birth-weight and normal-weight babies were <10 cm (odds ratio=17.4), <30.5 cm (odds ratio=25.0) and <33 cm (odds ratio=19.4), respectively, for mid-upper arm circumference (MUAC), chest circumference, and head circumference. The sensitivity and specificity were best for chest circumference (83.3% and 83.6% respectively). At lower cut-off points of <9 cm, <29.5 cm, and <32 cm, respectively, for MUAC, chest circumference, and head circumference, high-risk babies could be identified with a minimum number of false-positive cases. Chest circumference was the best detector of birth-weight with a correlation-coefficient of just above 0.84, followed by MUAC with a correlation-coefficient of just below 0.84. Based on the findings of the study, it is recommended to use <29.5 and 29.5 to <30.5 cm for chest circumference to identify 'high-risk' and 'at high-risk' newborns respectively.

Key words: Infant, Low birth-weight; Birth-weight; Anthropometry; Bangladesh

INTRODUCTION

In recent years, there has been a considerable interest in using simple anthropometric measures as a proxy for birth-weight. As in most developing countries, a large number of deliveries take place outside health facilities. Screening for low-birth-weight babies is, thus, difficult and warrants proxy indicators which can be used for low birth-weight and for preventing infant mortality. An early identification and immediate direct interventions, such

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as extra nutrition, can result in low-birth-weight infants catching up with their heavier contemporaries (1).

In Bangladesh, most deliveries take place at home and are mostly attended by relatives or traditional birth attendants. These people are not aware of the importance of weight-recording at birth. Even the trained traditional birth attendants (dais) have no weighing scale in their delivery-kits. Also in most health complexes, babies are not weighed routinely due to paucity of a suitable weighing scale at the centre. To overcome this problem, a number of alternative anthropometric measurements have been proposed as surrogate for birth-weight (1-3). These include the circumferences of the newborn's head, chest, and mid-arm, and crown-heel length.

This study was conducted to find appropriate proxy indices for low birth-weight which can be used in Bangladesh, particularly in rural areas. The present study aimed at relating birth-weight and other anthropometric measures of newborns, such as mid-upper arm circumference (MUAC), chest circumference, head circumference, and crown-heel length. There is a high correlation between birth-weight and other anthropometric parameters, such as MUAC, chest circumference, head circumference, crown-heel length, and abdominal girth of newborns (1-6). In absence of facility-based delivery care in Bangladesh, a proxy indicator that can be used in a field situation can contribute to substantial reduction in infant mortality.

MATERIALS AND METHODS

The study was conducted at the Maternal and Child Health Training Institute in Dhaka, Bangladesh. Live babies who were born during January-May 1999 comprised the study population (n=1,028). Of them, 316 singleton newborns were examined within 12 hours of birth. The study included both term and pre-term babies. A systematic random-sampling technique was adopted to recruit the study subjects. The first one was selected daily by lottery, and then every third baby was considered. On an average, 2-3 newborns were selected daily.

Gestational age was calculated as total duration of pregnancy in weeks from the first date of the last menstrual period (LMP) to birth of the baby. Due to availability of specialists in the Institute, it was possible to calculate the gestational age as proximate as possible. Gestational ages of these infants ranged from 31 to 44 weeks.

To ensure reliability, the principal investigator (B. Dhar) recorded anthropometric parameters of the newborns using standard techniques as described by DB Jelliffe (7). Babies were weighed naked on spring type of weighing scale to the nearest of 50 g. The weighing machine was checked daily by known standard weight before weighing them. MUAC was measured at the mid-point between the tip of acromion process and olecranon process in the left upper arm with a fibre-glass measuring tape to the nearest of 0.1 cm. Head circumference was also measured with the help of a fibre-glass measuring tape to the nearest of 0.1 cm. Maximum occipitofrontal circumference of head was recorded. Crown-heel length was recorded to the nearest of 0.1 cm on an infantometer with the baby supine, knees fully extended, and soles of feet held firmly against the foot board and head touching the fixed board. Chest circumference was measured at the level of nipple by a fibre-glass measuring tape to the nearest of 0.1 cm at the end phase of expiration.

Data were analyzed using standard statistical methods, which include correlation-coefficient, analysis of variance, simple and multiple regressions, and sensitivity and specificity analyses for different cut-offs of the newborns (MUAC, chest circumference, and head circumference).

RESULTS

Table 1 shows the mean anthropometric values of the newborns. The mean birth-weight was 2,889±468 g. All the mean anthropometric values (except MUAC which was equal) for the male newborns were a bit higher (significant differences were found for birth-weight, head circumference, and crown-heel length) than those for the

Table 1. Anthropometric characteristics of newborns by sex

Anthropometry	Mean (male)	SD	Mean (female)	SD	Mean (both sexes)	SD
Birth-weight (g)	2,951	471	2,813	454	2,889	468
Chest circumference (cm)	31.9	2.2	31.5	2	31.7	2.1
Head circumference (cm)	33.8	1.7	33	1.3	33.5	1.6
Mid-upper arm circumference (cm)	10.4	1	10.4	1	10.4	1
Crown-heel length (cm)	48.2	2.4	47.5	2.5	47.9	2.4

SD=Standard deviation

female babies. The total number of low-birth-weight babies was 48 (15.18%). Distribution of birth-weight using a 500-g category is shown in the Figure.

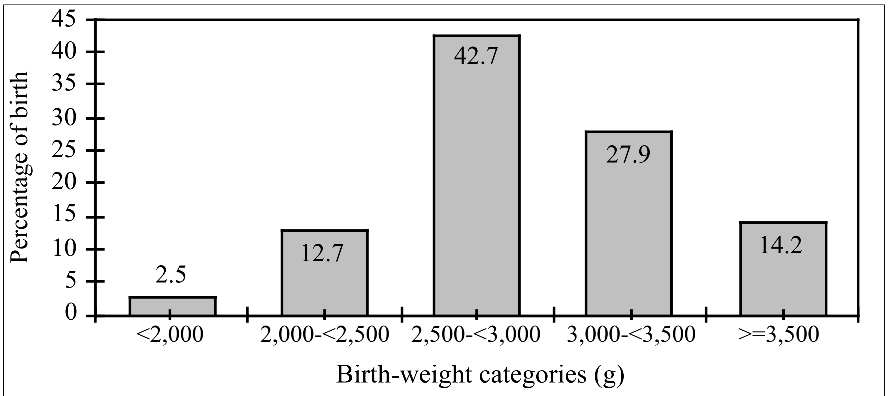

Fig. Distribution of birth-weight by category

Matrix of zero-order correlation-coefficients between birth-weight and other anthropometric parameters of the newborns at birth showed that all parameters significantly correlated with one another (Table 2). The correlation was the highest with chest circumference (0.841) and the lowest with head circumference (0.718). Table 3 presents the mean birth-weight of newborns in relation to different categorized values of MUAC, chest circumference, head circumference, and crown-heel length. The mean birth-weight significantly increased with increasing

Table 2. Matrix of zero-order correlation-coefficients between birth-weight and other anthropometric parameters of newborns

Anthropometry	Birth-weight	Mid-upper arm circumference	Chest circumference	Head circumference	Crown-heel length
Birth-weight (g)	1.0000	0.8365	0.8410	0.7180	0.7913
Mid-upper arm circumference (cm)		1.0000	0.7973	0.6005	0.6726
Chest circumference (cm)			1.0000	0.6753	0.7239
Head circumference (cm)				1.0000	0.6709
Crown-heel length					1.0000

p=0.001 for all variables

Table 3. Relationship between birth-weight and other anthropometric parameters of newborns

Variable	Mean	SD	F (p value)	Total no. of cases
Mid-upper arm circumference (cm)				
7-9.9	2,408	332	152.8	86
10-10.9	2,847	250	(.000)	107
11-11.9	3,145	307		86
12+	3,553	328		37
Chest circumference (cm)				
26-29.9	2,272	338	187.8	53
30-31.9	2,733	227	(.000)	108
32-33.9	3,071	261		103
34-38.0	3,481	346		52
Head circumference (cm)				
27.0-29.9	1,950	412	70.3	9
30.0-32.9	2,510	341	(.000)	79
33.0-35.9	3,029	361		210
36.0-37.0	3,387	453		18
Crown-heel length (cm)				
40.0-44.9	2,212	363	134.4	33
45.0-479	2,664	280	(.000)	108
48.0-50.9	3,066	317		141
51.0-52.9	3,529	317		34

SD=Standard deviation

Table 4. Mean values of neonatal anthropometric variables for low, inadequate and adequate birth-weight of newborns

Birth-weight (g)	Mid-upper arm circumference (cm)	Chest circumference (cm)	Head circumference (cm)	Crown-heel length (cm)
<2,500 (n=48)	9.2±0.9	29.0±1.6	31.5±1.6	44.9±2.4
2,500-<3,000 (n=135)	10.1±0.7	31.1±1.3	33.2±1.1	47.3±1.8
≥3,000 (n=133)	11.2±0.7	33.3±1.5	34.5±1.0	49.6±1.5
	F=153	F=185	F=120	F=140

p=0.000 for all variables

Table 5. Simple regression equations for estimating birth-weight

Anthropometry	Regression equations	F (p value)	Adjusted R^2
Mid-upper arm circumference (cm)	Y=-1008.47+373.98 MUAC	731.79 (.000)	69.97
Chest circumference (cm)	Y=-3048+187.24 CC	758.73 (.000)	70.73
Head circumference (cm)	Y=-4335.17+215.75 HC	334.17 (.000)	51.56
Crown-heel length (cm)	Y=-4416.48+152.47 CHL	525.83 (.000)	62.61

Y=Birth-weight

values of MUAC, chest circumference, head circumference, and crown-heel length. Table 4 depicts the significant differences in the mean values for neonatal anthropometric variables for low (<2,500 g), inadequate (2,500-<3,000 g), and adequate (≥3,000 g) birth-weight.

Simple regression equations for predicting birth-weights are presented in Table 5. Using these regression equations, the predicated birth-weights for a child with MUAC measuring 8.4, 10.2, and 12.2 cm were 2,132, 2,806, and 3,480 g against actual birth-weights of 2,000, 2,900, and 3,500 g respectively. Similarly, for chest circumference of those infants, predicted birth-weights were 2,101, 2,962, and 3,374 g against actual birth-weights of 2,000, 2,900, and 3,500 g respectively.

Sensitivity and specificity analyses were carried out with different cut-off points for MUAC, chest circumference, and head circumference of the newborns to identify low-birth-weight babies (Table 6). The aim of selecting cut-off points was to identify correctly all the low-birth-weight babies with a least number of false-positive cases.

DISCUSSION

The mean birth-weight of 2,889±468 g and the prevalence of low birth-weight as 15.18% among the newborns in the sample are to some extent in conformity with another recent study in Bangladesh which took samples from urban areas reported low birth-weight rate and mean birth-weight as 21% and 2,860 g respectively (8). The 1994 multi-centre study on low birth-weight

Table 6. Estimation of low birth-weight by mid-upper arm circumference, chest circumference, and head circumference of newborns

Anthropometry	Sensitivity (%)	Specificity (%)	Predictive positive value (%)	Predictive negative value (%)	Odds ratio	CI 95%
Mid-upper arm circumference (cm)						
<9	37.50	98.88	85.71	89.83	53.00	13.59-125.77
<10	79.17	82.09	44.19	95.65	17.42	7.70-40.33
<11	93.75	44.78	23.32	97.56	12.16	3.52-33.17
Chest circumference (cm)						
<29.5	60.42	94.03	64.44	92.99	24.04	10.47-57.08
<30.5	83.33	83.58	47.62	96.55	25.05	10.54-63.62
<31.5	93.75	64.93	32.37	85.00	27.77	8.00-67.09
Head circumference (cm)						
<32	50.00	97.01	75.00	91.55	32.50	12.22-89.23
<33	81.25	81.72	44.32	96.05	19.37	8.31-46.24
<34	89.58	54.10	25.90	96.67	10.14	3.70-30.10

CI=Confidence interval

and infant mortality reported the prevalences of low birth-weight as 28.1%, 14.4%, and 18.4% in India, Nepal, and Sri Lanka respectively. The mean birth-weight in the multi-centre study was 2,630 g, 2,780 g, and 2,840 g, respectively, for India, Nepal, and Sri Lanka (9). The findings of this study are comparable with the findings of these South Asian countries. The present study revealed that all anthropometric parameters of the newborns significantly correlated with one another.

For an early identification of low-birth-weight babies, we considered arm, chest and head circumferences as surrogates and found that all were significantly linked to birth-weight. Most studies used cut-off points of 28, 29, and 30 cm for chest circumference for a proxy indicator for birth-weights (2). A comparative analysis using these and cut-off values of 29.5 and 30.5 cm for this study is shown in Table 7. At a cut-off point of 30.5 cm for chest circumference, 12.7% of these babies were diagnosed as having low birth-weight with a sensitivity of 83.33%. However, at this cut-off point, the positive predictive value was low (47.62%), indicating a fair number of false-positive cases. Again, at a cut-off point of 29.5 cm, only 9% of the babies were diagnosed as having low birth-weight, but, this time, the predictive value was relatively high (64.44%) suggesting that the false-positive cases are low. Therefore, for any parameter (MUAC, chest circumference, and head circumference), it is wise to select two cut-off points. At a lower cut-off point, the 'high-risk' babies can be identified with a minimum number of false-positive cases, and at a higher cut-off point, the babies 'at-risk' can be identified at the cost of a fair number of false-positive cases. In this study, 9, 29.5, and 32 cm were chosen as lower cut-off points, and 10, 30.5, and 33 cm as higher cut-off points for mid-upper arm circumference, chest circumference, and head circumference respectively. More or less similar cut-off points were also selected in other studies. In Ethiopia, chest and head circumferences were used for identifying low-birth-weight pre-term infants, and the cut-off points with the best sensitivity and specificity were 30 cm for chest circumference and 31 cm for head circumference respectively (10).

Table 7. Sensitivity, specificity, positive and negative predictive values for predicting low birth-weights using different cut-off points for chest circumference

Cut-off for chest circumference (cm)	Sensitivity	Specificity	Positive predictive value	Negative predictive value
28	27.08	100	100	88.4
29	41.67	97.76	76.92	90.34
29.5	60.42	94.03	64.44	92.98
30	68.75	92.54	62.26	94.29
30.5	83.33	83.58	47.62	96.55
31	87.50	77.61	41.18	97.20

Results of studies in India also showed a chest circumference of ≤30 cm, and MUAC of ≤8.7 cm to have the best sensitivity and specificity for identifying low-birth-weight infants (3,11). In a Brazilian study, head circumference of 33 cm and chest circumference of 31 cm had been identified as cut-off points for identifying low-birth-weight pre-term babies (12). In Egypt, two cut-off points of 29 to <30 and <29 cm were selected for chest circumference to identify 'at-risk' and 'high-risk' infants respectively (1).

It is estimated that, in Bangladesh, about 80-90% of deliveries take place either at home or in the community till today. The results of the present study showed that chest, mid-upper arm and head circumferences can be used for identifying low-birth-weight babies at the community level, where weighing scales are not easily available. Since low birth-weight is highly predictive of neonatal mortality, and chest, mid-upper arm and head circumferences can identify infants with low birth-weight with a fair degree of accuracy, it would be logical to assume that these substitute measurements would be useful in predicting neonatal outcome. Furthermore, in the community, where taboos exist regarding weighing of newborns, these measurements can be used without any obstruction from the community to identify low-birth-weight babies.

Here, we would like to raise one issue that whether we will choose all the parameters for identifying low-birth-weight babies or choose only one single parameter. The findings of the present study revealed that, of three parameters, chest circumference is the best one to identify low-birth-weight infants. There was highest correlation between chest circumference and birth-weight. Multiple regression equation also showed that chest circumference alone explained the variation of birth-weight by 71%, and the use also of mid-upper arm circumference and head circumference did not significantly improve the prediction of birth-weight. Moreover, its (chest circumference) measurement is more replicable than that of MUAC. In most cases, measurement of head circumference at birth could not be accurate due to moulding of head, particularly in cases of prolonged and obstructed labour.

Trained birth attendants and health and family-planning workers residing at the community can easily be provided with a measuring tape. Since it is a simple tool to measure babies and also to detect low-birth-weight babies, grassroots-level health and family-planning workers and trained birth attendants can play a significant role in identifying low-birth-weight babies and in giving proper advice to mothers and other caretakers. Even at the Upazila Health Complexes and District Hospitals, physicians can also identify 'at-risk' babies by measuring different circumferences, particularly chest circumference.

In conclusion, we recommend the use of chest circumference rather than arm or head circumferences as a surrogate for birth-weight. We also propose to select two cut-off points of <29.5 and 29.5-<30.5 cm for chest circumference for identifying 'high-risk' and 'at-risk' newborns respectively.

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