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Evaluation of Mid-Arm Circumference in Estimating Low Birth-Weight

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Abstract :
Background: *Low birth weight is a sensitive index of a nation's health and development. In developing countries, such babies are at risk of increased morbidity and mortality due to diverse causes. It is therefore essential to identify low birth-weight babies early so that appropriate measures can be taken to minimize the risk to them. At times appropriate weight measuring tools may not be readily available to weigh newborn babies. In the absence or unavailability of appropriate weighing scales, simple surrogate measuring tools like mid-arm circumference may have considerable importance for easy and rapid identification of low birth weight babies.*
Objectives *: To determine the mid-arm circumference of newborn babies and to find an optimal cut off of mid-arm circumference for determining the low birth in newborn babies.*
Methods: *Study population consisted of 324 newborn babies admitted to the Pediatric Ward of RIMS Hospital. Birth weight and mid-arm circumference of the enrolled babies were measured within 48 hours of life using standard methods. Data were analyzed using Independent samples t-test and Chi-square test in SPSS version 21. Receiver Operating Curve (ROC) analysis was performed to find out the cut-off value of mid-arm circumference for neonates with birth weight < 2500 gm.*
Results: *Of the 324 studied neonates 165 (50.9%) were males and 159(49.1%) were females (M:F = 1.03:1). Mean birth weight was 2.681±0.569 kg (range 1.6 – 4.2 kg); number of low birth neonates was 116(30.6%) with 60(18.5%) male and 56(17.3%)female babies. The mean mid-arm circumference of the study population was 9.6±1.0 cm (range 7 - 12.4 cm). There was significant association of mid-arm circumference in relation to birth weight with a Pearson product moment coefficient of 0.982 [p=<0.001(2-tailed)]. The optimal cut-off of mid-arm circumference for identifying neonates with a birth weight of <2500 gm with ROC curve analysis was 9.45 cm(sensitivity -97.4%;specificity- 96.6%;PPV-94.2%NPV-98.5%;p= <0.001). A linear regression analysis to predict low birth weight babies from mid-arm circumference resulted in the linear equation model – birth weight = -2.489 + (0.536 x newborn mid-arm circumference value).*
Conclusion*: Mid-arm circumference is a simple, quick and reliable indicator for predicting low-birth weight babies which can be used by healthcare personnel when recording birth weight is not feasible.*
Keywords: *Mid-arm circumference, low birth weight, neonates.*

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I. Inroduction

Birth weight is the most sensitive and reliable indicator of the healthcare in a community. Globally, it is estimated that 15 percent of infants, or more than 1 in 7, weigh less than 2,500 grams at birth. India has the highest incidence of low birth-weight (LBW) with nearly 8 million low birth-weight babies annually.[1] LBW is generally associated with increased morbidity and mortality, impaired immune function and poor cognitive development for neonates and infants. They account for 60 - 80% of neonatal death thus necessitating early identification and prompt referral of LBW newborns which is vital in preventing neonatal deaths.[2] Many LBW babies remain undetected because they are either born at home or due to logistical problems like non-availability of weighing scales, they are not weighed and are therefore deprived of the much needed care. More than half of newborns globally are not weighed; in South Asia, which has the highest incidence of low birth-weight babies, two out of three newborns are not weighed.[3] A study based on the National Family Health Survey (NFHS-2) showed that 70.1 percent of babies were not weighed within two days of birth, and of those weighed, 22.6

percent babies were below 2500 grams at the time of birth in India in 1999. In Manipur, India, percentage of babies not weighed at birth was 69.4.[4]

There are efforts to improve survival of newborns through home visits by community health workers (CHWs) who are trained to identify and provide care for at risk newborns.[3] To aid them, there is a need to develop simple inexpensive and practical methods for identifying LBW newborns soon after birth. One such method may be the use of anthropometric surrogates to identify LBW babies.[6] So a proxy indicator, in absence of facility based delivery care in India, which can be used in a field situation is needed. Mid-arm circumference (MAC) might be an alternative anthropometric measurement useful to estimate the state of nutrition.[7] A multi-center study carried out by the World Health Organization (WHO) reported that validity of mid-arm circumference (MAC) and chest circumference (CHC) and cut-off points for identifying LBW babies varied across the nations and ethnic groups.[8] Therefore, this study was undertaken in an attempt to find out the optimal cut off of mid-arm circumference for determining the low birth-weight in newborn babies in our region where there is a high number of babies who are not weighed at birth.

II. Materials & Methods

This hospital based prospective cross sectional study was carried out in Pediatrics ward of Regional Institute of Medical Sciences (RIMS) Hospital, Imphal, Manipur, between September 2013 to September 2015. Inclusion criteria consisted of babies admitted within 48 hours (both born in- and out-side RIMS Hospital). Those newborn babies who weighed less than 1500 grams, admitted after 48 hours, with congenital anomalies or birth injury of upper arms, with severe cardiorespiratory compromise and whose parents refuse consent to participate in the study were excluded from the study population. Ethical approval was taken from the institutional ethics committee before the commencement of the study. Birth-weight of all the newborns was measured with the baby naked, in dorsal decubitus position using spring dial weighing machine (to the nearest of 100 grams) within 48 hours of life. Newborns weighing less than 2500 grams were labeled as low birth-weight. Mid-arm circumference was measured in the left arm between the midpoint of tip of acromion process of scapula and olecranon process of ulna, with the newborn lying in dorsal decubitus position with arm lying laterally to the trunk using a flexible, non-stretchable fibre glass measuring tape to the nearest of 0.1 cm within 48 hours of life. Data thus collected were analyzed using standard statistical methods which include Independent sample student t test, Chi square test with Pearson's correlation coefficient, Receiver Operating Characteristic Curve (ROC) analysis and Linear regression. Results were considered as significant if P value is < 0.05.

III. Results And Observation

324 newborn fulfilled the inclusion criteria and majority were males (50.9%). The male to female ratio observed in the study population was 1.03:1. 208 (64.2%) babies had normal birth weight and 116 (35.8%) were low birth weight. 233 (71.9%) were term and 91 (28.1%) were pre-mature babies. The mean birth-weight of the study population was 2.681 ± 0.569 kg**.** The mean birth weight for a male baby was 2.705 ±0.58 kg and for a female baby – 2.656±0.55 kg. The minimum and maximum mid-arm circumference observed among study population was 7 and 12.4 cm (Table 1). The mean mid-arm circumference of the study population was 9.6±1.0 cm with 9.6±1.0 and 9.6±0.9 for a female baby. Among the low birth weight babies the mean mid-arm circumference observed was 8.5±0.7 cm, and in normal birth weight babies it was 10.2±0.6 cm; there was significant difference between the two with a mean difference of 1.6 cm (p=<0.001). Significant differences in mean mid-arm circumference was also observed between term and preterm babies with a mean difference of 1.4 cm (p= <0.001).

Gender	Statistics	Birthweight (kg)	Mid arm circumference (MAC) cm	Geststational age (wks)	Mother's age (yrs)
Male	Mean	2.705	9.6	37.3	28.2
	SD	0.58	1.0	2.6	5.3
	Minimum	1.6	7	30	17
	Maximum	4.2	12.4	41	40
Female	Mean	2.656	9.6	37.3	27.9
	SD	0.55	0.9	2.4	5.9
	Minimum	1.6	7.2	30	17
	Maximum	3.9	11.7	41	39
Combined	Mean	2.681	9.6	37.3	28
	SD	0.56	1.0	2.3	5.6
	Minimum	1.6	7	30	17
	Maximum	4.2	12.4	41	40

Table 1 - Characteristics of Study Subjects Among Genders.

Minimum gestational age observed was 31 weeks and maximum was 41 weeks among the studied subjects with a mean gestational age of 37 weeks 3 days (± 2 weeks 6 days) in the study population. Mother's age observed in the study population ranged between 17 and 40 years with a mean of 28 years (± 5 years 6 months). No statistical differences were observed between mid-arm circumference, birth weight with baby's gender, mother's age.

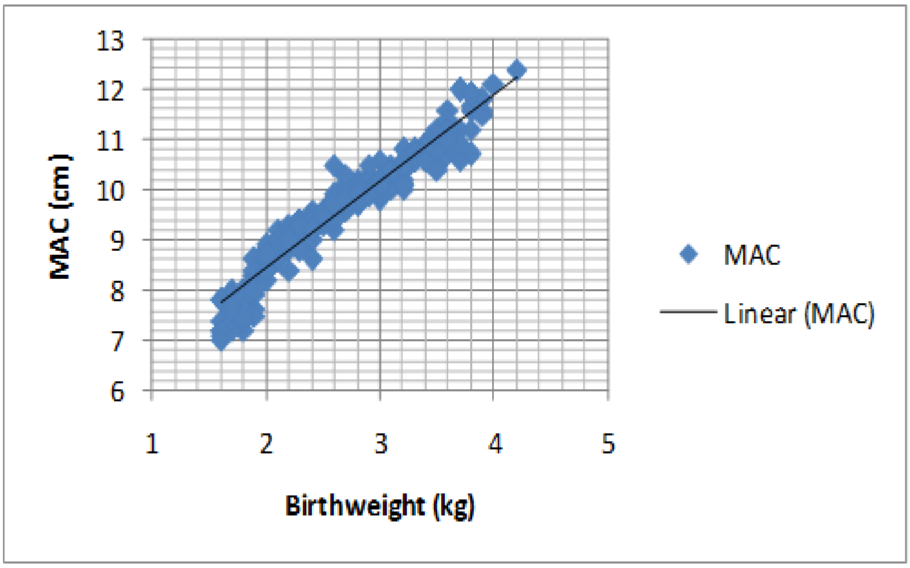

Figure 1. Scatter diagram showing linear correlation between Birth-weight and Mid-arm circumference values of newborn

Figure 1 depicts the significant association between mid-arm circumference of newborn babies in relation to the birth-weight. Pearson's product-moment correlation coefficient of 0.982 showed that mid arm circumference has highly significant positive correlation with the birth-weight with a P value of < 0.001 (2-tailed).

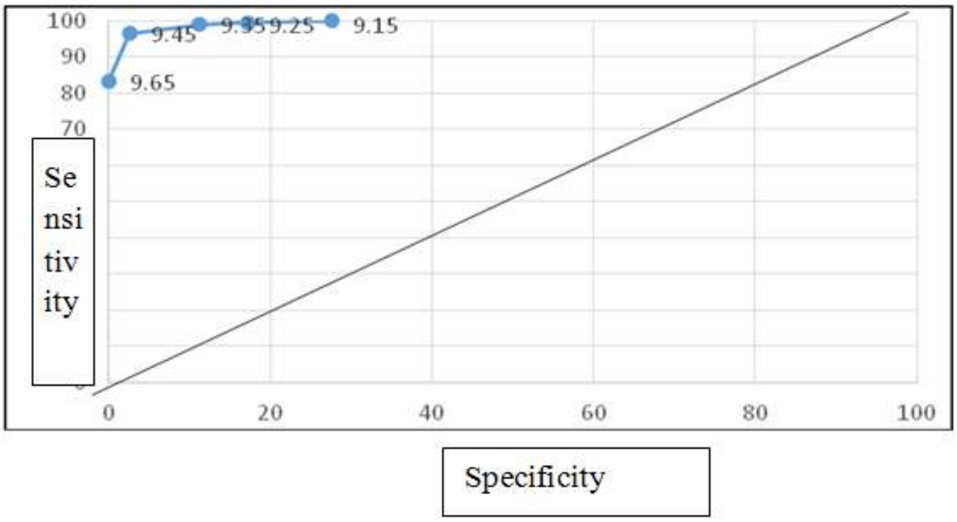

Figure 2 . Receiver operating characteristics (ROC) curve to choose the optimal cut-off point of Mid-arm circumference(MAC).

(The points represent the sensitivity and specificity for each vale of MAC. The MAC point which is nearest to upper and outer corner in the chart i.e., 9.45 cm is the optimal cut off point)

MAC (cm)	Sensitivity (%)	Specificity (%)	Average % [Sn+Sp÷2]	PPV (%)	NPV (%)
9.25	82.8	99.5	91.2	98.9	91.9
9.35	88.8	99.0	93.9	98.1	94.1
9.45	97.4	96.6	97	94.2	98.5
9.55	99.1	91.8	95.4	87.1	99.5
9.65	100	83.4	91.7	76.8	100

PPV – positive predictive value; NPV – negative predictive value

Table 2. Sensitivity, specificity, positive and negative predictive values for different cut-off values of mid-arm circumference.

The optimal cutoff of mid-arm circumference determined in identifying low birth-weight babies using ROC curve analysis was 9.45cm, which had the best combination of sensitivity (97.4%), specificity (96.6%), positive predictive value (94.2%) and negative predictive value (98.5%). ROC-AUC was 0.995 (95% CI 0 .991 to 0 .999) which is highly significant with a P value of <0.001.

A Linear regression analysis was carried out in this study to predict birth-weight of newborn babies from mid-arm circumference, which resulted in following linear equation model using which we can estimate the birth-weight.

Birth weight = -2.489 + (0.536 X Newborn mid-arm circumference value)

IV. Discussion

The mean birth-weight of population studied was 2.681 kg, which was similar to the average birth weight reported by WHO multicenter study for newborns in India of 2630 gms.[8] Male to female ratio (1.03:1) of this study was comparable to that of India (1.06:1).[1] The percent of low birth-weight babies (35.8%) in this study was slightly higher than that for India (30.6%).[1] Lesser percent of low birth-weight babies were observed in some studies[10,11,19,23] as these studies were conducted in different countries like Egypt, Iran, Tanzania and Nepal, where incidence of LBW babies can vary. The mean mid-arm circumference observed was 9.6 cm (±1.0) which is lower than the previous studies in Egypt[5] (10.7 cm), Iran[6] (10.2 cm), Indonesia[7] (11.4 cm), Brazil[9] (10.7 cm), Burkina Faso[10] (9.9 cm), Nepal[11] (11.4 cm), Nigeria[17] (11 cm) and in Maharashtra, India (10.2 cm)[18] which may be due to several factors, including ethnicity, genetics, nutritional and economic status prevalent in those population, as well as possible differences in measurement procedures. Some studies have shown that, head circumference,[11.15] chest circumference,[12,15]calf circumference,[13] length[16] and thigh circumference[17] can also be used as a proxy indicator for birth-weight. Although it is easier to identify the point of measurement of chest circumference by identifying nipple line of newborn babies, mid-arm circumference is readily accessible for measurement even in winter months without disturbing the warm environment of neonate by not removing clothes of newborns, which is a drawback in India's context with reference to maintenance of warm chain for newborn babies. Also timing the end of expiration to measure the chest circumference was challenging. This could have implications for use of these measurements by community health workers. It is argued that measurement of head circumference may not be accurate due to moulding of head during birth especially during prolonged and obstructed labour. And also estimation of head circumference is particularly prone to error because standard methods and precision instruments are not always used in the routine measurement of head circumference.

It is estimated that, in India, about 60-70% of deliveries takes place either at home or in the community till today.[1] The results of the study showed that the optimum cutoff of mid-arm circumference value to identify LBW was 9.45cm, a suitable and simple surrogate parameter could be used in the domiciliary outreach where most of the babies were born at the hands of untrained or semi-trained birth attendants, relatives or neighbors when it is impossible to record weight of baby at birth. Numerous cut off values of mid-arm circumference to identify birth-weight has been reported in various studies conducted abroad and in India[5-7,10,12,16-8] which could be explained by the different characteristics of population studied, racial differences and genetic background of the babies and a reflection of nutritional and economic conditions prevalent across the countries and different areas in the same countries. And most of these studies included only full term, singleton babies delivered by normal vaginal delivery. The following linear equation model was obtained to estimate the birth-weight of newborn babies from mid-arm circumference. Similar equations were obtained in previously conducted studies[5-7,14]

BW = -2.489 + (0.536 X Newborn MAC value)..

These measurements are easy to learn and can conveniently be introduced into the existing system of health care to use by paramedical workers to detect neonate who are LBW and at risk. A colour coded, measuring tape may be suggested for use by health workers or family members to identify LBW newborns in home setting. The potential bias was eliminated by the same investigator taking all measurements within 48 hours after birth and daily checking of the weighing scale with a known standard. However, there could have been some intra-observer bias in measurements. Generalizing results to the community may be cautiously considered since this study was carried out on a sample elevated from a hospital during a short period. Poor precision (nearest 100 grams) of spring type of weighing scale used in the study was another limitation.

Further studies on a community-based sample of newborns using a more precise weighing scale may be necessary. Moreover, the mid-arm circumference value to identify LBW newborns should be validated in the field setting as the mid-arm circumference values are intended to be used by health workers in the field setting.

V. Conclusion

Simple, low cost and reliable mid-arm circumference measurements can be used by health workers to predict birth weight at gross-root level so as to identify LBW babies immediately after birth and to decide on the need for either home management or further referral to specialized centers with neonatal care units, thus improving their survival by preventing short term as well as long term mortality and morbidity.

References

[1]. UNICEF; WHO. Low Birthweight: Country, regional and global estimates. New York. UNICEF; 2004. Available from:http://data.unicef.org/nutrition/lowbirthweight.html.Accessed September 4, 2015.

[2]. Ashworth A. Effects of intrauterine growth retardation on mortality and morbidity in infants and young children. Eur J Clin Nutr 1998;52(1):34-42.

[3]. Lawn JE, Kerber K, Laryea CE, Bateman OM. Newborn survival in low resource settings-are we delivering? BJOG 2009;116(1):49-59.

[4]. Chellan R, Paul L, Kulkarni PM. Incidence of Low-Birth-Weight in India: Regional Variations and Socio-Economic Disparities**.** Journal of Health and Development 2007;3(1):147-62.

[5]. Mohsen MA, Youssef MM, Zaki ST. Mid-upper arm, chest and head circumference cut-off points and equations for identifying low birth weight in Egypt. International Journal of Food, Nutrition and Public Health 2011;4(1):31-8.

[6]. Sajjadian N, Shajari H, Rahimi F, Jahadi R, Barakat MG. Anthropometric measurements at birth as predictor of low birth weight. Health [serial online] 2011;3(12):752-56. Available from: http://www.scirp.org/journal/HEALTH. Accessed September 14, 2015.

[7]. Taufiq MA, Madjid DA, Lisal JS, Daud D. Relationship between newborn mid-upper-arm circumference and birth weight. Paediatr Indones 2009;49(1):11-4.

[8]. WHO. Use of a simple anthropometric measurement to predict birth weight. Bull World Health Organ 1993;71(2):157-63.

[9]. Figueira BB, Segre CA. Mid-arm circumference and mid-arm/head circumference ratio in term newborns. Sao Paulo Med J 2004;122(2):53-9.

[10]. Sauerborn R, Ouiminga RM, Kone B, Sama R, Oepen C, Ebrahim GJ. Neonatal mid-upper-arm circumference is a valid proxy for birth-weight. Trop Med Parasitol 1990;41(1):65-7.

[11]. Sreeramareddy CT, Chuni N, Patil R, Singh D, Shakya B. Anthropometric surrogates to identify low birth weight Nepalese newborns: a hospital-based study. BMC Pediatr [serial online] 2008;8:16. Available from: http://www.biomedcentral.com/1471-2431/8/16. Accessed September 14, 2015.

[12]. Elizabeth NL, Christopher OG, Patrick K. Determining an anthropometric surrogate measure for identifying low birth weight babies in Uganda: a hospital-based cross sectional study. BMC Pediatr [serial online] 2013;13:54. Available from: http://www.biomedcentral.com/1471-2431/13/54. Accessed September 14, 2015.

[13]. Kumar PS, Sudarshan KP, Kumari V. A comparative study of calf circumference with other anthropometric measurements to measure low birth weight babies at risk. JEMDS 2013;2(12):1958-65.

[14]. Kaur M, Singh Z, Kaur G, Goyal LD. Correlation of birth weight with other anthropometric measurements of newborns. Indian Journal of Basic and Applied Medical Research 2013;8(2):870-9.

[15]. Huque F, Hussain AM. Detection of low birth-weight new born babies by anthropometric measurements in Bangladesh. Indian J Pediatr 1991;58(2):223-31.

[16]. Nagargoje M, Chaudhary SS, Deshmukh JS, Misra SK. An institutional study of anthropometric surrogates for birth weight. Indian J Community Health 2012;24(3):215-21.

[17]. Achebe C, Ugochukwu EF, Adogu PO, Ubajaka C. Prediction of low birth weight from other anthropometric parameters in Nnewi, South eastern Nigeria. Niger J Paed 2014;41(1):59 – 63.

[18]. Ahmed M, Colaco SM, Ali MA, Ahmad Z. Birth Weight Status of Newborn and Its Relationship With Other Anthropometric Parameters. Int J Med Health Sci [serial online] 2014;3(1):1-6. Available from: http://www.ijmhs.net/journals-aid-164.html. Accessed September 14, 2015.

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