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Original Research Article

Correlation of foot length with birth weight and gestational age in newborns

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ABSTRACT

Background: The objective is to determine the correlation between foot length and birth weight and gestational age, and to evaluate the diagnostic accuracy of foot length in identifying low birth weight (LBW) and preterm newborns, within 24 hours of birth.

Methods: This descriptive observational study was conducted in a tertiary care teaching hospital in Bengaluru from July 2025 to April 2026. 200 newborns within 24 hours of birth were enrolled. Foot length was measured using a transparent plastic ruler, birth weight using a digital weighing scale, and gestational age was assessed using the New Ballard Score. Correlation between foot length, birth weight, and gestational age was analyzed using Pearson's correlation coefficient. Receiver operating characteristic (ROC) curve analysis was performed to determine the diagnostic accuracy of foot length in identifying low birth weight and gestational age categories.

Results: The mean gestational age, birth weight, and foot length were 37.68±2.27 weeks, 2.83±0.55 kg, and 7.83±0.57 cm, respectively. Foot length showed a strong positive correlation with birth weight ($r=0.83$, $p<0.001$) and gestational age ($r=0.77$, $p<0.001$). Preterm neonates had significantly lower foot length than term neonates (7.23±0.87 cm vs 7.99±0.31 cm; $p<0.001$). Foot length increased significantly across birth weight categories ($p<0.001$). ROC analysis demonstrated excellent discriminatory ability for identifying LBW neonates (AUC=0.92). A foot length cut-off of ≤7.7 cm predicted LBW with 83.3% sensitivity and 87.3% specificity.

Conclusions: Neonatal foot length correlates strongly with birth weight and gestational age and may serve as a simple, inexpensive, and reliable screening tool for identifying LBW and preterm newborns, particularly in resource-limited settings.

Keywords: Foot length, Birth weight, Gestational age, Low birth weight, Prematurity

INTRODUCTION

Birth weight and gestational age are important determinants for the growth, maturity and survival of the newborn. Therefore, accurate assessment of birth weight and gestational age is essential. In peripheral and rural healthcare settings in India, reliable weighing scales, methods for assessment of gestational age and trained personnel may not always be available.

Hence simple anthropometric measurements like foot length can be used as a surrogate marker for birth weight and gestational age in newborns.[1-3] Several studies have reported a positive correlation between foot length and neonatal anthropometric indices.[4-10]

This study aimed to determine the correlation between foot length, birth weight, and gestational age among newborns.

METHODS

Study design

Hospital-based descriptive observational study.

Study setting

Department of Pediatrics and Neonatology, Kempegowda Institute of Medical Sciences, Bengaluru.

Study duration

9 months (11 July 2025 to 11 April 2026).

Study population

Two hundred live-born neonates examined within 24 hours of birth.

Inclusion criteria

All newborn babies born in Kempegowda Institute of Medical Sciences within 24 hours of life whose mothers/legal guardians give valid written consent for examination.

Exclusion criteria

Newborns with any congenital limb anomalies.

Methodology

Detailed maternal history, maternal comorbidities and birth history of the newborn were recorded in a predesigned proforma. Routine newborn examination was done. Foot length of the newborns was measured from the posterior most prominence of the left foot to the tip of the longest toe by a stiff transparent plastic ruler.[11,12] The birth weight of the babies was measured on the calibrated digital weighing scale to the nearest 5 g, protective measures to prevent hypothermia were taken while weighing the baby. Gestational age was calculated by New Ballard score.[13]

Statistical analysis

Descriptive statistics were used to summarize the study variables and were expressed as mean±standard deviation, median with interquartile range, frequency, and percentage. Pearson correlation test was used to assess the correlation of neonatal foot length with birth weight, gestational age. Comparison of mean foot length between two groups was performed using the Independent Samples t-test, and comparison across birth weight categories was performed using one-way ANOVA. Receiver Operating Characteristic (ROC) curve analysis was performed to determine the diagnostic accuracy of foot length in identifying low birth weight and preterm neonates by calculating the area under the curve, sensitivity, specificity, and optimal cut-off values (determined using the Youden index). All statistical analyses were performed using SPSS version 25.0. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Among 200 newborns, 101 were male and 99 were female. The mean birth weight was 2.83±0.55 kg, mean gestational age was 37.68±2.27 weeks, and mean foot length was 7.83±0.57 cm. Low birth weight was present in 47 newborns, while 42 newborns were preterm. Foot length showed a strong positive correlation with birth weight: Pearson r=0.83, p<0.001. Foot length also showed a strong positive correlation with gestational age: Pearson r=0.77, p<0.001. Low birth weight babies had significantly lower foot length than babies weighing ≥2.5 kg: 7.18±0.78 cm vs 8.02±0.29 cm; p<0.001. Preterm babies also had significantly lower foot length than term babies: 7.23±0.87 cm vs 7.99±0.31 cm; p<0.001. There was no statistically significant difference in foot length by gender, mode of delivery, or maternal comorbidity. ROC analysis showed that foot length had excellent discrimination for low birth weight, with AUC=0.92. A foot length cut-off of approximately 7.7 cm identified low birth weight with 83.3% sensitivity and 87.3% specificity. For preterm birth, ROC AUC was 0.833, with a cut-off of approximately 7.5 cm showing 54.8% sensitivity and 92.4% specificity.

Table 1: Distribution of continuous study parameters.

Parameters	Mean±SD	Median (IQR)	Range
Gestational age, weeks	37.68±2.27	38.07 (37.11–39.14)	26.00–40.86
Birth weight, kg	2.83±0.55	2.92 (2.54–3.17)	0.74–4.21
Foot length, cm	7.83±0.57	7.90 (7.70–8.10)	4.50–9.00

Table 2: Foot length by gestational age and birth weight category.

Category	N (%)	Foot length, mean±SD, cm	Foot length, median (IQR), cm	P value
Gestational age				
Preterm, <37 weeks	42 (21.0%)	7.23±0.87	7.50 (6.93–7.80)	<0.001

Continued.

Category	N (%)	Foot length, mean±SD, cm	Foot length, median (IQR), cm	P value
Term/post-term, ≥37 weeks	158 (79.0%)	7.99±0.31	8.00 (7.80–8.20)	
Birth weight				
Very low birth weight, <1.5 kg	5 (2.5%)	5.64±1.21	5.30 (4.60–6.60)	<0.001
Low birth weight, 1.5–2.49 kg	42 (21.0%)	7.38±0.45	7.50 (7.20–7.67)	
Normal birth weight, 2.5–3.99 kg	150 (75.0%)	8.01±0.28	8.00 (7.80–8.20)	
Macrosomia, ≥4.0 kg	3 (1.5%)	8.53±0.42	8.40 (8.30–8.70)	

p values derived from independent samples t-test (gestational age, two groups) and one-way ANOVA (birth weight, four groups).

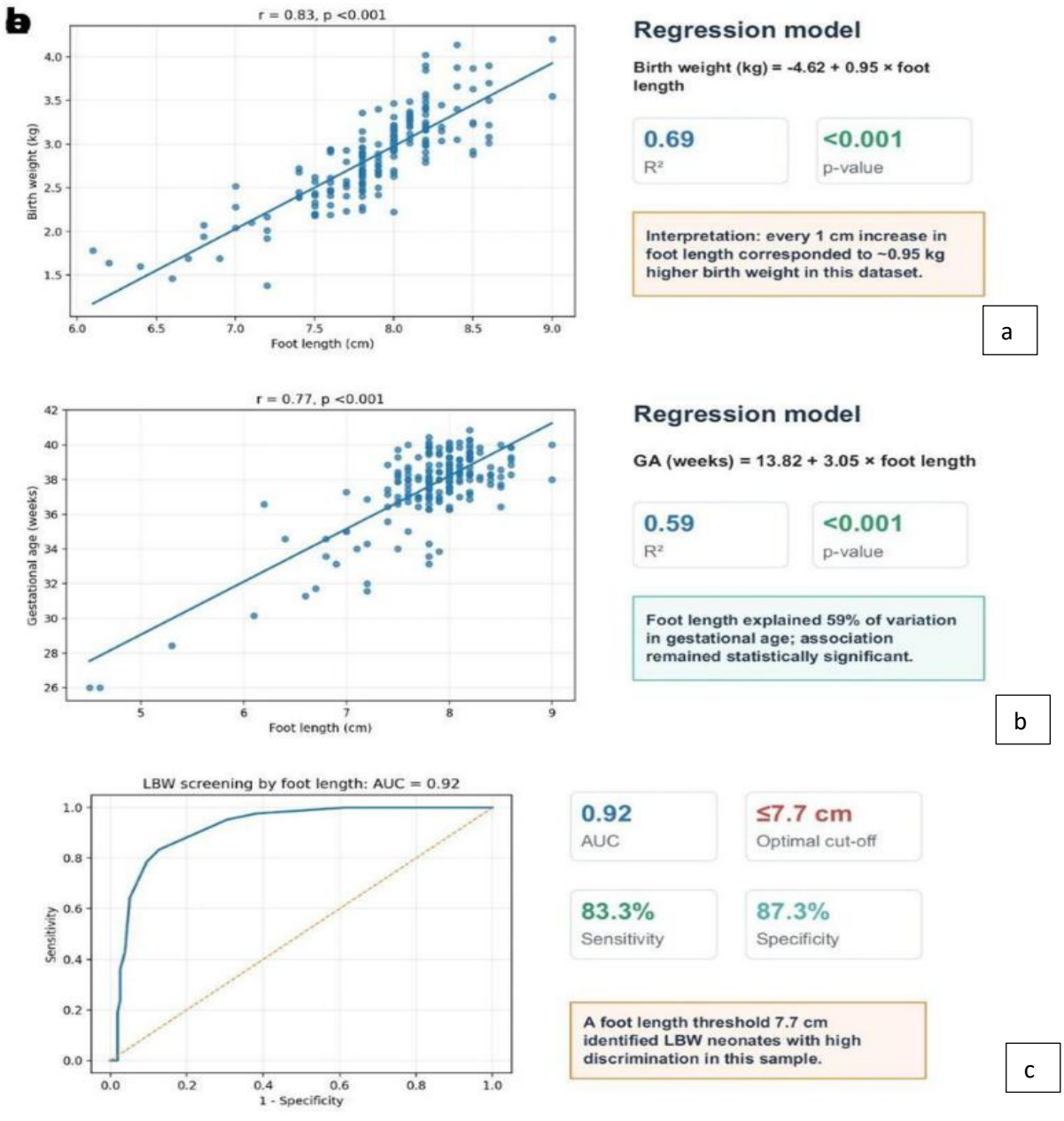


Figure 1 (a-c): Correlation of foot length with birth weight and gestational age, and ROC curve for identification of low-birth-weight neonates.

Panel (a): Scatter plot with regression line for foot length versus birth weight (r=0.83, p<0.001; regression equation: birth weight (kg) = -4.62 + 0.95 × foot length; R^2=0.69); Panel (b): Scatter plot with regression line for foot length versus gestational age (r=0.77, p<0.001; regression equation: GA (weeks) = 13.82 + 3.05 × foot length; R^2=0.59); Panel (c): ROC curve for identification of low birth weight using foot length (AUC=0.92; optimal cut-off ≤7.7 cm; sensitivity 83.3%; specificity 87.3%).

DISCUSSION

The present study demonstrated a positive correlation between foot length and both birth weight (r=0.83) and gestational age (r=0.77). This is comparable to Gowri and Kumar, who reported a similarly strong correlation between foot length and birth weight in a South Indian tertiary care setting, and to Gaur et al who found a comparable correlation in a large cohort of over 1000 newborns in North India.[4,6]

Our AUC of 0.92 for LBW screening is consistent with the pooled diagnostic accuracy reported in the systematic review and meta-analysis by Folger et al, and is further supported by a more recent systematic review and meta-analysis of neonatal anthropometric measures across Africa by Williams et al as well as with the hospital-based findings of Hadush et aland is consistent with early work by Daga et al who first proposed foot length (measured via footprint) as a simple tool for identifying at-risk newborns.[8,9,14,15] The correlation with gestational age observed in our cohort aligns with the findings of Gavhane et al, Srivastava et al, Srinivasa et al and Kapoor et al who also used New Ballard scoring as the reference standard for gestational age assessment.[5,2,16,17] Tergestina et al and Van Wyk and Smith similarly proposed foot length cut-offs for identifying high-risk and preterm infants, with sensitivity and specificity values broadly comparable to those reported here.[18,19]

Tenali et al reported comparable predictive value for gestational age in a separate hospital-based cohort, and a diagnostic accuracy study from rural Sindh, Pakistan by Tikmani et al reported a strikingly similar foot length cut-off of ≤7.6 cm for identifying LBW with high sensitivity and specificity.[20,21] Community-based studies from Tanzania and Ethiopia have further validated foot length as a field-friendly screening tool where formal gestational dating is unavailable, supporting the applicability of our findings to peripheral Indian settings.[3,10] Chandrasekaran et al extended this concept by developing a colour-coded calliper for use by primary healthcare workers, illustrating the practical translation of foot length measurement into low-resource screening programs.[22] The simplicity and low cost of foot length measurement make it particularly useful in peripheral health centers and community settings.[12,23,24]

Limitations

This study has several limitations. It was conducted at a single tertiary care center, which may limit generalizability to community or peripheral settings. The very low birth weight (n=5) and macrosomia (n=3) subgroups were small, limiting the precision of category-specific estimates. Foot length was measured by a single examiner without formal assessment of inter-observer or intra-observer reliability.

CONCLUSION

Foot length has a strong positive correlation with birth weight (r=0.83, p<0.001), also correlates strongly with gestational age (r=0.77, p<0.001). Lower foot length is significantly associated with LBW and preterm status. It may serve as a simple bedside marker where weighing scales or accurate dating are limited.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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