Original Article

Calf Circumference at birth: A screening method for detection of low birth weight

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Abstract

Background: Low Birth Weight (LBW) babies run a higher risk of morbidity and mortality in the perinatal period. However, in our country where almost 70-80% births take place at home and peripheral hospitals, taking accurate weight is a problem due to unavailability of weighing scale and trained personnel. Hence there is a constant search for newer methods to detect LBW babies so that early interventions can be instituted. Various authors have used different surrogate anthropometric measurements from different parts of our country. In the present study, an attempt was made to validate the feasibility of using calf circumference as a predictor of LBW babies that can be used by a trained or untrained person.

Objectives: To study various anthropometric measurements including calf circumference in newborns and to correlate various measurements with birth weight.

Methods: The present study was conducted in the department of Social & Preventive Medicine, MLB Medical College, Jhansi (UP) for a period of one year. The study included 1100 consecutively delivered neonates in the maternity ward of MLB Medical College Hospital, Jhansi (UP). The birth weight (Wt), crown heel length (CHL), crown rump length (CRL), head circumference (HC), chest circumference (CC), mid arm circumference (MAC), thigh circumference (TC) and calf circumference (CC) by standard techniques. All the measurements were taken by a single person throughout the study period with in 24 hours of delivery. Standard statistical methods were adopted for determination of critical limit, sensitivity, specificity and correlation coefficient of different anthropometric measurements in relation to birth weight.

Results: Analysis of data indicates that out of 1100 newborns, 55.64% were low birth weight. The percentage of newborns $\geq$ 2500gm was 44.36. Overall average birth weight was 2348 $\pm$ 505gm. Out of 1100 newborns, 608 (55.27%) were males and 492 (44.73%) were females. Average birth weight for males was 2412 $\pm$ 482gm and for females it was 2272 $\pm$ 502gm out of 1100 newborns, 608 (55.27%) were males and 492 (44.73%) were females. Average birth weight for males was 2412 $\pm$ 482gm and for females it was 2272 $\pm$ 502gm. The highest sensitivity for detecting LBW babies was seen with calf circumference (98.4%) followed by thigh circumference (91.6%). The specificity of calf circumference was less than that of thigh circumference; it was 92.0% and 96.2% respectively.

Conclusion: Calf circumference is a simple, cheap, reliable and quick indicator for predicting LBW babies in the community. Furthermore, it is easy to train traditional birth attendants to screen out high risk group new bourns by simply measuring the calf circumference.

Key words: birth weight (Wt), crown heel length (CHL), crown rump length (CRL), head circumference (HC), chest circumference (CC), mid arm circumference (MAC), thigh circumference (TC) and calf circumference (CC)

Introduction:

By international agreement babies who weigh less than 2.5Kg are termed as low birth weight (LBW) and babies delivered before 37 weeks of gestation are labeled as preterm[21]. So, low birth weight babies include preterm, full term and post term for their gestational age. Their clinical problems and prognosis is quite different from others. The magnitude of LBW babies is quite large particularly in the developing countries. WHO estimates that globally about 25 million LBW babies are born every year in the world, consisting 17 percent of all live births, out of them 32% in South Asia, 9% in Eastern Asia alone[21].

Birth weight has been universally used as a measure of low birth because its correlation with gestation and ease of recording in hospital setting. It is a reliable and sensitive indicator for predicting the immediate and later outcome of newborn babies. Low Birth Weight (LBW)

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babies run a higher risk of morbidity and mortality in the perinatal period[20]. However, in our country where almost 70-80% births take place at home and peripheral hospitals, taking accurate weight is a problem due to unavailability of weighing scale and trained personnel. Hence there is a constant search for newer methods to detect LBW babies so that early interventions can be instituted. Various authors have used different surrogate anthropometric measurements from different parts of our country. In the present study, an attempt was made to validate the feasibility of using calf circumference as a predictor of LBW babies that can be used by a trained or untrained person. The objectives of present study were-

- To study various anthropometric measurements including calf circumference in newborns.
- To correlate various measurements with birth weight.

Material and Methods:

The present study was conducted in the department of Social & Preventive Medicine, MLB Medical College, Jhansi (UP) for a period of one year. The study included 1100 consecutively delivered neonates in the maternity ward of MLB Medical College Hospital, Jhansi (UP). Twins and newborns with apparent congenital anomalies were excluded from the study. The birth weight (Wt), crown heel length (CHL), crown rump length (CRL), head circumference (HC), chest circumference (CC), mid arm circumference (MAC), thigh circumference (TC) and calf circumference (CC) by standard techniques. All the measurements were taken by a single person throughout the study period with in 24 hours of delivery. Weight of the nude baby was recorded to nearest 50 gm. The baby's supine crown heel length was recorded by placing him/her in an infantometer with knees fully extended and soles of the feet held firmly against the foot board. Crown rump length also was measured by an infantometer. Head circumference was measured by placing a flexible, non-stretchable tape anteriorly at the glabella, posterioly along the most prominent points. Chest circumference was measured at the level of xiphoid cartilage. The mid arm circumference was measured midway between acromian process and olecrenon process of the left arm. Thigh circumference was measured in supine position at the level of lowest furrow in the gluteal region; the tape was placed perpendicularly to the long axis of lower limb. Calf circumference was measured at the most prominent point in the semiflexed position of the leg. All the measurements were taken nearest to 0.1cm. Standard statistical methods were adopted for determination of critical limit, sensitivity, specificity and correlation coefficient of different anthropometric measurements in relation to birth weight.

Results:

Analysis of data indicates that out of 1100 newborns, 55.64% were < 2500gm i.e. low birth weight according to WHO standard. The percentage of newborns ≥ 2500gm was 44.36. Overall average birth weight was 2348 ± 505gm. (table-1)

Table-1: Distribution of Newborns by Birth Weight.

Birth Weight (gm)	Newborns	
	No.	%
≤1000	24	02.18
1001-1500	52	04.73
1501-2000	132	12.00
2001-2499	404	36.73
subtotal	612	55.64
2500-3000	386	35.09
>3000	102	09.27
Total	1100	100.00
Average birth weight (gm) : 2348 ± 505		

Table 2 shows that out of 1100 newborns, 608 (55.27%) were males and 492 (44.73%) were females. Average birth weight for males was 2412 ± 482gm and for females it was 2272 ± 502gm. The incidence of males and females weighing < 2500gm were 56.74% and 54.27% respectively. The incidence of low birth weight was higher in males than that of females. However, the difference was not statistically significant (p>0.10).

Table 2: Distribution of Newborns according to birth weight and Sex.

Birth Weight (gm)	Male		Female	
	No.	%	No.	%
≤1000	22	03.62	02	00.41
1001-1500	34	05.59	18	03.66
1501-2000	78	12.83	54	10.66
2001-2499	211	34.70	193	39.22
Subtotal	**345**	**56.74**	**267**	**54.27**
2500-3000	205	33.72	181	36.79
>3000	58	09.54	44	08.94
Total	**608**	**100.00**	**492**	**100.00**
Average birth weight (gm) :				
	2412 ± 482		**2272 ± 502**	

$\chi^{2=}$ 0.68, d.f.= 1, p > 0.10

Table 3 shows information regarding mothers of newborns at a glance. Maximum number of the mothers were in the age group of 19-35 years (75.81%) and from urban background (50.27%). Literacy was low and only 17.64% mothers were in the group intermediate, graduate and above. Most of the mothers were from joint families. Nearly 40.00% of the mothers were found to be anemic and were of para 2-4.

Table 3 : Information regarding mothers of newborns at a glance

S.No.	Variable	No. of Mothers	Percentage
1.	**Age (years):**		
	≤18	118	10.73
	19-35	834	75.81
	>35	148	13.46
2.	**Family Background:**		
	Urban	553	50.27
	Rural	469	42.64
	Slum	78	07.09
3.	**Educational status:**		
	Illiterate and just literate	497	45.18
	Junior high school and high school	409	37.18
	Intermediate, graduate & above	194	17.64
4.	**Type of family:**		
	Nuclear	97	08.82
	Joint	1003	91.18
5.	**Parity:**		
	1	296	26.91
	2-4	440	40.00
	>4	364	33.09
6.	**Type of delivery:**		
	Normal Vaginal	853	77.55
	Forceps	93	08.45
	Caesarian section	154	14.00
7.	**Disease during pregnancy:**		
	Anemia	442	40.18
	Hypertension	116	10.54
	Others	163	14.82

Analysis of data indicate that for a birth weight of 2500 gm, the critical limit of calf circumference was ≤10.8 cm. Critical limits for crown heel length, crown rump length, head circumference, chest circumference, mid arm circumference and thigh circumference were ≤45.2cm, ≤28.5cm, ≤32.2cm, ≤30.1cm, ≤09.0cm and ≤15.4cm respectively. All measurements showed significant correlation with birth weight. The highest correlation was found with calf circumference (r=0.98), followed by thigh circumference (r=0.93) and mid arm

circumference (r=0.910). Using the above critical limits, the highest sensitivity for detecting LBW babies was seen with calf circumference (98.4%) followed by thigh circumference (91.6%) and mid arm circumference (89.5%). The specificity of calf circumference was less than that of thigh circumference; it was 92.0% and 96.2% respectively. The minimum specificity was seen with chest circumference i.e.68.7% (Table-4).

Table 4 : Comparison of statistical validity of various anthropometric indices for screening of low birth weight newborns

S.No.	Anthropometric indices	Cut off limit (cm)	Sensitivity (%)	Specificity (%)	Correlation coefficient 'r'
1.	Crown heel length	≤45.2	68.7	69.0	0.89
2.	Crown rump length	≤28.5	74.8	76.8	0.72
3.	Head circumference	≤32.2	76.7	86.3	0.77
4.	Chest circumference	≤30.1	83.2	68.7	0.86
5.	Mid arm circumference	≤09.0	89.5	90.8	0.91
6.	Thigh circumference	≤15.4	91.6	96.2	0.93
7.	Calf circumference	≤10.8	98.4	92.0	0.98

The calf circumference was found to have best sensitivity and highest correlation with birth weight followed by thigh circumference and mid arm circumference in the diagnosis of low birth weight newborns.

Discussion- In the present study, percentage of low birth weight babies was higher as compared to other studies carried out by Achar et al[1], Saigal et al[12], Singh et al[16], Parmar et al[10] , Samal et al[13] .The overall average birth weight of newborns was 2348 ± 505gm. The average birth weight recorded in this study was lower than reported by Srivastava et al[19], Devi & Sarkar[3], Mittal et al[7], Bhatia & Tyagi[2], Sood et al[18]. The average birth weight of male and female newborns were 2412±482gm and 2272±502gm respectively. However difference was not statistically significant. Similar reports that male babies are heavier than female babies were also given by Singh et al[14], Mukherji et al[8], Singh and Venkatachalam[17], Madhavan et al[6], Saigal et al[12], Singh et al[15].

Calf circumference increased progressively with increase in birth weight. The overall calf circumference was 10.5 ± 0.5cm in the present study. Progressive increase in calf circumference with increase in birth weight was also reported by Landicho et al[5], Neela et al[9], Raman et al[11], Gupta et al[4] and Samal & Swain[13]. On comparing various anthropometric indices, the calf circumference with critical limit of ≤10.8cm showed maximum sensitivity for screening low birth weight newborns. Sensitivity and specificity of calf circumference in the present study was 98.4% and 92% respectively. Similar observations were also reported by Neela et al[9] and Raman et al[11]. In both studies, maximum sensitivity was reported with calf circumference and critical limit of calf circumference was ≤10.0cm. Gupta et al[4] reported that calf circumference was best predictor of low birth weight babies. Critical limit and sensitivity for calf circumference was 10.8cm and 98.4% respectively. Samal & Swain[13] found similar results in their study. The critical limit for calf circumference was 9.9cm and sensitivity was 85.9%.

Since identification of LBW 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 an inexpensive method for screening,

such newborns. In the present study, a significant correlation of various anthropometric measurements was observed with birth weight. Calf circumference had the best correlation with birth weight followed by thigh circumference. With calf circumference of ≤10.8cm as the cut off limit, almost 98% of LBW babies can be identified with fair degree of accuracy.

In conclusion, calf circumference is a simple, cheap, reliable and quick indicator for predicting LBW babies in the community. Furthermore, it is easy to train traditional birth attendants to screen out high risk group new bourns by simply measuring the calf circumference.

References:

1. AcharST, Yankaner A. Study on birth weight of South Indian infants. Ind J Ch Hlth. 1962; 11: 157-161.
2. Bhatia BD, Tyagi NK. Maternal determinants of Birth weight. A multivariable analysis. Indian Pediatr. 1984; 21: 365-371.
3. Devi B, Sarkar D. A study of the birth weight and birth length of Bengali infants. Indian Pediatr. 1972; 39: 131-143.
4. Gupta V, Hatwal SK, Mathur S, Tripathi VN, Sharma SN, Saxena SC, Khadwal A. Calf circumference as predictor of low birth weight babies. Indian pediatr. 1996; 33: 119-121.
5. Landicho B, Lechtig A, Klein RE. Anthropometric indicators of low birth weight. Journal of Tropical Pediatr. 1985; 31: 301-305.
6. Madhawan S, Taskar AD. Birth weigh of Indian babies born in hospitals. Indian Pediatr. 1969; 36: 193-204.
7. Mittal SK, Singh PA, Gupta RC. Intrauterine growth and low birth criteria in Punjabi infants. Indian Pediatr. 1976; 13: 679-682.
8. Mukherji S, Biswas S. Birth weight and its relationship to gestation period, sex, maternal age, parity and socio-economic status. Journal of Indian Medical Association. 1959; 32: 389-398.
9. Neela J, Raman L, Balakrishna N, Rao KV. Usefulness of calf circumference as a measure for screening low birth weight infants. Indian Pediatr. 1991; 28: 881-884.
10. Parmar VR, Ball L, Sood KK, Randhawa I. Anthropometric measurements and prevalence of low birth weight in Himachal Pradesh. Indian Pediatr. 1987; 24: 561-565.
11. Raman L, Neela J, Balakrishna N. Comparative evaluation of calf, thigh and arm circumference in detecting low birth weight infants part II. Indian Pediatr. 1992; 29: 481-484.
12. Saigal S, Srivastava JR. Anthropometric studies on 1000 consecutive newborns with special reference to determine criteria of prematurity. Indian Pediatr. 1969; 6: 24-32.
13. Samal GC, Swain AK. Calf circumference as an alternative to birth weight for identification of low birth weight babies. Indian Pediatr. 2001; 38: 275-277.
14. Singh A, Paul S, Ahluwalia D. Report of anthropometric measurements of healthy newborns in Delhi. Indian J Child Health. 1957; 6: 863.
15. Singh M, Giri SK, Ramachandran K. Intrauterine growth cures of live born single babies. Indian Pediatr. 1974; 11: 475-478.
16. Singh M, Tripathi K, Arya LS. Birth weight gestational age correlates of neonatal mortality. Indian J Pediatr. 1982; 49: 511-517.
17. Singh R, Venkatachalam PS. Anthropometric studies of newborns. Indian J Med Res. 1962; 50: 794-799.
18. Sood SL, Saiprasad GS, Wilson CG. Mid arm circumference at birth : A screening method for detection of low birth weight. Indian Pediatr. 2001; 39: 838-842.
19. Srivastava BC, Maheshware BB, Gupta RD. The effect of various biological factors on birth weight. Indian J Pediatr. 1971; 38: 202-207.
20. Visweswara Rao K, Reddi PS, Narayaran N. Comparison of arm and calf circumference as indicators of protein energy malnutrition. Indian J Nutr Dietet. 1978; 15: 112-119.
21. World Health Organisation. The incidence of low birth weight: A clinical review of available information. World Health Organisation. 1980; 33: 197.