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Original Article

Paediatrics Section

Newborn with Small Feet

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ABSTRACT

Introduction: The birth weight indicates maternal and child health, and reflects the health of the overall community. Low birth weight is strongly associated with neonatal, infant and child morbidity and mortality.

Aim: To evaluate the correlation of foot length to birth weight in new born so as to use it as a proxy measure for detecting low birth weight neonates.

Materials and Methods: A pilot study was carried out on a prospective basis over a period of three months from June 2019 to August 2019 in our tertiary care centre. All consecutive inborn neonates were included in the study. Values of birth weight in grams using digital weighing scale and foot length in centimetres using callipers were recorded. Data was tabulated in the standard proforma and statistical analysis done by SPSS software.

Results: A total of 60 neonates were included in the study. The mean foot length and birth weight was 7.59 cm and 2850 g. Foot length had a linear correlation with birth weight which was statistically significant (p>0.01). The mean foot length birth weight below 2500 grams, 2500 to 3500 grams and more than 3500 grams were 7.0cm, 7.63cm and 8.17, respectively.

Conclusion: The foot length correlates well with birth weight of the neonate, and can be a proxy measure for birth weight. This simple, easy, anthropometric variable can be used for screening for low birth weight in hospital and community with a proposed cut-off of 7.2 cm.

Keywords: Foot length, Low birth weight, Prematurity

INTRODUCTION

The Birth Weight (BW) not only indicates maternal and child health, morbidity and mortality, but in fact reflects the health of the community, country and region. Birth weight is strongly associated with neonatal, infant and child morbidity and mortality.

The birth weight is indicative of the immediate and long-term viability and quality of life of the neonate and the generations to come [1].

Even as late 2010, it is reported that in India, about 45% births in urban and 75% births in rural areas take place outside health care facilities, usually at homes or even outside in fields, cowsheds, public places or during transport in vehicles [2]. Many times, these deliveries are not even under the supervision of basic trained persons like midwives and dais. The coverage of home deliveries by the presence of a trained birth attendant both in rural and urban settings is a dismal 25% [2].

Though the Indian government has been working from 2000 towards changing the scenario with an increased commitment to institutional deliveries and universal access to high-quality intrapartum and Emergency Obstetrical Care (EmOC), yet in 74% population in rural areas, a significant proportion of deliveries still are conducted at home [3].

The importance of prompt identification of low birth weight in rural areas with meagre medical care facilities and early referral to higher centres cannot be denied. Practical difficulties are of health care staff and accurate working weighing machine. Hence various anthropometric measurements such as crown heel length and head circumference have been identified as proxy measure for birth weight but they still require a health worker for proper measurement [4].

Foot Length (FL) is simple, cheap, easy to perform, rapid, requiring less handling and disturbance to the baby and can be used even by the mother/caretaker. Studies indicate it to be a suitable tool with high sensitivity and specificity. Thus, foot length; an anthropometric measurement must be the essential alternative method, a proxy measure for estimation of birth weight that researchers are questing. It can be developed as the screening tool for identifying low birth weight [5,6]. Thus,

the present study was aimed to evaluate the correlation of foot length to birth weight in new born so as to use it as a proxy measure for detecting low birth weight neonates.

MATERIALS AND METHODS

The present study was a pilot study which was carried out on a prospective basis for the period of three months (Duration: June 2019 to August 2019) by Department of Paediatrics & Neonatology. This hospital is a teaching hospital attached to East Point College of Medical Sciences and Research Centre, Bangalore, Karnataka, India. It is a fledging tertiary care referral centre with a dedicated paediatric department and neonatal unit with intensive care facilities, in the outskirts of Bengaluru, the state capital catering to a predominantly rural population and drawing patients from Chikkabalapura, Kolar and Bengaluru Rural and Urban districts of Karnataka and also the adjoining Chittoor and Anantpur districts, Andhra and Krishnagiri district, Tamil Nadu. All consecutive inborn neonates born after the gestational age of viability (28 weeks) were included in the study. Neonates with congenital anomalies, dysmorphic features, vertebral, cranial, limb deformities and out born neonates were excluded from the study.

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 measurement was carried out using same standard metallic calliper. The length of foot was documented in centimetres. All the measurements were recorded within 24 hours of birth by single observer (paediatrician). Babies were weighed naked on the same digital weighing machine nearest to 50 g in the delivery room. Informed consent of the parents and Institutional Ethical committee (IEC) was obtained.

STATISTICAL ANALYSIS

Data was collected using standard proforma meeting the objectives of the study and tabulated accordingly by entering into Microsoft Office Excel sheet. Statistical analysis was carried out using Package for Social Sciences (SPSS) software version 17. Descriptive statistics such as mean, standard deviation and Karl Pearson correlation coefficient were used to determine correlation between foot length and birth weight. Regression equation was derived to predict birth weight from foot length. The sensitivity, specificity and accuracy of using a cut-off of 7.2 cm of newborn foot length as a screening tool to identify low birth weight was analysed.

RESULTS

The present study included a total of 60 neonates of which males were 33 and females were 27 with a ratio M:F=1.1:0.9. In the study group 10 babies (16.67 %) had weight below 2500 gram that is Low Birth Weight (LBW). Forty four newborns (73.33 %) had birth weight in the range of 2500 to 3500 gram. Six newborns (10%) had birth weight greater than 3500 gram. Maximum number of newborns was in 2500 to 3500 gram group.

The birth weight of 60 neonates studied ranged from 1840 gram to 3720 gram, with a mean of 2850 gram and the standard deviation of 420 gram. The mean foot length was 7.59 cm with a range of 6.2 to 8.7 cm and standard deviation of 0.51 [Table/Fig-1].

The neonates weight ranges with range, mean and standard deviation of foot length is analysed and shown in [Table/Fig-1].

Birth weight in g	Number	Range in cm	Mean Foot length in cm±Standard deviation
<2500	10	6.2-7.9	7.04±0.52
2500-3500	44	7.09-8.4	7.63±0.38
>3500	6	7.8-8.7	8.17±0.38
Total	60	6.2-8.7	7.59±0.51

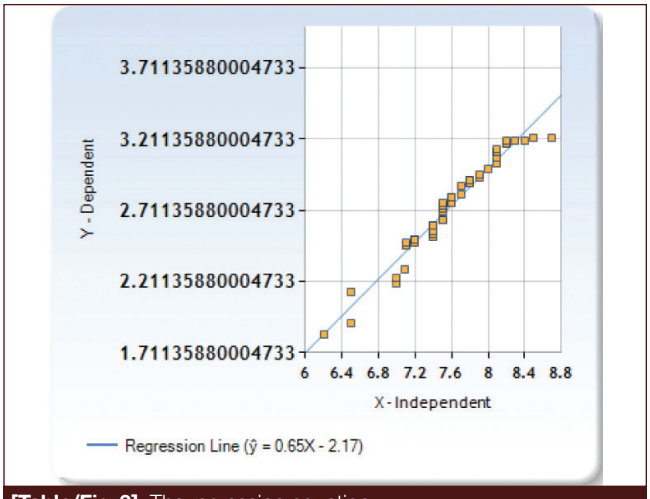
[Table/Fig-1]: Number of neonates in each weight group with mean foot length and standard deviation.

On Karl Pearson correlation analysis the following results were obtained [Table/Fig-2].

Birth weight in g	Correlation coefficient (r)	r^2	p-value
<2500	0.569	0.31	p=0.092 (p<0.1)
2500-3500	0.485	0.23	p=0.0008 (p<0.01)
>3500	0.807	0.66	p=0.05 (p<0.1)

[Table/Fig-2]: Shows different weight groups and their correlation coefficient to foot length.
Overall, Foot length had a linear positive correlation with birth weight with correlation coefficient r=0.98, r^2= 0.96 and p =0.00001 which was statistically significant (p<0.01)

The regression equation for birth weight was derived with foot length as the independent variable and birth weight as the dependent variable [Table/Fig-3].



[Table/Fig-3]: The regression equation.

BW=0.64638 FL- 2.16694

Authors propose a cut-off of 7.2 cm as foot length for screening of all neonates below which birth weight is likely to be less than 2500 g that is low birth weight. This has a sensitivity of 90.9 %, specificity of 91.8%, Positive Predictive Value (PPV) 71.4%, and Negative Predictive Value (NPV) of 97.8% and overall accuracy of 91.7%.

DISCUSSION

When the majority of deliveries occur at homes, especially in rural regions and backward communities lack of reliable and handy methods of measuring birth weight makes early identification of low birth weight babies difficult. Early identification of low birth weight neonates helps in reducing the attendant mortality and morbidity.

To quote the first Indian study by Kulkarni ML; Rajendran NK in JJM Davanagere, Karnataka in 1992 published in Indian Paediatrics "Because of the potential diagnostic implication of the foot length measurement the present study was undertaken" [7].

The present study was a pilot study of short duration of three months with n=60 to study the birth weight and foot length correlation in an effort to establish foot length measurement as a proxy for birth weight and thereby use it as a screening tool for identifying low birth weight neonates.

Many larger studies with long term duration have also been carried out previously studying birth weight, gestational age and various anthropometric indices including foot length. The numbers included for some of the studies is given below: Kulkarni ML et al., n= 817; Gowri S et al., n=600; Srinivasa S et al., n=500; Mukherjee S et al., n= 351; Amar MT et al., n=520; Ashish KC et al., n= 811; Mullany LC et al., n = 1640; Saroj AK et al., N=250; Sudhapriya P et al., n=1000; Akukwu DA et al., n=1000; Elizabeth N et al., n= 706. However, only few of these studies have specifically focussed on the relationship between birth weight and foot length of the neonate, [1,2,4,7-14].

The sex ratio in this pilot study was skewed with a slight male preponderance with 55.5% males as against 44.5% females. This finding is similar to studies in India which have reported slight male preponderance. The studies with the male percentage are as follows: Srinivasa S et al., 55.4%; Gowri S et al., 54.6%; Joshi G et al., 54%; Negar S et al., 52%, Amar MT et al., 51%, Rakkappan I et al., 53.7%. Saroj AK et al., was the only author reporting a female preponderance [4,8,10,13,15-17].

Other studies in developing countries also found a slight male preponderance with Ashish KC et al., in Nepal reporting 53% males and African studies reported 54% by Elizabeth N et al., in Uganda and 52% by Akukwu DA et al., in Nigeria [1,11,14]. Mean birth weight in the present study was around 2850 gram. This is similar to recent studies in India where the mean birth weight is reported as 2640 gram by Gowri S et al., 2740 gram by Srinivasa S et al., and 2929 gram by Ashish KC et al., in Nepal [Table/Fig-4] [2,4,8-11].

Studies	Mean BW (kg)	Mean FL (cm)	Correlation coefficient (r)
Present study	2.85	7.59	0.98
Mukherjee S et al., 2013 [9]	2.09	7.23	0.973
Gowri S et al., 2017 [4]	2.64	7.47	0.94
Amar MT et al., 2016 [10]	2.55	7.83	0.715
Srinivasa S et al., 2017 [8]	2.92	7.58	0.87
Sudha Priya P et al., 2019 [2]	2.54	7.39	0.921

[Table/Fig-4]: Shows the comparison of mean foot length, birth weight and correlation coefficient with other studies [2,4,8-10].

In neonates with birth weight less than 2500 gram i.e., low birth weight the mean foot length was as follows. Our present study noted mean foot length of 7.06 cm versus 6.94 cm and 7.2 cm as noted by Gowri S et al., and Elizabeth N et al., [4,14].

Correlation coefficient (r) for birth weight and foot length in the neonate in the present study is 0.98. This was in coherence with previous papers by Gowri S et al., 0.94; Mukherjee S et al., 0.973; Mathur A et al., 0.98 [4,9,18]. African studies report much lower correlation coefficients with Elizabeth N et al., at 0.76 and Modibbo MH et al., at 0.657 [14,19].

Hereby, derived the regression equation for birth weight with foot length as the independent variable and birth weight as the dependent variable in the present study.

BW=0.64638 FL-2.16694

The regression equation has been derived differently by previous authors from their data analysis [2,3]. At the completion of our data analysis we propose a cut-off of 7.2 cm as foot length for screening of all neonates below which birth weight is likely to be less than 2500 gram (low birth weight). This has a sensitivity of 90.9%, specificity of 91.8%, PPV 71.4%, and NPV of 97.8% and overall accuracy of 91.7% [Table/Fig-5] [8,12,20,21].

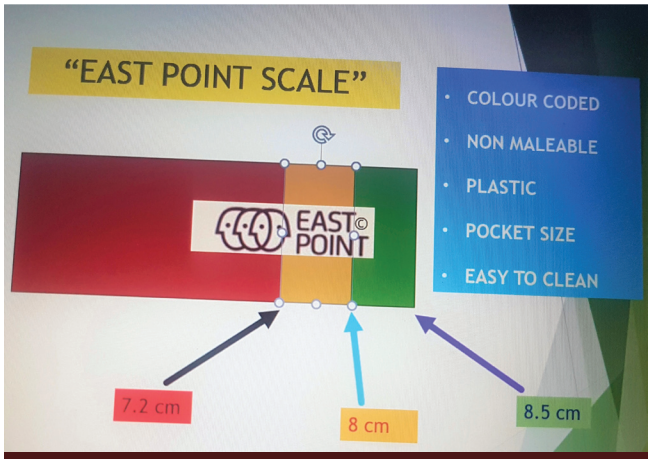
Various researchers through previous studies have proposed different cut-offs of foot length in the neonate at birth or early neonatal period for screening for low birth weight. The cut-off values suggested is as follows. Mathur A et al., 7.2 cm; Saroj AK et al., 7.27 cm; Sudha Priya P et al., 7.3 cm; Srinivasa S

7.4 cm; Mullany LC et al., 7.4 cm; Kulkarni MI 7.5 cm; Hirve SS 7.6 cm; Mukherjee S et al., 7.9 cm; Marchant T et al., 8 cm [3,7,8,9,12,13,18,20,22].

It is already known that the birth weight and foot length of the neonate have significant positive correlation. Foot length could be the ideal simple accurate proxy to birth weight assessment that would be a boon in resource limited settings to be a handy screening tool to detect low birth weight with a proposed cut-off of 7.2 cm with a colour coded 'EAST POINT' scale [Table/Fig-6].

Studies	Cut-off FL (cm)	Sensitivity	Specificity
Present study	7.2	90.9	91.8
Srinivasa S et al., 2017 [8]	7.4	97	87
Mullany LC et al., 2007 [12]	7.4	97.03	87.05
Marchant T et al., 2010 [20]	8	87	60
Holambe VM et al., 2014 [21]	6.75	92.8	65

[Table/Fig-5]: Comparison table showing the cut-off foot length with specificity and sensitivity with other studies [8,12,20,21].



[Table/Fig-6]: EAST POINT scale.

LIMITATIONS

Our study had certain limitations. Pilot study, hospital based, small sample size, foot lengths measured within 24 hours of life and no community trial.

CONCLUSION

Foot length may be considered an alternate anthropometric parameter to birth weight to detect low birth weight babies, especially in remote rural backward areas in developing and under developed countries and regions. Implementation on a large scale is likely to be simple, low cost, handy, less technology based and least demanding on constrained and sparse medical personnel and logistics.

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