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Original Research Article

Clinical study of the correlation of foot length and birth weight among newborns in a tertiary care hospital

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ABSTRACT

Background: Gestational age and birth weight are the two most useful parameters for assessing maturity of the newborn. Major causes of neonatal mortality are diseases associated with low birth weight babies (LBW). It has been shown that foot length measurement is particularly valuable in premature babies who are so ill that conventional anthropometric measurements cannot be carried out due to the incubator and intensive care apparatus.
Methods: The cross-sectional study was conducted in the department of pediatrics Sri Siddhartha Medical College Hospital, Tumkur, India. The birth weight in grams and length of the foot were documented in centimeters. Data was collected using standard proforma.
Results: A total of 600 neonates were studied of which, males were 54.67 % (328) and females were 45.33 % (272). The neonates weighing less than 2.5 kg had a mean foot length of 6.94. The mean foot length for neonates weighing between 2.5 to 3.5 was 7.68. The mean foot length for neonates weighing more than 3.5 kg was 8.2cm. The correlation coefficient of birth weight with foot length was maximum in low birth weight babies (r= 0.94).
Conclusions: The foot length is an efficient screening tool in identifying low birth weight babies. Foot length is a simple, quick and reliable anthropometric measurement which can be used as a proxy measurement to birth weight especially in sick and pre-term neonates receiving intensive care.

Keywords: Gestational age, Foot length, Low birth weight, Neonates

INTRODUCTION

Parameters of growth are the most sensitive indicators of nutritional status of the community. Gestational age and birth weight are the two most useful parameters for assessing maturity of the newborn. The biggest direct cause of neonatal death is complication due to preterm birth, leading to 35% of the 2.6 million neonatal deaths each year globally.[1] India's IMR remains high at 53/1000 live births. UNICEF estimated the IMR of India at 2020 as 35/1000 live births.

IAP has proposed mission 20/20 to accelerate the reduction in IMR with a target to achieve an IMR of 20 by the year 2020.[2] The most challenging part of infant mortality is large proportion of new born deaths, contributing to an estimated 64% of all infant deaths, mostly in the first week of life.[3] Accurate assessment of gestation maturity is not possible in all newborn infants specially when they are sick and need intensive care support.

Anthropometric measures such as: birth weight, crown heel length and head circumference are the commonly used measures of growth in neonates, and they do correlate fairly with maturity. Weight measurements are significantly affected by changes in water, carbohydrate, fat, protein, and mineral levels.[4] Major causes of neonatal

mortality are diseases associated with low birth weight babies (LBW). Thus, birth weight is an important indicator of survival, future growth and overall development of the child. It is associated with socio-economic, clinical, racial, hereditary, personal and geographical factors.[5] Low birth weight is associated with high neonatal morbidity and mortality due to susceptibility to adverse environmental influences, predilection to infections and difficulties in maintaining adequate nutrition. Low birth weight is also associated with post-neonatal mortality and with infant and childhood morbidity.

Low birth weight accounts for about 70% of all perinatal and 50% of all infant deaths in India.[6,7] Birth weight and gestational age have been traditionally used as strong indicators for the risk of neonatal death. For any given weight, shorter the gestational duration, higher will be neonatal mortality. For any given duration of gestation, lower the birth weight, higher will be neonatal mortality.

All these factors thus underline the importance of early identification of low birth weight in rural setup where no medical care facilities are available and hence early referral to higher centers. But the situation is worse due to non-availability of resources in the form of trained or expert health care staff and lack of basic facilities such as weighing machine.[8]

However, 74% of India's population live in rural areas. Most of the deliveries in rural areas are conducted at home by untrained relatives and dais where weight recording is a problem.[9] Thus, the present study was conducted with an aim to find out practicable method for identification of LBW babies and to find out an alternate, low cost, reliable method of low birth weight estimation which can be used by person with little training.

The foot of the new born is usually readily accessible for measurement, even in incubators. It has been shown that foot length measurement is particularly valuable in premature babies who are so ill that conventional anthropometric measurements cannot be carried out due to the incubator and intensive care apparatus. The aim of this study was to study correlation of foot length and birth weight among neonates.

METHODS

The present study was conducted in the department of pediatrics Sri Siddhartha Medical College Hospital, Tumkur, Karnataka, India, from November 2014 to September 2016. All new born babies born at or referred to Sri Siddhartha Medical College hospital within 48 hours of birth were included in the study. Newborns having congenital anomalies, dysmorphic features, vertebral, cranial, limb deformities and newborns after 48 hours of birth were excluded from the study. Foot length of all the babies was measured by using Plastic ruler. Foot length was measured from posterior most prominence of foot to the tip of the longest toe of the right foot. At the time of measuring ventral surface of foot was straightened out using gentle pressure. The length of foot was documented in centimeters. Data was collected using standard proforma meeting the objectives of the study.

The data collected will be entered in Microsoft Office Excel sheet and analyzed using Epi-Info 3.4.3 software. Descriptive statistics such as mean, median, standard deviation and proportion and Karl Pearson correlation co-efficient will be used to determine correlation between foot length and birth weight. Regression equation was derived to predict birth weight from foot length in various groups of babies.

RESULTS

The present study included a total of 600 neonates of which males were 54.67 % (328) and females were 45.33 % (272). In the study group 197 babies (32.84 %) were low birth weight babies, i.e. weight below 2.5 kg. 374 newborns (62.34 %) had birth weight in the range of 2.5-3.5 kg. 29 newborns (4.83 %) had birth weight >3.5 kg. Maximum number of newborns were in 2.5-3.5 kg group. Males predominate over females in all groups (Table 1).

The birth weight of 600 neonates studied ranged from 0.7-3.88 kg, with a mean of 2.64 kg and the standard deviation of 0.53 with 95% confidence interval for mean between 2.60 to 2.68 kg (Table 2). Of the 600 neonates studied, the mean foot length was 7.47 cm with a range of 5 - 8.5 cm and standard deviation of 0.56.

Table 1: Sex distribution of babies based on their birth weight.

Birth weight	Male		Female		Total	
	Number	**%**	**Number**	**%**	**Number**	**%**
<2.5	103	17.17	94.00	15.67	197	32.84
2.5-3.5	208	34.67	166.00	27.67	374	62.33
>3.5	17	2.83	12.00	2.00	29	4.84
Total	**328**	**54.67**	**272.00**	**45.33**	**600**	**100**

Table 2: Descriptive statistics of birth weight under different categories.

Birth weight	No. of subjects	Range	Mean	Standard deviation	95% confidence interval for mean	
					Lower bound	Upper bound
<2.5	197	0.7-2.48	2.05	0.42	1.99	2.11
2.5-3.5	374	2.5-3.48	2.88	0.24	2.86	2.90
>3.5	29	3.5-3.88	3.61	0.1	3.57	3.65
Total	**600**	**0.7-3.88**	**2.64**	**0.53**	**2.60**	**2.68**

The neonates weighing less than 2.5 kg had a mean foot length of 6.94. The minimum and maximum foot length of neonates was 5 cm and 7.7 cm, respectively in less than 2.5 kg neonates. The mean foot length for neonates weighing between 2.5 to 3.5 was 7.68.

The minimum and maximum foot length of neonates was 7 cm and 8.4 cm respectively in neonates weighing between 2.5 to 3.5 kg. The mean foot length for neonates weighing more than 3.5 kg was 8.2cm. The minimum and maximum foot length of neonates was 7.2 cm and 8.5 cm, respectively in more than 3.5 kg neonates (Table 3).

Table 3: Descriptive statistics of foot length according to birth weight of babies.

Birth weight	No. of subjects	Range	Mean	Standard deviation	95% confidence interval for mean	
					Lower bound	Upper bound
<2.5	197	5-7.7	6.94	0.56	6.86	7.02
2.5-3.5	374	7-8.4	7.68	0.31	7.65	7.71
>3.5	29	7.2-8.5	8.2	0.25	8.1	8.3
Total	**600**	**5-8.5**	**7.47**	**0.56**	**7.43**	**7.51**

Table 4: Correlation between birth weight and foot length in neonates.

Birth weight	No. of subjects	Correlation	R sq.	p value
<2.5 kg	197	0.94	0.88	<0.001
2.5-3.5 kg	374	0.64	0.41	<0.001
>3.5 kg	29	0.29	0.08	0.12

In the present study, it was observed that the birth weight correlated significantly ($p < 0.01$) with foot length in babies less than 3.5kgs, with highest co-relation for babies weighing less than 2.5kgs, with co-relation factor 0.94 (Table 4). The regression equation for birth weight was derived with foot length as the independent variable and birth weight as the dependent variable (Table 5).

Table 5: Regression equation of birth weight on foot length.

Birth weight(kg)	Dependent variable	Regression equation
<2.5	Birth weight	BW=-2.69+0.151 FL
2.5-3.5	Birth weight	BW =-0.9+0.23 FL
>3.5	Birth weight	BW =2.63+ 0.6FL

DISCUSSION

Of the 600 neonates studied, male neonates were more than female neonates in number consisting 54.67% and 45.33% respectively. This is comparable to the study done by Elizabeth et al where 54% were male and 46% females out of 706 neonates studied. Gurudutt Joshi et al study showed that, out of 316 low birth weight newborns 172 (54%) were male and 144 (46%) were females.[10,11]

A total of 500 newborns (52.2% male and 47.8% female) were studied by Negar Sajjadian et al. Ashish KC et al study showed 53.1% males and 46.8% females out of 811 neonates studied.[12,13] In the study done by Amar M.T et alit was 51.34 % males and 48.65 % females out of 520 neonates studied.[14]

The birth weight of 600 neonates studied ranged from 0.7-3.88 kg with a mean of 2.64 kg. LC Mullany et al. studied 1640 infants.[15] Among them, 469(28.6%) were low birth weight. In these 469 neonates, the mean birth weight was 2.22(±0.23) kg ranging between 1.25 to 2.49 kg.

Satarupa Mukherjee et al. study showed that 182 (51.8%) were LBW (<2.5 kg) out of 351 neonates studied.[16] The mean birth weight was 2.09 (±0.81) kg. In the study done by Elizabeth et al.[10] the birth weight ranged from 1.37–5.35 kg with a mean of 3.05 kg (SD 0.53) with 85 (12%) babies having a birth weight less than 2500 grams.

In the study done by Modibbo, M. H et al. mean birth weight (BW) was 3.08 ± 0.55 kg, with minimum and maximum values of 1.50 and 5.50 respectively.[17] Ashish KC et al study showed that the mean birth weight of the infants was 2.929 ± 0.532 kg and there were 30 infants who were LBW (3.7%)[13] The mean birth weight of these LBW infants was 1.631 ± 0.24 kg. In the study done by Amar M.T et al in 520 neonates, the mean birth weight was 2.55kg with standard deviation of 0.40285.[14]

Of the 600 neonates studied the mean foot length was 7.47 cm with a range of 5 - 8.5 cm and standard deviation of 0.56. The neonates weighing less than 2.5 kg had a mean foot length of 6.94. The minimum and maximum foot length of neonates was 5 cm and 7.7 cm, respectively in less than 2.5 kg neonates. The mean foot length for neonates weighing between 2.5 to 3.5 was 7.68. The minimum and maximum foot length of neonates was 7 cm and 8.4 cm respectively in neonates weighing between 2.5 to 3.5 kg.

The mean foot length for neonates weighing more than 3.5 kg was 8.2cm. The minimum and maximum foot length of neonates was 7.2 cm and 8.5 cm, respectively in more than 3.5 kg neonates. This shows that as the birth weight increases, the foot length also increases. This is comparable to study done by LC Mullany et al. in which 469 low birth weight neonates had mean foot length of 6.8 (±0.4) ranging between 5.7 and 7.7cms.[15]

In the study done by Elizabeth et al., the mean value for foot length was 7.9cm in 711 neonates studied ranging between 6.0 and 9.3.[10] In neonates less than 2.5kg, the mean foot length was 7.2cm. In the study done by Modibbo, M. H et al. mean value for foot length was 8.12 ± 0.58 cm; the minimum value was 6.30 cm, while the maximum value was 9.50 cm.[17] In the study done by Amar M.T et al in 520 neonates, the mean foot length was 7.83cm with standard deviation of 2.21 (Table 6).[14]

Table 6: Mean and Standard deviation of foot length in various studies.

Study	Mean foot length	Standard deviation
LC Mullany et al	6.8cm	0.4
Elizabeth et al	7.2cm	0.46
Modibbo, M. H et al	8.12cm	0.58
Amar M.T et al	7.83cm	2.21
Present study	6.94cm	0.56

Though the mean foot length of many of the above studies showed there is a positive linear relationship between foot length and birth weight, the correlation coefficient (r-value) of foot length and birth weight was different in different studies. The birth weight correlated well with one or many anthropometric measurements, though the extent of correlation was different for different birth weight groups (Table 7).[10,14,16,17]

Table 7: Correlation of foot length with birth weight in various studies (r-value).

Study	Correlation coefficient (r) for foot length
Satarupa Mukherjee et al	0.973
Elizabeth et al	0.76
Modibbo, M. H et al	0.657
Amar M.T et al	0.715
Present study	0.94

The regression equation for birth weight was derived with foot length as the independent variable and birth weight as the dependent variable. In neonates <2.5 kg, the estimation of birth weight can be done using the regression equation BW=-2.69+0.151 FL (Table 8).[16-18]

Table 8: Regression equation for birthweight using foot length in various studies.

Study	Regression equation
Minhajuddin Ahmed et al	BW(male)= (0.377) x FL – (-0.44) BW(female)= (0.424) x FL – (-0.444)
Holambe V. M. et al	BW=470.33 x FL - 1066.88
Modibbo, M. H et al	BW = 0.624 x FL- 1.98
Present study	BW = 0.151 x FL- 2.69

CONCLUSION

Significant correlation was observed between foot length and birth weight in new born with low birth weight (< 2.5 kg) and in new born with birthweight between 2.5 to 3.5 kg. The correlation (r value) of birth weight with foot length was higher in neonates weighing less than 2.5 kg (r = 0.94) than in neonates whose birth weight was between 2.5 and 3.5 kg (r = 0.64). Low birth weight babies showed higher correlation (r value) of birth weight with foot length. The foot length is an efficient screening tool in identifying low birth weight babies. Foot length is a simple, quick and reliable anthropometric measurement which can be used as a proxy measurement to birth weight especially in sick and pre-term neonates receiving intensive care. It can be easily measured by medical practitioners and traditional birth attendants in the community.

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