Anthropometric determinants of low birth weight in newborns of Hoshiarpur district (Punjab) - A hospital based study

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ABSTRACT

Objective: The main aim of the study was to determine best surrogate anthropometric measurement to determine low birth weight newborns among institutional deliveries in district Hoshiarpur, Panjab (India).
Subjects: Subjects comprises of 504 newborns of singleton pregnant women delivering in reputed hospitals of Hoshiarpur, Panjab (India).
Methods: Singleton pregnant women were booked in last trimester of pregnancy and followed them till delivery. Selective newborn measurements were taken within 48 hours of birth using standard scales.
Results: In the present study, out of 504 newborn babies studied, 20.23% were having birth weight <2500gm. Birth weight was significantly correlated with all selected anthropometric measurements i.e. Crown Heel Length (CHL), Head circumference (HC), Chest circumference (CC), Mid-arm circumference (MAC), Abdominal circumference (AC), Thigh circumference (TC), Subscapular, Biceps, triceps, thigh and calf skinfold thicknesses at p<0.01. Univariate linear regression analysis was done to identify the optimal cut off points of these anthropometric measures to identify low birth weight babies.
Conclusion: Mid-arm circumference was found to be best surrogate measurement followed by chest circumference to identify low birth weight newborns.

Keywords: Low birth weight, Anthropometry, Institutional deliveries

INTRODUCTION

Birth weight is the most sensitive and reliable indicator of health of the community. It is universally acknowledged that size at birth is an important indicator of foetal and neonatal health in the context of both an individual and the population (Onis and Habicht, 1996). LBW is considered to be an important factor compromise healthy survival of infants. More than 20 million infants worldwide, representing 15.5% of all births are born with low birth weight, 95.6% of them in developing countries. The level

of low birth weight in developing countries (16.5%) is more than double the level in developed regions i.e. 7% (WHO 2005). The national neonatal perinatal database reported that nearly about one third of all neonates born in major hospitals of India every year are LBW. Of all neonatal death, nearly 82% occur among LBW, which is highest in the world (NNF, 2005). Low birth weight is associated with long term disabilities such as mental retardation, cerebral palsy, vision and hearing impairments and other developmental disabilities. IUGR can contribute to adult short stature and infants with LBW can be at higher risk for later metabolic disorders, hypertension, cardiovascular disease and stroke. Adults who were IUGR can exhibit disparities in academic achievement and professional attainment relative to their appropriately grown counterparts (Ventura et al. 2001). Therefore, prevention of LBW is an issue of public health importance. Thus an early identification and prompt referral is primordial to reduce neonatal morbidity and mortality.

Numerous studies from developing countries have suggested different anthropometric surrogates to identify LBW babies and recommended various cut off values (Naik et al., 2003; Samal and Swain, 2001; Verma et al., 1996).

This paper aims to identify best surrogate measurement and its cutoff points to identify LBW babies.

MATERIAL AND METHOD

Sample

This study was carried out in one government and four reputed private hospitals of Hoshiarpur district. Hoshiarpur district is located in the north-east part of the Indian state of Punjab (India). The potential sample included all the singleton pregnant mothers along with newborns delivered at these hospitals from May 2009 to September 2010. After deleting data of missed cases, 504 mothers between age group 20-35 years were taken for this study. The mothers were contacted during the last trimester of their pregnancy and women with 9th month of pregnancy who are willing to participate were recruited for the study. Women with multiple pregnancies, those with clinical diagnosis of chronic illness such as diabetes mellitus, hypertension, heart disease, severe anemia, thyroid disease and those tested positive for hepatitis B(HbsAg),HIV or syphilis (VDRL)

infections or who were anticipated to move out of the city before delivery were excluded. Gestational age was calculated from the reported first day of last menstrual period. Booked mothers were followed till their delivery. The information regarding date, type and time of delivery and sex of newborn were recorded from delivery notes. Neonates with gross congenital anomalies were excluded from the study.

Newborn Anthropometry

All live births born to recruited mothers were taken within 48 hours of birth and measurements were taken according to the techniques described in Lohman et al. (1988). Height was measured using an infantometer and weight with digital weighing scale. The newborn was weighed without clothes. The babies weighing less than 2.5 kg were labeled as LBW babies. A Harpender skinfold caliper was used to measure skinfold thickness and an inelastic tape to measure circumference measurements of the newborn. Height and weight measured to the nearest 0.1cm and 0.2 kg respectively. Circumference measures namely crown heel length, mid-upper arm, head, chest, thigh, calf, and abdominal were made to nearest 0.1 cm. Skinfold thicknesses at biceps, triceps, subscapular and thigh were taken to the nearest 0.2 mm.

Statistical Procedures

The information thus collected, was analyzed and tested for statistical significance. Univariate Analysis was done by applying t-test and Chi-square. Multivariate Analysis was done to see the combined effect of variables through Multiple Step Regression Model. Single Variable linear regression analysis was used to find out cut-off values of various anthropometric measurements. Sensitivity analysis of anthropometric parameters was done to identify best surrogate measurement.

The analysis was carried out using the SPSS 16.0 program. The level of significance was set at $p \leq 0.05$.

RESULTS

The data given in Table 1 revealed that 20.23 percent of the total babies were found to be low birth weight babies. As per gender wise distributions of newborns, it has been observed that among low birth weight newborns, 56.86% were males and 43.14% were females. Among normal weight newborns, 53.23% were males and 43.14% were females.

Hence in both the groups, male newborns were having higher percentage than female newborns and the differences between birth weight and gender of the newborns were found to be non significant. Table 2 depicts that differences between all anthropometric measurements of newborns and birth weight were found statistically significant at p<0.01.

Table 1: Gender wise distribution of newborns according to birth weight

Birth Weight(Kg)	Male (n = 272)	Female (n = 232)	Total (n = 504)
Normal birth weight	214(53.23)	188(46.77)	402(79.77)
Low birth weight	58(56.86)	44(43.14)	102(20.23)
Chi-square	0.19		

Figures in parentheses are percentages

Table 2: Comparative distribution of anthropometric measurements of normal birth weight and low birth weight newborns

Anthropometric measurements of newborns	Normal birth weight		Low birth weight		't' value
	Mean	SD	Mean	SD	
Crown Heel Length (cm)	49.13	1.66	46.73	1.62	13.10*
Head circumference (cm)	33.70	1.03	32.33	1.13	11.76*
Chest circumference (cm)	31.49	1.76	29.66	1.27	9.87*
Mid Arm circumference (cm)	9.75	1.35	8.81	0.57	6.87*
Abdominal circumference (cm)	30.40	1.99	28.74	1.98	7.53*
Thigh circumference (cm)	13.86	1.41	12.22	1.19	10.81*
Calf circumference (cm)	10.00	1.00	8.72	0.66	12.26*
Subscapular skinfold (mm)	4.63	0.90	3.45	0.87	11.91*
Biceps skinfold (mm)	4.79	0.96	3.57	0.88	11.65*
Triceps skinfold (mm)	5.41	1.08	4.04	1.00	11.61*
Thigh skinfold (mm)	6.86	1.61	4.82	1.16	9.42*

*p<0.01

The cut off values of different anthropometric measurements of newborns for determining low birth weight newborns, univariate regression analysis was employed (Table 3). An optimum cut off point identifying low birth weight newborns was 47.45 cm

Table 3: Cut off values of significant anthropometric parameters of Newborns for identifying low birth weight babies

Anthropometric measurements of newborns	Univariate Linear Regression Analysis					
	Constant	Regression coefficient	t-value	R-square	Mean	Cut-off value
Crown Heel length (cm)	-5.661	0.172	24.08*	0.536	48.65	47.45
Head circumference (cm)	-5.109	0.234	17.47*	0.378	33.42	32.52
Chest circumference (cm)	-0.853	0.115	11.83*	0.218	31.12	29.16
Mid arm circumference (cm)	0.905	0.189	15.02*	0.310	9.50	8.44
Abdominal circumference (cm)	0.029	0.087	10.5*	0.180	30.06	28.40
Thigh circumference (cm)	0.430	0.178	16.77*	0.359	13.53	11.63
Calf circumference (cm)	0.095	0.281	20.03*	0.444	9.74	8.56
Subscapular Skinfold (mm)	1.584	0.284	18.66*	0.410	4.39	3.23
Biceps skinfold (mm)	1.532	0.286	20.54*	0.457	4.54	3.38
Triceps skinfold (mm)	1.463	0.266	22.53*	0.503	5.14	3.90
Thigh skinfold (mm)	1.614	0.188	23.69*	0.529	6.45	4.71

* $p < 0.01$

Table 4: Sensitivity analysis of significant anthropometric parameters of newborns with their cut off values

Anthropometry of newborns	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Accuracy
Crown Heel length (cm)	60.00	85.65	38.24	93.53
Head circumference (cm)	75.61	84.67	30.39	97.51
Chest circumference (cm)	90.48	82.82	18.63	99.50
Mid arm circumference (cm)	100.00	80.72	5.88	100.00
Abdominal circumference (cm)	66.67	81.48	11.76	98.51
Thigh circumference (cm)	72.09	84.60	30.39	97.01
Calf circumference (cm)	76.32	84.33	28.43	97.76
Subscapular Skinfold (mm)	67.42	89.88	58.82	92.79
Biceps skinfold (mm)	60.98	87.68	49.02	92.04
Triceps skinfold (mm)	70.73	84.23	28.43	97.01
Thigh skinfold (mm)	67.19	86.59	42.16	94.78

for crown heel length, 32.52 cm for head circumference, 29.16 cm for chest circumference, 8.44 cm for mid arm circumference, 28.40 cm for abdominal circumference, 11.63 cm for thigh circumference, 8.56 cm for calf circumference, 3.23 mm for subscapular skinfold, 3.38 mm for biceps skinfold, 3.90 mm for triceps skinfold and 4.71 mm for thigh skinfold. Cut off values indicate that below this anthropometry risk appears to be LBW baby. With the help of these values, sensitivity analysis was done which has been presented in table 4. Sensitivity is supposed to be best indicator of predicting positive low birth weight cases. Hence from point of view of predicting positive low birth cases, mid arm circumference (100.00%) emerged as the best surrogate, followed by chest circumference (90.48%) as depicted in table 4. Hence mid arm circumference was found to be best surrogate measurement to identify low birth weight newborns followed by chest Circumference. Table 5 depicts logistic regression of neonatal anthropometric parameters with birth weight. In the 1st run equation, the coefficient of multiple determination (R^2) came to be 0.765, indicating that 76.50 percent

Table 5: Logistic Regression of neonatal anthropometric parameters with birth weight

Anthropometric measurements of newborns	Multiple Linear Step Regression Analysis			
	1st Run Equation		Final Run Equation	
	Regression Coefficient	t-value	Regression Coefficient	t-value
Constant	-3.415	8.53**	-3.441	8.79**
Crown Heel length (cm)	0.059	7.60**	0.064	8.73**
Head circumference (cm)	0.029	2.45**	0.034	3.02**
Chest circumference (cm)	0.011	1.36		
Mid arm circumference (cm)	0.178	7.52**	0.192	10.06**
Abdominal circumference (cm)	-0.017	2.35*	-0.015	2.30*
Thigh circumference (cm)	0.004	0.45		
Calf circumference (cm)	0.015	0.86		
Subscapular skinfod (mm)	0.058	4.21**	0.064	4.94**
Biceps skinfold (mm)	0.027	1.66	0.035	2.23*
Triceps skinfold (mm)	0.022	1.19		
Thigh skinfold (mm)	0.024	1.86	0.033	3.13**
R-square	0.765	144.96 (F)	0.763	143.44 (F)

*p<0.05
**p<0.01

of the variation in the birth weight of newborns was explained by all the anthropometric measurements of newborns included in the equation. Only four measurements were found to be significant in the 1st run equation. In the final run equation, the value of R^2 reduced slightly to 0.763 with seven significant measurements. This showed that the contribution of remaining four variables was only 0.20 percent towards birth weight of newborns.

In the final run equation, the regression coefficients of crown heel length, head circumference, mid arm circumference, subscapular skinfold, biceps skinfold and thigh skinfold thicknesses came to be significantly positive. This showed that an increase in these anthropometric measurements of newborns would lead to an increase in the birth weight of newborns. On the other hand, the regression coefficient of abdominal circumference was found to be significantly negative. This revealed that an increase in the abdominal circumference of newborns, would lead to a decline in the birth weight of newborns. This indicated that of crown heel length, head circumference, mid arm circumference, subscapular skinfold, biceps skinfold and thigh skinfold thicknesses are the significant contributors of birth weight of newborns.

DISCUSSION

The prevalence of LBW is high in Indian babies and is a significant contributor to neonatal mortality. Therefore, prevention of LBW is an issue of public health importance and simple reliable and suitable anthropometric surrogates need to be discovered to identify LBW babies (Chhabra et al. 2006). The objective of the present study was to find surrogate measures for birth weight that could be used by birth attendants and health workers in the north India to identify low birth weight neonates. Such an indicator needs to be highly sensitive so that a good proportion of "at risk" neonate will be managed immediately in health settings.

The percent of LBW in present study population was lower (20.24) than reported by UNICEF (2004) i.e. the incidence of low birth weight in India is 30%. On the contrary these were higher than that of the incidence of Nepal (8.5%) and Tanzania (18%-8%) study. The reason of these findings may be related to different characteristics of

population studied (genetic, nutritional, environmental background). The mean birth weight of the newborns in the present study was found 2.83±0.45 which is higher than average birth weight reported by WHO multicenter study that the birth weight was 2630 gms for newborns in India. The reason may be inclusion of only singleton live births for the present study. Previous studies did not specify such criteria (Samal and Swain 2001, Das et al., 2005, WHO Collaborative Study 1993). Above cited studies may have also included birth weight of newborns born before 37 weeks of gestation (full term).

Anthropometric studies of the newborn helps to evaluate the maturity status of the baby and identifies the relationship between health and disease (Golalipour et al. 2003). Bangladesh and other developing countries have suggested different anthropometric surrogates to identify LBW babies and have also recommended various cutoff values for identification of LBW babies. Multicentre study carried out by WHO suggested the validity of mid upper arm circumference and chest circumference and cut off points for identifying LBW babies that varied across the nations and ethnic groups (Sreeramareddy et al. 2008).

Mid upper arm circumference is an important tool for identifying malnutrition and mortality risk. Mid upper arm circumference of the newborn is strongly associated with birth weight and is an indicator of low and insufficient growth (Bhargava et al. 1985; Ramaiya et al. 1994; Drossou et al. 1995; Karim and Mascie-Taylor 1997; Figueria and Segre 2004; Nair et al. 2006). Numerous cut off values for mid arm circumference has been reported in various studies conducted in abroad and in India. In identifying newborns of less than 2500 gm, mid arm circumference of <9 cm had the best sensitivity (96.2%) and specificity (97.3%). A value of <8 cm and <6.8 cm for mid arm circumference showed highest validity for picking up newborns weighing <2000 gm and <1500 gm respectively in India (Das et al, 2005). In Bangladesh, it has been concluded that a mid arm circumference of <9 cm had the best sensitivity and specificity for identifying newborns with a birth weight of less than 2500 gm (Ahmed et al, 2000). Validity of cut off values of best surrogate anthropometric parameters in the present study depict that mid arm circumference ≤8.44 and chest circumference of ≤29.16 had better sensitivity and specificity in the combination for identifying infants weighing <2,500 gms. Another study done on Indian babies' shows mid arm circumference of 8.7

cm predicts a birth weight of 2580 gm and it definitely excludes newborns with birth weight less than 2000 gm (Sood et al, 2002).

In the present study, a chest circumference of 29.16 cm was found to be second best indicator after mid arm circumference. Other studies have also reported a cutoff point between 29.5 and 30 cm (Bhargava et al. 1985; Singh et al. 1988; Arisoy and Sarman 1995) and WHO collaborative study recommended a cutoff point of 30 cm (WHO collaborative study).

CONCLUSION

Detection of LBW immediately at birth is of paramount importance to ensure infant's survival, thus validity of cut off values of anthropometric parameters depict that mid arm circumference ≤8.44 and chest circumference ≤29.16 had better sensitivity for identifying infants weighing < 2,500 gms.

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