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Research Paper

Comparison of Various Anthropometric Parameters as Predictors of the Birth Weight in Newborns

Medical Science

KEYWORDS : Anthropometry, birth weight, crown heel length, circumference - mid arm, head, chest, calf

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ABSTRACT

Birth weight is a most reliable and sensitive indicator of the neonatal health. There is high prevalence of low birth weight babies (30% to 40%) in India as compared to the developed countries (5% to 7%). A major factor contributing to high prevalence of low birth weight is failure to identify high risk babies and to institute timely management. There is constant search for the newer, simpler and better methods to identify low birth weight babies, which can be used by the traditional birth attendants or the people attending the deliveries at home. Neonatal anthropometry is a simple reliable and reproducible method that can be used to identify low birth weight babies.

Aim: To find out the anthropometric parameter that can best identify low birth weight babies

Method: This observational, crosssectional study included total 306 full term, normal, singleton newborns (163 male & 143 female). Each was subjected to anthropometric measurements like birth weight, crown to heel length and circumference of head, chest, mid arm, abdomen, thigh & calf. Analysis of the data was done by using statistical methods like Mean & Standard deviation, Correlation, Step-down multiple regression analysis, linear regression analysis, sensitivity & specificity.

Results & conclusion: The mean birth weight of male newborns was higher (2719.3 gm) as compared to the female newborns (2597.6 gm). Statistically significant difference was observed in the mean values of crown to heel length and head circumference (P<0.001). Highest correlation of birth weight was observed with mid arm circumference and calf circumference in either sexes. Chest circumference (Mean critical limit = 29.3 cm) has the best sensitivity and specificity in predicting the low birth weight babies regardless of the sex, followed by the crown to heel length.

INTRODUCTION:

"There is no indicator in human biology which tells us so much about the past events and the future trajectory of life, as the weight of infant at birth" – V Ramalingaswami [1]

Birth weight, as a most reliable and sensitive indicator of the neonatal health, was recognized much earlier by the workers in this field, and reported for the first time by Miller in 1886 [2]. Many diseases with multifactorial etiology like coronary artery disease and diabetes are supposed to have their origin in the fetal and early postnatal life. Therefore, routine monitoring of the antenatal growth, assessment of height and weight at birth, and re-evaluation of the same at the end of infancy are gaining great attention [3].

Less than 60% of the pregnant women receive antenatal care in India, most of which is of poor quality. The percentage of hospital deliveries in rural India is only 24.5%. Of the remaining domiciliary births, only 47.8% are attended by traditional birth attendants (dais) [4]. Therefore, there is high prevalence of low birth weight babies (30% to 40%) in India as compared to the developed countries (5% to 7%) [4]. This is reflected in having high perinatal mortality rate, which is about 8 times higher as compared to the Western countries [5].

Besides poor quality of life, a major factor contributing to high prevalence of low birth weight is failure to identify high risk babies and to institute timely management. This is because use of accurate weighing scales is difficult in rural and tribal areas in India, due to nonavailability of weighing scales and higher percentage of home deliveries [6].

Hence, there is constant search for the newer, simpler and better methods to identify low birth weight babies, which can be used by the traditional birth attendants or the people attending the deliveries at home. In 1919, Ylppo [2] suggested that besides weight, other anthropometric measurements should also be used for finding out high risk babies. Since then many workers (Gupta et al [5]- calf circumference, S Ramji [7]– thigh circumference & mid arm circumference, J Neela [6] -) have tried using various anthropometric parameters to find out low birth weight babies.

Because of the scarcity of such studies in Maharashtra and the curiosity to find out one amongst many anthropometric parameters that can best predict the birth weight, the study was undertaken.

MATERIAL & METHODS

This observational, crosssectional study was conducted in the post-natal ward of Sassoon General Hospitals, Pune, with prior permission of dept of obstetrics, in the period between March 2000 to January 2001. Total 306 full term, normal, singleton newborns (163 male & 143 female) were subjected to anthropometric measurements like birth weight, crown to heel length, circumference of head, chest, mid arm, abdomen, thigh & calf. Preterm/post term babies, babies with congenital anomalies & twins were excluded. All the measurements were taken after a due consent from the mother/father, by same person throughout the study period, within 48 hrs of delivery and confirmed twice before recording.

The weight was recorded by a beam balance weighing machine to the nearest of 20 gm. Crown to heel length was measured by using infantometer calibrated in cm to the nearest of 1mm [2]. Other measurements were taken with the help of a non-stretchable measuring tape in cm.

Head circumference was measured at a point one inch above the glabella anteriorly and the maximum point of occipital protuberance posteriorly. Chest circumference was measured at the level of xiphoid cartilage, in mid-inspiration, with the tape perpendicular to long axis of trunk. Mid arm circumference was measured at a level corresponding to the midpoint of the line joining the tip of acromion above & tip of olecranon below in an extended elbow, on left side only. Abdominal girth was measured in mid inspiration at a level just above the attachment of umbilical cord to abdominal wall, with tape perpendicular to the trunk and just touching the perimeter of abdomen. Thigh circumference was measured on left side with hip extended at the level of lowest gluteal furrow. Calf circumference was measured at the most prominenet point of left calf in semiflexed position of leg [8,9].

RESULTS

Anthropometric data was collected from 163 male and 143 female newborns (n=306). The data was analysed using SPSS software. The statistical methods used were Mean & Standard devia-

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tion, Correlation, Step-down multiple regression analysis, linear regression analysis, sensitivity & specificity.

Table 1: Gender wise Mean & Standard deviation

S No	Parameters	Sex	Mean	SD	P
1	Birth Weight (gm)	M	2719.3	385.9	< 0.01
		F	2597.6	326.5	
2	Crown Heel length (cm)	M	47.9	1.9	<0.01
		F	47.2	1.8	
3	Head Circumference	M	33	1.2	<0.001
		F	32.2	1.1	
4	Chest circumference	M	30.4	1.6	>0.05
		F	30.1	1.7	
5	Mid arm circumference	M	9.2	0.8	>0.05
		F	9.1	0.7	
6	Abdominal girth	M	28.4	1.7	>0.05
		F	28.3	1.7	
7	Thigh circumference	M	15.2	1.3	>0.05
		F	15.2	1.3	
8	Calf circumference	M	10.1	0.8	>0.05
		F	10	0.7	

The mean birth weight of male newborns was higher (2719.3 gm) as compared to the female newborns (2597.6 gm). Statistically significant difference was observed in the mean values of crown to heel length (P< 0.01) and head circumference (P<0.001) among male and female newborns than other anthropometric parameters. **(Table 1)**

Table 2: Correlation matrix for male & female newborns

S No	Parameters	Sex	BW	CHL	HC	CHC	MAC	AG	TC	CC
1	Birth Weight (gm)	M	1							
		F	1							
2	Crown Heel length (cm)	M	0.82	1						
		F	0.71	1						
3	Head Circumference	M	0.69	0.62	1					
		F	0.69	0.62	1					
4	Chest circumference	M	0.83	0.73	0.56	1				
		F	0.72	0.56	0.64	1				
5	Mid arm circumference	M	0.84	0.64	0.57	0.77	1			
		F	0.79	0.52	0.62	0.74	1			
6	Abdominal girth	M	0.74	0.65	0.52	0.80	0.63	1		
		F	0.74	0.55	0.50	0.75	0.69	1		
7	Thigh circumference	M	0.83	0.66	0.49	0.84	0.84	0.70	1	
		F	0.77	0.57	0.55	0.65	0.85	0.77	1	
8	Calf circumference	M	0.84	0.67	0.69	0.85	0.85	0.68	0.90	1
		F	0.79	0.59	0.64	0.68	0.87	0.70	0.86	1

Highest correlation of birth weight was observed with mid arm circumference and calf circumference in either sexes (correlation coefficient r=0.84 in males, 0.79 in females for both the parameters) followed by thigh circumference (r= 0.83 in males & 0.77 in females) & chest circumference (r=0.83 in males & 0.72 in females). **(Table 2)**

Table 3: Stepdown multiple regression analysis

Step No	Sex	Constant	Regression coefficient			R^2	Df	F	p
			CC	MAC	TC				
1	M	-1512.1	140.5	188.3	70.4	78.1	3,159	189.8	<0.001
	F	-1127.9	146.4	163.9	49.8	68.2	3,139	99.4	
2	M	-1535.8	220.5	219.2		77.2	2,160	271.0	<0.001
	F	-1137.4	187.7	202.6		67.4	2,140	145.2	
3	M	-1313.4	398.5			72.0	1,161	414.1	<0.001
	F	-928.0	350.6			63.3	1,141	243.8	

(R^2 =Coefficient of determination, df = degrees of freedom, F = F test)

The step down multiple regression analysis of birth weight with the three *best correlated* parameters i.e. calf circumference, mid arm circumference & thigh circumference showed that contribution of calf circumference alone was highest in explaining the variation in the birth weight (Coefficient of determination, R^2 = 72% in males & 63.3% in females). For calf circumference and mid arm circumference together, the R^2 = 77.2% in males & 67.4% in females. Addition of thigh circumference did not make much difference, R^2 = 78.1% in males & 68.2% in females. **(Table 3)**

Table 4: Regression equations to predict the birth weight from various parameters (n=306)

S No	Parameters (x)	Birth Weight (y) (gm) Y = mx+ b
1	Crown Heel length (cm)	Y = 149.6 x – 4459.2
2	Head Circumference	Y = 225.7 x – 4057.4
3	Chest circumference	Y = 168.5 x – 2442.3
4	Mid arm circumference	Y = 408.0 x – 1081.4
5	Abdominal girth	Y = 156.2 x – 1770.0
6	Thigh circumference	Y = 222.9 x – 729.6
7	Calf circumference	Y = 381.2 x – 1183.08

Table 5: Mean Critical limits of the parameters along with sensitivity and specificity to predict the low birth weight (n=306)

S No	Parameters (x)	Mean Critical limit (cm)	Sensitivity (%)	Specificity (%)
1	Crown Heel length (cm)	46.5	68	89
2	Head Circumference	31.8	44	88
3	Chest circumference	29.3	70	88
4	Mid arm circumference	8.7	57	90
5	Abdominal girth	27.3	60	88
6	Thigh circumference	14.5	63	86
7	Calf circumference	9.6	61	87

The linear regression analysis of the data provided us the regression equations [y (birth weight) = m (regression coefficient) * x (parameter) + b (intercept)] for each parameter to predict the birth weight in either sex **(Table 4).** Using the regression equations, the critical limits for each parameter for predicting the low birth weight were calculated separately for male and female newborns (y = 2500). Using the critical limits the sensitivity and specificity analysis was done separately for male & female newborns as well as for total number of newborns. It was observed that chest circumference (Mean critical limit = 29.3 cm) has the best sensitivity and specificity in predicting the low birth weight babies regardless of the sex, followed by the crown to heel length **(Table 5)**. In female newborns, chest circumference has the best sensitivity and specificity (72% & 86% resp) followed by abdominal girth (72% & 82% resp). In males crown to heel length has the best sensitivity and specificity (78% & 98% resp) followed by mid arm circumference (70% & 90% resp).

DISCUSSION

Identification of high risk babies and timely intervention are the majors that can reduce the high perinatal and neonatal mortality in low birth weight babies in rural & tribal India. As most of the deliveries in rural and tribal areas are home deliveries, it is important that the paramedical workers should be able to identify the high risk babies. Measurement of various anthropometric parameters in a newborn is of great significance especially when weighing balance is not available. A simple measuring tape is sufficient to measure these parameters making newborn anthropometry a simple, reliable, easily applicable, reproducible, inexpensive method to identify the high risk babies. So the present study was conducted to find out correlation of various anthropometric parameters with the birth weight and with each other, and to compare their efficacy in predicting the birth weight.

The present study of 306 fullterm newborns (163 male & 143 female) showed higher mean values for all the parameters in males than females except for thigh circumference which showed equal values for either sex. This is in accordance with

Kalra and Singh [2]. Most of the measurements showed no statistically significant difference between two sexes except birth weight, crown to heel length and head circumference.

All the antropometric parameters showed significant correlation with birth weight similar to the studies by Gupta [5], Neela [6] & Samal [10]. Best correlation was shown by calf circumference & midarm circumference as in the studies by Neela and Samal. However, the study by Gupta shows best correlation of birth weight with calf circumference, followed by thigh circumference & chest circumference.

The results of stepdown multiple regression analysis showed that calf circumference alone has contributed highest to the total variation observed in the birth weight. Addition of other parameters like thigh circumference and mid arm circumference improved the results slightly. These findings are similar to Neela [11].

By using the mean critical limits to calculate sensitivity and specificity to predict the birth weight, the chest circumference has shown the best sensitivity (70%) and specificity (88%), followed by crown to heel length. Studies by Gupta, Neela & Samal,[5,11,10] showed highest sensitivity and specificity for calf circumference followed by thigh circumference. The possible reasons for this difference could be, the smaller sample size in the present study, less number of low birth weight babies in the sample, and lower mean critical limits for all the parameters.

Thus, the present study shows chest circumference as the best parameter for screening low birth weight babies in contrast to other studies which show calf circumference as the best parameter. To arrive at authentic conclusion more studies are essential on much larger scale and in different parts of the country using uniform standardized techniques.

CONCLUSIONS

All the anthropometric parameters showed significant correlation with the birth weight and with each other, implying direct relation.

Among all the parameters studied, chest circumference is the best for screening low birth weight babies

The mid arm circumference should be used along with chest circumference to confirm the low birth weight babies

The western Maharashtrian babies have lower values for all the parameters compared to the babies in northern India

The birth weight, crown to heel length & head circumference are higher in male newborns compared to female newborns

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