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Neonatal Foot Length: An Alternative Predictor of Low Birth Weight Babies in Rural India

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Abstract

Background: Birth weight is an important parameter and a determinant factor regarding perinatal morbidity and mortality. However in rural area of developing countries, weighing facility may not be available for all home deliveries, where an alternative parameter like foot length may be considered in place of birth weight.

Objective: The present study was undertaken to find out the best simple anthropometric parameter for identifying low birth weight (LBW) babies.

Study design: Hospital-based cross-sectional study.

Participants: Newborn babies born in AVBRH hospital, Sawangi (Meghe), Wardha.

Methods: All Consecutive full-term, Single ton, live born babies were included and anthropometric measurements carried out within 48 hours after birth.

Results: Out of 520 newborn babies, there were 267 male and 253 female babies. Foot length (FL) attained the highest correlation with birth weight (r = 0.715) while mid arm circumference (MAC) attained the lowest (r = 0.355). FL had the highest coefficient of determination (r2 value= 0.511). Receiver operating curve (ROC) analysis was done to identify the optimal cut-off points of these anthropometric measures separately for LBW babies. The best discrimination of LBW, as detected by Area under curve (AUC), was obtained by FL (AUC = 0.909, 95% CI 0.0133- 0.93538) followed by length (AUC = 0.89, 95% CI 0.87642-0.92969). Length of 49cm, head circumference (HC) of 33cm, MAC of 9.5cm, and chest circumference (CC) of 30cm and FL of 8cm were the corresponding cut-off values with the best combination of sensitivity and specificity for identifying LBW babies.

Conclusion: FL appears to be better indicators for picking up LBW babies. These parameter can be used at community level by health workers for early detection of LBW babies.

Keywords: Low birth weight; Foot length; Length; Midarm circumference.

Abbreviations: LBW: Low Birth Weight; Fl: Foot Length; Mac: Mid Arm Circumference; Roc: Receiver Operating Curve; AUC: Area Under Curve; HC: Head Circumference; CC: Chest Circumference; SPSS: Statistical Package For Social Sciences; Roc: Receiver Operating Characteristic; P: Probability; TC: Thigh Circumference; CFC: Calf Circumference

Introduction

Anthropometry is the measurement of physical dimensions of the human body at different ages. When assessing intrauterine growth, the anthropometric parameters in neonate at birth are considered to be of great value. Comparison of these measurements with standards measurements provides a reliable and simple method of identifying the neonates that deviates from the normal [1]. The physical growth of a newborn is evaluated by comparing body measurements such as weight, length and HC, with standards established in Western countries [2-5]. Birth weight has been accepted as the reliable index of the health status of the community and is an indicator of neonatal morbidity and mortality [2]. Babies with birth weight of less than 2500gm is called as low birth weight babies. They are more susceptible to infection and they do not grow to their full potential of physical and leads to high-infant morbidity and mortality. The perinatal mortality in LBW babies is eight times higher than that in infants weighing more than 2500gms [6]. However, in our country where most of the births take place at home, measuring accurate birth weight is a big problem due to unavailability of weighing scale and trained personnel. So, other authors have used different surrogate anthropometric measurements from different parts of our country to predict LBW babies [2,3]. Hence it is imperative to identify the newborns with LBW and to give them adequate and needed care instantly for their survival. The proportion of LBW infants is particularly high in south- Asia, especially India, where between 20-40% of babies have LBW [4-7]. Thus the present study was conducted to find out the predictor of LBW by measuring the foot length and other anthropometric parameter in neonates.

Material and Methods

This study was carried out in the Pediatric department, AVBRH hospital, Sawangi (Meghe), Wardha. AVBRH hospital being a tertiary care hospital situated in a rural area and all types of deliveries take place here. It was a hospital based cross-sectional study. The study was done on 520 live born neonates who were born during the month of Jan 2013 to July 2013. All newborn infants were term babies (gestational age 37-42 weeks) included in the study. Babies of mothers with risk factors, premature, and malformed babies were all excluded. Equipments used during the study were of flexible, non-stretchable measuring tapes, electronic weighing machine, and infant meter. Nude weight of the baby was taken in a beam balance electronic measuring scale. Length were recorded to the nearest of 0.1cm on an infant meter with baby supine, knees fully extended and soles of the feet held firmly against the foot board and head touching fixed board. Head circumference (HC) was measured by putting the measuring tape interiorly at glabellas and posterior along with the most prominent point. Chest circumference (CC) was measured at the level of lipoid cartilage by measuring tape to the nearest of 0.1 cm. Mid-arm circumference (MAC) was measured midway between acromion process and olecranon process of left arm to the nearest of 0.1 cm by measuring tape. Foot length was measured from an imaginary line tangential to the posterior prominence of the heel to the tip of the longest toe (the first or the second toe). Babies left foot was used to maintain standard during study period. All the measurements were recorded by trained social worker within 48 hour of birth.

Statistical Analysis

Data were entered in Microsoft excel and analyzed using the Statistical Package for Social Sciences (SPSS) software version 17. The anthropometric measures of newborn babies are presented as mean and standard deviation. Correlation and linear regression analyses were done to examine linear relationship between two continuous variables. To define the cut-off point which best discriminates between low birth weight and normal birth weight, the value which yielded the highest accuracy, or percentage of correct classification was determined. Sensitivity, specificity, likelihood ratio for positive test (LR+) and Likelihood ratio for negative test(LR-) were calculated at all cut-points for any anthropometric measurement. Receiver operating characteristic (ROC) curves were used to evaluate the accuracy of different anthropometric measurements to predict LBW. Probability (p) value less than 0.05 was considered statistically significant.

Results

Out of 520 neonates, there were 267 male and 253 female babies. Means and standard deviation of anthropometric variables are shown in (Table 1). It was observed that weight, length, HC, CC, MAC and FL were higher in male babies than in female babies but not statistically significant. Table 2 shows the correlation coefficient between birth weight and anthropometric variables of the neonates, where birth weight significantly correlated ($p<0.000$) with other anthropometric variables i.e. FL, length, HC, CC and MAC. Foot Length attained the highest correlation with birth weight ($r = 0.715$) while MAC attained the lowest ($r = 0.355$). Also, FL had the highest coefficient of determination (R2 value= 0.511). This implies that FL has the highest proportion (51.1%) of variation in weight. Table 3 demonstrated the best discrimination of LBW, as detected by ROC- area under curve (AUC), was obtained by FL (AUC = 0.909, 95% CI 0.0133- 0.93538) followed by length (AUC = 0.89, 95% CI 0.87642-0.92969). Length of 49cm, HC of 33cm, MAC of 9.5cm, CC of 30cm and FL of 8cm were the corresponding cut-off values with the best combination of sensitivity and specificity for identifying LBW babies as shown in (Table 4). Also, the superiority of FL over other anthropometric indicators in the identification of LBW with 84.85% sensitivity and 85.94% specificity.

Table 1: Anthropometric data of the neonates.

Mean	Anthropometry (N=520)	Std. Deviation
2.5595	Birth weight (Kg)	0.40285
48.5192	Length (cm)	3.79504
32.4731	Head Circumference (cm)	2.94805
29.3500	Chest Circumference (cm)	2.88284
9.7800	Mid arm Circumference (cm)	1.71380
7.8385	Foot Length (cm)	2.21243

Table 2: Correlation between birth weight and anthropometric variables of the neonates.

Anthropometric variables (cm)	Pearson Correlation	R square	P value
Coefficient (r)	R square	P value	
Foot Length (FL)	0.715	0.511	<0.000
Length	0.699	0.489	<0.000
Head Circumference (HC)	0.634	0.401	<0.000
Chest Circumference (CC)	0.619	0.383	<0.000
Mid arm Circumference (MAC)	0.355	0.126	<0.000

Table 3: Area under curve (AUC) of anthropometric variable.

Anthropometry	ROC- AUC	Std. Err	95% Conf. Interval
Foot Length	0.9093	0.88328	0.0133- 0.93538
Length	0.8931	0.0136	0.87642-0.92969
Head Circumference	0.8738	0.0145	0.84159 - 0.90604
Chest Circumference	0.8595	0.0164	0.82729- 0.89170
Mid arm Circumference	0.7021	0.0226	0.65777- 0.74635

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Table 4: Cut-off value of anthropometric indicators for detecting LBW babies.

Anthropometry	Cut off value	Sensitivity	Specificity	LR+	LR-
Foot Length	8	86.85%	85.94%	6.0337	0.1763
Length	49	84.75%	83.84%	6.0337	0.1763
Head Circumference	33	82.85%	81.25%	4.5253	0.1865
Chest Circumference	30	78.79%	80.55%	4.2020	0.2611
Mid arm Circumference	9.5	69.70%	65.63%	2.0275	0.4618

Discussion

Anthropometry is an effective and frequently performed child health and nutrition screening procedure. Birth weight data indicate the important role of geographic location as an environmental factor on fetal growth. LBW babies detection in rural community is of highest priority to provide effective minimal perinatal care to decrease mortality. Also, there is a constant search for a simple and inexpensive method for screening such newborns. Number of studies has been done to find out the suitable alternative parameter for predicting the birth weight of the newborn. Many of the anthropometric indices have been proposed such as HC, MAC, CC, thigh circumference (TC) and calf circumference (CFC). The present study was conducted to find the best surrogate parameters, which could be used by birth attendants in rural areas and health workers at community level, to identify LBW babies.

Previous studies have shown that male babies are larger than the female babies [8,9]. Similar finding was present in our study group. Taksande A et al. [10] reported that HC appear to be better indicators for picking up <2500 g babies. MAC is easier to record and its effective use in community situation, by paramedical workers has been shown by earlier works [11]. Ramaiya et al. [12] reported the percentage of LBW were 18.8% with an arm circumference below 9.5 cm. Sacher et al. [13] reported that MAC can be used as a measurement to predict the birth weight of the newborn during the first few days as these do not change over this period. MAC is the better indicator in picking up less than 2000 g birth weight babies. A positive correlation existed between MAC and birth weight and a MAC of 8.7 cm predicts birth weight of 2500gm and definitely excludes newborns with birth weight less than 2000gm [14]. In our study, mid arm circumference is a less reliable parameter and less degree of correlation (0.35) with birth weight for identification of LBW babies with a cut off value of 9.5 cm in neonates. The best correlation between birth weight and surrogate parameter to identify LBW babies was shown by FL (0.71) followed by length (0.769), then HC (0.63), CC (0.590) and lastly MAC (0.355).

Bhargava et al. [15] found the highest degree of correlation of 0.86 between birth weight and CC and a cut off ≤ 30 cm. Verma et al. [16] had found the highest degree of correlation of 0.93 in males and 0.92 in female, thus they found CC to be most sensitive in estimation of LBW babies, by developing multiple linear regression – equations for predicting birth weight from CC. Whereas Sreeramareddy et al. [17] in their study found a correlation coefficient of 0.86 and Etio Goto et al. [18] found a coefficient correlation of 0.95 between CC and birth weight with a cut off value of 30.8 cm and 31.25 cm respectively. For determining LBW babies < 2.5kg the cut off limits or values were formed using regressions equation. The cut off value for FL, length, HC, CC and MAC were 8 cm, 49 cm, 33 cm, 30cms and 9.5 cm respectively babies. Many studies have been conducted in the past to determine the best surrogate parameters to determine birth weight.

Foot length is being considered as an important parameter for detection of birth weight and identification of high risk babies. This alternative measurement should be easy to be conducted even by inexperienced health care staff and should have a very little intra and inter observer variability. It is one such parameter which can be measured easily in neonates without disturbing the baby. Kakrani V et al. [19] reported the highest sensitivity was FL (92.8%) for detecting LBW less than 2000gms followed by MAC (89.5%). Many studies have reported positive correlation between FL and other indices of body [20-25]. Mathur et al. [24] had cut off FL <7.2cm, Mukherjee et al. [25] 7.9 cm , Joshi G et al. [26] had 8.2cm whereas in our case it was 8cm for predicting LBW babies. Joshi G et al. [26] found FL had highest correlation with birth weight (r=0.96), followed by HC (r=0.88), CC(r=0.82), CFC(r=0.76) and length (r=0.65). Elizabeth et al. [27] also reported the highest correlation of FL with birth weight (r=0.97) like us.

Some studies have recommended that FL, HC, MAC and HC may be used as anthropometric surrogates to identify LBW babies [28-30]. Therefore we considered all these anthropometric measurement. Thus the result of this study shows FL are among the best surrogate parameters to identify LBW babies which can be used at community level by health workers in rural areas.

Conclusion

In conclusion, the present study shows the significant correlation of birth weight with other anthropometric parameters. FL was both sensitive and specific for identifying LBW babies. Thus amongst all the parameters studied FL can be used as an alternative to birth weight as an indicator for detection of LBW babies. Thus these measurements can be easily used even in rural areas by health workers to predict the birth weight where weighing facilities for newborns is not available.

References

1. Hamill PV, Drized TA, Johnson CL, Reed RB, Roche AF, et al. (1979) Physical Growth. National center for health statistics percentiles. Am J Clin Nutr 32(3): 607-629.

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2. Ramji S, Marwah J, Satyanarayana L (1986) Neonatal thigh circumference as an alternative indicator of low birth weight. Indian J Med Res 83: 653-654.

3. Gupta V, Hatwal SK, Mathur S (1996) Calf circumference as a predictor of low birth weight babies. Indian Pediatr 33(2): 119-121.

4. Kumar V, Datta N (1984) Birth weight as an indicator of health. Ind Paediatr 21:113-118.

5. McCormick MC (1985) The contribution of low birth weight to infant morbidity and childhood mortality. N Engl J Med 312(2): 82-90.

6. Karan S, Mathur B, Surendra Y (1972) Incidence and causes of perinatal mortality at the institute of child health hospital. Indian pediatr 9(2): 99-106.

7. Sharma JN, Saxena S, Sharma U (1989) Thigh circumference at birth as the best predictor of low birth weight babies. Indian Pediatr 26(1): 18-21.

8. Rehan NE, Taffida DS (1979) Birth weight of Hausa infants in Northern Nigeria. BJOG 86: 443-449.

9. Ratnayake A, Wikramanayake TW, Godawatte R (1991) Size at birth of Sri Lankans. Ceylon Journal of Medical Science 34: 41-56.

10. Taksande A, Vilhekar K, Chaturvedi P, Gupta S, Deshmukh P (2007) Predictor of Low Birth Weight Babies by Anthropometry. Journal of Tropical Pediatrics 53(6): 420-423.

11. Kulkarni ML, Rehman M (1991) Neonatal assessment beyond birth weight. Indian Pediatr 28:929-31.

12. Ramaiya C, Msamanga G, Massawe S (1994) Newborn's arm circumference as a screening tool of low birth weight in Temeke District, Dar es Salaam, Tanzania. Trop Geogr Med 46(5): 318-321.

13. Sacher AC, Soni RK, Singh B (1994) Consistent accuracy of mid arm circumference and calf circumference as birth weight surrogates during first few days. Indian J Matern Child Health 5(2): 41-44.

14. Sood SL, Sai prasad GS, Wilson CG (2002) MAC at birth –a screening method for detection of LBW Indian Pediatrics 39: 837-842.

15. Bhargava SK, Ramji S, Kumar A Manmohan, Marwah J (1985) Midarm and chest circumference at birth as predictors of low birth weight and neonatal mortality in the community. Brit Med J 2919(6509): 1617-1619.

16. Verma S S, Sharma Y K (1999) Prediction of birth weight from simple anthropometric measurements in Indian male and female newborn babies. Indian J Med Sci 53(2): 68-76.

17. Sreeramareddy C T (2008) Anthropometric surrogates to identify low birth weight Nepalese newborns: a hospital based study. BMC Pediatrics 25: 8-16.

18. Goto Eita (2011) Meta-Analysis: Identification of Low Birth weight by Other Anthropometric Measurements at Birth in Developing Countries. J Epidemol 21(5): 354-362.

19. Kakrani V, Holambe V, Garade S, Gupte A (2008) Alternative Predictors of low birth weight. Indian J Prev Soc Med 39(4): 161-164.

20. James DK, Dry burgh EH, Cheswick ML (1979) Foot length a new potentially useful measurement in neonate. Arch Dis Child 54(3): 226-230.

21. Hirve SS, Gonatra BR (1993) Foot tape measure for identification of LBW newborns, Indian Pediatrics 30(1): 25-29.

22. Gohil JR ,Sosi M ,Vani SN ,Desai AB (1991) Foot length measurement in the neonate. Ind J of Ped 58(5): 675-677.

23. Daga SR, Daga SS, Dighole, Patil RP, Dhindole HL (1992) Rural neonatal care Dahanu experience, Indian Pediatrics 29: 189-193.

24. Mathur A, Tak S, Kothari P (1984) 'Foot length' -- a newer approach in neonatal anthropometry. J Trop Pediatr 30(6): 333-336.

25. Mukherjee S, Roy P (2013) Measuring new born Foot length to Identify small babies in need of extra care: a Cross sectional hospital based study. Iran J Pediatr 23(5): 508-512.

26. Joshi G, Chaudhary N (2014) Detection of low birth weights in newborns by Foot length as proxy Measure. International Journal of Biomedical Research 05(02): 87-90.

27. Elizabeth N, Christopher O (2013) Determining an anthropometric surrogate measure for identifying low birth weight babies in Uganda: A hospital based cross sectional study. BMC Pediatrics 12:13- 54.

28. Mullany LC, Darmstadt GL, Jhatry SK (2007) Relationship between the surrogate anthropometric measures, foot length and chest circumference and birth weight among newborn of sarlahi, Nepal. European Journal of Clinical Nutrition 61(1): 40-46.

29. Ezeaka VC, Egri-Okwaji MT, Renner JK, Grange AO (2003) Anthropometric measurements in the detection of low birth weight infants in Lagos. The Nigerian Postgraduate Medical Journal 10(3): 168-172.

30. Hossain MM, Habib M, DuPont HL (1994) Association between birth weight and birth arm circumference of neonates in rural Egypt. Indian Journal of Pediatrics 61(1): 81-87.

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