Original Research Article

Usefulness of anthropometric measurements to identify low birth weight babies

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Abstract

Background: India alone accounts for 40 per cent of LBW births in the developing world. More than half (58 percent) of births are not weighed. According to NFHS-3 survey (2005-2006) only 34% of births were weighed at birth and 22% of them were of LBW (<2.5kgs). **Objective:** To compare the sensitivity and specificity of various anthropometric indicators and to determine the relationship between birth weight and the anthropometric indicators to find out the most precious indicator in detection of LBW babies. **Methods:** The study was carried out on 500 newborns delivered in Silchar medical college hospital, over a period of one year, from July 2015 to June2016. Birth weight was recorded within 24 hours of birth. All anthropometric measurements were carried out within 48 hours of birth. The collected data was analyzed by using ROC curve for calculating sensitivity and specificity. To establish the co-relation between birth weight and anthropometric measurements karl pearson correlation co-efficient was used. **Results:** The critical cut-off values for a birth weight of 2.5 kg were 30.6cm, 8.8cm, 14 cm and 9.3 cm for chest circumference, mid-arm circumference, thigh circumference and calf circumference and the sensitivity & specificity were 90.40% & 90.71%, 89.93% & 96.28%, 85.31% & 95.36% and 85.88% & 90.09% respectively. Mid-arm circumference had highest value of correlation co-efficient (0.972) in relation to birth weight. **Conclusion:** Mid-arm circumference of ≤8.8 cm at birth is a simple, reliable, cost effective and culturally acceptable method for screening the at risk neonate <2500 gm

Keywords: Anthropometry, Low birth weight (LBW), National family healthy survey-3 (NFHS-3), Receiver Operating Characteristic curve (ROC)

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Introduction

Babies with a birth weight of less than 2,500gm irrespective of the period of their gestation are classified as low birth weight babies. These include both preterm and term small-for-date babies [1]. A baby's low weight at birth is either the result of preterm birth (before 37 weeks of gestation) or due to restricted fetal (intrauterine) growth. Low birth weight is closely associated with fetal and neonatal mortality and morbidity, inhibited growth and cognitive development, and childhood onset adult chronic diseases later in life.

Many factors affect the duration of gestation and foetal growth, and thus, the birth weight. They relate to the infant, the mother, or the physical environment and play an important role in determining the birth weight and

the future health of the infant [2]. Globally, more than 20 million infants are born with low birth weight, of which nearly 8 million in India. 94% of these low birth weight babies are born in developing countries. India alone accounts for 40 per cent of low birth weight births in the developing world [2]. Birth weight is the single most important marker of adverse perinatal and neonatal outcome. Over 80% of all neonatal deaths and 50% of all infant deaths, in both developed and developing countries, occur among the LBW babies [1].

Immediate special problems of these low birth weight babies are hypoglycemia, hypocalcemia, poor thermo-regulatory response because of less brown fat.

The major causes of mortality in these babies are hypothermia, infection, pulmonary hemorrhage and biochemical disorders [1].

Low birth weight is a major determinant of malnutrition during infancy because over 40% of low birth weight babies are malnourished at one year of age. It is estimated that in a developing country, LBW infants have 2.3 times increased risk of mortality due to infections compared to normal birth weight babies after controlling for all the confounding variables [1].

The neuro-developmental sequelae of birth asphyxia are three times in low birth weight babies compared to their normal weight counterparts. Small-for-date babies may remain stunted throughout life leading to impaired physical work capacity. They are more vulnerable to develop atherosclerotic coronary artery disease, hypertension and diabetes mellitus during adult life [1].

According to NFHS-3 survey (2005-2006) only 34% of births were weighed at birth and 22% of them were of low birth weight (<2.5kgs) [3].

The large proportion of infants not weighed at birth constitutes a significant impediment to reliable monitoring of low birth weight. In the developing world, more than half (58 percent) of births are not weighed. In the developing world, 58 percent of babies are born with a skilled attendant at delivery, of which only 42 percent are weighed. These data indicate that not all babies born with the assistance of skilled health personnel are weighed or have their weight recorded [2].

In the developing countries including India recording of birth weight has always been problem. Majority of deliveries in our country is conducted at home by traditional birth attendants or relatives.

Therefore, the newborn remain un-weighed at birth due to lack of weighing scale, hence it is essential and important to look for an alternative method to identity the low birth weight babies at birth in village setup [4].

Since majority of deliveries are conducted at home it is imperative to develop methodologies and tools, which are simple and sensitive for use at community level, to screen low birth weight babies for their appropriate management.

To achieve, this studies have been conducted to correlate the various anthropometric measurements of newborn via, mid-arm circumference, thigh circum-ference, chest circumference, calf circumference with birth weight, which have different sensitivity and specificity.

Material and Methods

Setting: The present study was conducted in Silchar Medical College and Hospital situated in Silchar, cachar district in Assam, India.

Type of study: Hospital based cross sectional study.
Duration of study: The study was conducted from July 2015 to July 2016.

Sample size calculation: The sample size for this study was determined by using the cochrans formula n $=Z^2 *p(1-p)/c^2$. 500 live born, full term singleton normal babies delivered at Silchar Medical College & Hospital were included in this study.

Inclusion criteria: All the live born term singleton normal neonates with gestational age of 37 weeks to 41weeks and 6 days were included and anthropometric measurement were taken within 48 hrs of birth.

Exclusion criteria: Preterm babies less than 37 weeks of gestation, babies with congenital anomalies and twin pregnancies were excluded from the study.

Method of collection of data: All anthropometric measurements were carried out within 48 hours of birth by the investigator to avoid any interpersonal measurement error. All anthropometric measurement were taken with the newborn to the nearest 0.1 cm using a non-elastic, flexible, measuring tape according standard techniques. Birth weight was recorded within 24 hours of birth. Information of the study population was obtained by history, thorough clinical examination and anthro-pometric measurements was taken by a pediatric resident. The following anthropometric measurements were recorded in the study group: Weight, Chest circumference, Mid-arm circumference, Thigh circumference and Calf circumference.

Newborn was weighed nude on an electronic type weighing scale to the nearest 10 gm. Chest circumference was measured at the level of nipple. The measurement was taken during quiet respiration with tape applied in such a manner as to permit contact without compression of underlying tissue. Mid arm circumference was taken mid way between tip of acromion process of scapula and olecranon process of ulna in left upper limb. Thigh circumference was recorded using the left thigh at the level of lowest fold in gluteal region. Most prominent point in semi flexed position of the left leg was measured for calf circumference.

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Data analysis: The collected data was analyzed by using Receiver operating characteristic curve (ROC) for calculating sensitivity and specificity of each anthropometric measurement.

The SPSS 16.0 software and XLSTAT 2016 were used to find out the cut-off values with the highest sensitivity and specificity for birth weight <2500 gm. The sensitivity and specificity value so achieved were used to find out the positive predictive value and negative predictive value of each anthropometric parameter for above birth weights.

To establish the co-relation between birth weight and anthropometric measurements karl pearson correlation co-efficient was used. Informed consent was taken from the parents of the study population. Ethical clearance was taken from ethical committee of college.

Results

Out of 500 newborn babies, 323 babies had normal birth weight and 177 babies were low birth weight. The frequency of occurrence of low birth weight babies was 35.4%. Male to female ratio was 1.25:1 and there was a male predominance.

Table-1: Socio-Demographic profile and prevalence of low birth weight in study population.

| Variables	Number of cases	Percentage (%)	Number of LBW babies	Percentage (%)
Sex				
Male	278	55.6	88	31.56
Female	222	44.4	89	40.09
Religion				
Hindu	267	53.4	98	36.7
Muslim	231	46.2	78	33.8
Christian	2	0.4	1	50
Birth order				
1	193	43	71	36.7
2	186	30	53	28.4
3	105	23	45	42.8
4 or more	16	4	8	50
Maternal age				
≤19 yrs	59	12	40	67.7
20-34 yrs	416	83	123	29.5
≥35 yrs	25	5	14	56
Maternal weight				
<50 kg	151	31	64	37.3
≥50 kg	349	69	113	35.1
Maternal height				
<145 cm	67	13	25	37.3
≥145 cm	433	87	152	35.1
Socio-economic status (modified kuppusamy scale)				
Upper	0	0	0	0
Upper middle	18	3.6	5	27.7
Lower middle	225	45	78	34.6
Upper lower	254	50.8	91	35.8
Lower	3	0.6	3	100
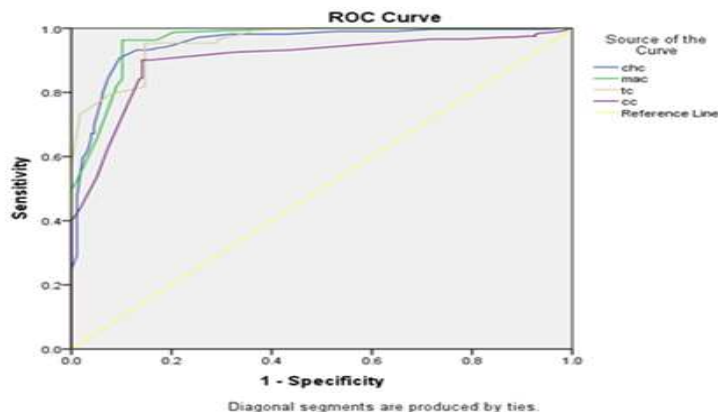
Figure-1: ROC curve for <2500 gm and ≥2500 gm

In figure-1 The mid-arm circumference shows the maximum area under the curve (0.961), hence has the maximum sensitivity and specificity in identifying <2500 gm babies. The area under the curve for other anthropometric measurements in descending order: thigh circumference (0.958), chest circumference (0.952) and calf circumference (0.900).
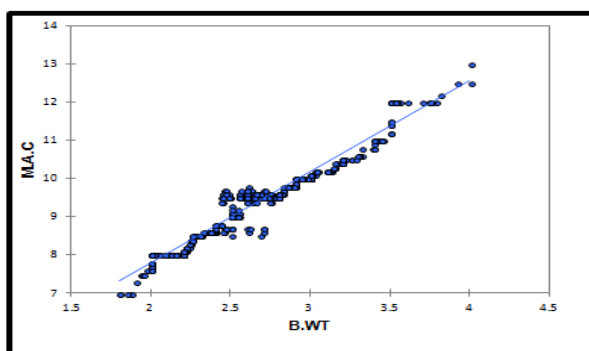

Figure-2: Scatter Diagram Showing Correlation between Birth Weight and Mid-Arm Circumference.

From the figure-2 Scatter diagram, it was clearly made out that mid-arm circumference at birth correlated positively with birth weight.

Table-2 Cut-off value with sensitivity and specificity for each anthropometric indicators predicting <2500 gm birth weight babies.

Anthropometric indicators	Cut-off limit(cm)	Sensitivity (%)	Specificity (%)	Positive predicitive value (%)	Negative predicitive value (%)	P value
Mid-arm circumference	8.8	89.93	96.28	92.98	94.53	<0.01
Thigh circumference	14	85.31	95.36	90.96	92.22	<0.01
Chest circumference	30.6	90.40	90.71	84.21	94.52	<0.01
Calf circumference	9.3	85.88	90.09	82.61	92.09	<0.01

Table-2 details mid-arm circumference of ≤8.8 cm had higher specificity (96.28%), chest circumference of ≤30.6 cm had higher sensitivity in the detection of birth weight <2500 gm than other anthropometric measurements

Table-3: Comparison of correlation coefficients of individual anthropometric measurements with respect to birth weight:

Anthropometric measurements	Correlation co-efficient	p-value
Chest circumference	0.810	<0.001
Mid-arm circumference	0.972	<0.001
Thigh circumference	0.955	<0.001
Calf circumference	0.780	<0.001

From table-3 it can be made out mid-arm circumference had maximum correlation coefficient of 0.972 compared to any other anthropometric measurements to identify any low birth weight babies.

Discussion

Low birth weight accounts for nearly 25% to 35% of birth in India. Low birth weight accounts for 80% of neonatal death and 50% of infant deaths. Since identification of low birth weight babies in the community is the highest priority to provide effective minimal perinatal care to decrease mortality, there is constant search for a simple and inexpensive method for screening such newborns. A number of studies have been done in this regard by comparing various anthropometric indicators with birth weight. The present study is an attempt to know the feasibility of anthropometric indicators for identification of low birth weight babies at birth.

The birth weight of the baby, apart from the nutritional status of the mother, maternal health and antenatal care also genetically determined. Hence standards of birth weight would be different for the different population which explains the regional differences in the incidence of low birth weight.

In light of above facts the present study was designed to establish cut-off values of various anthropometric measurements for detection of birth weight <2500 gm at community level and attempt is being made to find such substitute for birth weight and to establish a cut-off value for the detection of Birth weight of <2500 gm. In the present study, a significant correlation of various anthropometric measurements was observed with birth weight. According to table-3 Mid-arm circumference (0.972) has best correlation followed by Thigh circumference (0.955), Chest circumference (0.810) and Calf circumference (0.780) to assess low birth weight babies. The cut-off value of ≤8.8 cm for mid-arm circumference had maximum sensitivity (89.95%) and specificity (96.28%) for birth weight <2500 gm. In a study by Biswas AB et al, 400 full term newborns were assessed of which 40% were <2500 gm. It found that Correlation of birth weight was highest with mid-arm circumference, followed by calf circumference and thigh circumference, the cut-off values were 9.6 cm, 10.1 cm and 15.6 cm for mid-arm, calf and thigh circumference respectively for a birth weight of <2500 gm [4]. In a study by Sharma et al, birth weight was compared with mid-arm, chest, head circumference, length and abdominal girth, in 1000 newborn infants. Of which 244 were LBW infants and correlation had maximum for mid-arm circumferences. Mid-arm circumferences of <8.6 cm, <7.4 cm, and <6.1 cm had the best sensitivity and specificity for identifying babies with weight of <2500 gm, <2000 gm and <1500 gm respectively.

It was concluded that birth weight and mid-arm circumference (<8.6 cm) were equally useful in predicting early neonatal morbidity [5]. A study conducted by Huque F and hussain Z, on 217 term newborns by comparing birth weight with chest, thigh and mid-arm circumference. It was concluded that the sensitivity, specificity and predictive value for detecting new born with birth weight <2000 gm with mid-arm circumference was more reliable because of its more accuracy, specificity and predictive value [6].

In a study by Bhargava SK et al, two groups of infants were analyzed. A study of 520 term live births in hospital revealed a strong correlation between birth weight and anthropometric variables but the correlation had maximum for chest circumference and mid-arm circumferences. A mid-arm circumference of <8.7 cm and chest circumference of <30 cm had the best sensitivity and specificity for identifying LBW neonates. In another group 501 consecutive term live birth in the community was assessed and only mid-arm circumference was measured as complete undressing was not permitted because of social customs, beliefs and taboos. Mid-arm circumference had a strong correlation with birth weight [7].

In a study conducted by Gozal D et al, 490 neonates were studied and a mid-arm circumference of <9.5 cm was most sensitive in prediction of LBW babies and was also the best of all variables in prediction of early neonatal morbidity [8].

A study in Egypt by Hossian MM et al, on 148 neonates were reported that mid-arm circumference of <9.5 cm had a strong and highly significant positive linear correlation with birth weight [9].

A study conducted by Chandan. R Barman on 197 neonates by tricoloured mid-arm circumference (MAC) measuring tape with a borderline yellow-zone between 7.5 cm and 8.5 cm and two peripheral zones, red and green beyond 7.5 cm and 8.5 cm respectively.

The sensitivity and specificity of MAC critical limit of 8.5 cm identifying neonate below 2000 g were 93.7% and 98.2% respectively. And this simple MAC measuring tape can be used by field worker for easy assessment of low birth weight neonates [10]

All the above studies showed that mid-arm circumference is a better indicator to identify low birth weight babies. Advantages of measuring mid-arm circumference are: Easy for health workers to measure in field conditions, Need minimal handling of the baby and can be measured with the baby on the bed. No need to undress the baby completely.

These values which were found were from one hospital and one geographical location. So, generalizability to whole of the population will be an issue. In spite of these limitations, mid arm circumference ia an easy and feasible method to screen babies born in remote areas.

Conclusion

Since identification of low birth weight babies in rural community is of highest priority to provide effective minimal perinatal care to decrease mortality, there is a constant search for a simple and inexpensive method of screening, such newborns.

In the present study, an attempt was made to validate the feasibility of using anthropometric indicators as a predictor of low birth weight babies that can be used by a trained or untrained person.

In the present study it was concluded that all anthropometric measurements had positive correlation with birth weight with statistical significance. Mid-arm

circumference of ≤8.8 cm at birth is a simple, reliable, cost effective and culturally acceptable method for screening the at risk neonate <2500 gm in community by health workers and referral of them to the appropriate health care facility, where birth weights are not measured by standardized weighing scales. Further research will ensure that the application of these measures is reliable in community settings.

What this study adds to the existing knowledge?

This study stresses anthropometric indicator, Mid-arm circumference of ≤8.8 cm is a good predictor of low birth weight babies in a rural community.

Author's contribution

Dr. Hariharan S: Handled the concept, design, literature search, data acquisition, data analysis, statistical analysis, manuscript preparation, editing and review.

Dr. Anupama Deka: Handling of concept, design, manuscript editing, review and guarantor.

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