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A STUDY OF CORRELATION OF FOOTLENGTH AND GESTATIONAL MATURITY IN NEONATES

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ABSTRACT **Background:** Early identification of low birth weight (LBW) neonates is crucial for ensuring early identification of high risk babies and thus, reducing mortality, but standard anthropometric measurements may be difficult to interpret at field worker level. Foot length offers a simple, reliable and cost effective alternative to anthropometry. This study aimed to investigate the potential of foot length as a proxy for estimating gestational age and birth weight in neonates. **Methods:** A cross-sectional study was conducted from June 2022 to December 2023, examining 402 neonates within 72 hours of birth. Data on foot length, gestational age, birth weight, head, and chest circumference were collected. **Results:** The mean birth weight was 2.90 kg (range 1.1-4.5 kg). LBW prevalence was 16.6% (67 neonates), with 49.25% being preterm and 50.7% term. Small for gestational age (SGA) and large for gestational age (LGA) neonates constituted 6.8% and 3.8%, respectively Foot length correlated significantly ($p < 0.05$) with gestational age in preterm AGA ($r=0.390$) and SGA ($r=0.265$) babies. The highest correlations in preterm SGA were with crown-heel length ($r=0.746$) and in preterm AGA with birth weight and head circumference ($r = 0.629$). **Conclusion:** The findings suggest that foot length holds promise as a readily obtainable measurement for initial assessment in settings with limited resources or when minimal handling is required.

KEYWORDS : footlength, correlation, gestational maturity, neonates

INTRODUCTION

Global infant mortality[1] has decreased significantly from 65 deaths per 1000 live births in 1990 to 29 in 2018 and 26.693 in 2022. India's rate, while improving from 129 in 1971 to 26.62 in 2023, still needs to reach the SDG[2] target of ≤25 by 2030. A major challenge is the high proportion of newborn deaths (64%), primarily due to preterm birth, LBW, and congenital anomalies. LBW is a critical concern due to its association with increased morbidity and mortality.

Accurate and early identification of LBW and preterm infants, essential for timely interventions, is often difficult in rural India due to limited resources like trained healthcare staff and basic equipment, including weighing machines[3]. This scarcity highlights the urgent need for a reliable and simple alternative measurement to predict birth weight and gestational age across all newborn categories (preterm, term, SGA, AGA, LGA).

An ideal substitute should be easily performable by minimally trained staff, exhibit low intra- and inter-observer variability, and strongly correlate with both birth weight and gestational age. Foot length presents itself as a promising candidate[4]. Its accessibility, even in premature and sick infants, and the simplicity of measurement using a readily available ruler, make it particularly suitable for resource-limited and remote settings. Establishing a robust correlation between foot length and key neonatal parameters could provide a valuable tool for early identification of high-risk newborns, facilitating prompt referrals and potentially improving infant survival[5].This study was planned to assert the strength of this correlation.

MATERIALAND METHODS

MATERIALS

A)Source of Data The study sample of 402 live newborns were selected by simple random sampling technique born at Tirath Ram Shah Hospital, Delhi .

Inclusion Criteria:

Live newborns of different gestational ages within 24 to 72 hours of birth.

1.Pre-term (Small-for-gestational age, Appropriate-for-gestational age, Large for- gestational age)

2.Term (Small-for-gestational age, Appropriate-for-gestationa age, Large-for gestational age)

3.Post-term (Small-for-gestational age, Appropriate-for-gestational age, Large for- gestational age)

Exclusion Criteria:

Babies with skeletal deformities of the foot.

B)Instruments used

1.Sliding calipers and ruler for measuring foot length.
2.Flexible, non-stretchable measuring tape for head circumference.
3.Infantometer for measuring crown heel length.
4.Electronic weighing scale for measuring weight.

METHOD OF COLLECTION OF DATA

Data was collected using standard proforma meeting the objectives of the study.

a) Gestational age assessment was done using modified Ballard's score .

b) Foot length was measured using sliding calipers and metallic ruler with an accuracy of a millimeter. 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. There was no difference in measurements taken by either callipers or ruler, when taken by same observer. The measurements were done by a different observer and readings were compared with those recorded by the first observer.The first observer redocrded reading over callipers first, while the second recorded readings with ruler first; No significant difference was observed in readings taken by two observers. This was done, to remove any observer bias and checking reproducibility of results.The length of foot was documented in centimeters.

c) Head circumference was measured using flexible, non-stretchable fiber measuring tape on lateral aspect of skull by overlapping method. The tape was applied encircling the occipital prominence posteriorly, just above the ear lobes laterally, and just above the supra orbital ridge anteriorly. Measurement was done to the accuracy of a millimeter. Head circumference was documented in centimeters.

d) Crown heel length was measured using infantometer. An assistant's help was sought to do the length measurement. Baby's lower limbs were straightened out before doing the measurement. Measurement was documented in centimeters.

e) Nude weight of the baby was measured using electronic weighing scale. The scale had an accuracy of ± 5 gms.

Babies were grouped into preterm, term and post-term categories. Babies less than 37 completed weeks of gestation were categorized in the preterm group. Babies ≥ 42 weeks of gestation were categorized in the post-term age group. All babies were categorized into small for gestational age (SGA), appropriate for gestational age (AGA) and large for gestational age (LGA) groups. This classification was done by using Fenton growth curve. The data was analyzed using SPSS 30 for Windows software. The correlation between foot length and other parameters such as gestational age, birth weight, head circumference and crown heel length was analyzed by applying correlation and regression analysis. Correlation coefficient (r) values and R square (r2

) values was derived for the nine groups of babies who had undergone analysis. Scatter diagram was plotted to demonstrate the correlation between foot length and other anthropometric parameters. Regression equation was derived to predict gestational age from foot length in various groups of babies.

The sample size for the present study was calculated using the following formula (12): $N = [(Z\alpha+Z\beta)/C]2 + 3$.

Where The standard normal deviate for $\alpha = Z\alpha = 1.96$.

The standard normal deviate for $\beta = Z\beta = 0.84$ $C = 0.5 * \ln[(1+r)/(1-r)] = 0.1440$

Using an r = 0.143 based on the study by Tiruneh C, the final calculated sample size is 382 rounded of to 400.

Sampling Method:
All consecutive newborns, meeting the inclusion and exclusion criteria were recruited from Tirath Ram shah hospital into the study, until the sample size was reached.

RESULT
This study investigated the relationship between foot length, gestational age, and birth weight in 402 preterm, term, and post-term neonates, also examining correlations with other variables (head circumference, crown-heel length) in SGA, AGA, and LGA babies. Males slightly predominated (57.7%). The majority were term (83.3%) and AGA (89.4%). Mean birth weight was 2.900 kg (SD 0.4639), mean foot length 7.184 cm (SD 0.3039), and mean gestational age 38 weeks (SD 1.415).

Significant foot length correlations ($p < 0.05$) were found with gestational age in preterm AGA and SGA babies. In preterm SGA, the highest correlation was with crown-heel length ($r = 0.746$), and in preterm AGA, with birth weight ($r = 0.628$). In term AGA and SGA, foot length significantly correlated with all parameters, with the highest correlation being with gestational age (term SGA: $r = 0.755, p=0.000$; term AGA: $r = 0.184, p=0.001$). No correlation was found in term LGA babies. No post-term newborns were observed.

The study indicates that foot length is significantly related to gestational age and other anthropometric measures in preterm and term SGA/AGA neonates, suggesting its potential as a useful indicator of growth and development at birth, particularly in relation to gestational age and growth status. The lack of correlation in term LGA babies warrants further investigation.

DISCUSSION
This study investigated the relationship between foot length and gestational age, birth weight, head circumference, and crown-heel length in 402 neonates categorized by gestational age (preterm, term) and size (SGA, AGA, LGA). In term neonates, foot length also correlated significantly with all parameters in AGA and SGA groups. The highest correlation in term SGA was with gestational age ($r = 0.755, p=0.000$) and in term AGA also with gestational age ($r = 0.184, p=0.001$). No significant correlations were found in term LGA babies.

The study's findings, showing a positive correlation between foot length and other anthropometric measurements, are comparable to previous research. Notably, the strength of these correlations varied across gestational age and size groups, with stronger correlations observed in preterm compared to term babies. Foot length appears to be a useful indicator, particularly in preterm and term SGA/AGA neonates, for assessing growth and development at birth. The lack of correlation in term LGA babies warrants further investigation.

CONCLUSION
Foot length showed a significant positive correlation with gestational age, birth weight, head circumference, and crown-heel length in preterm AGA, preterm SGA, term AGA, and term SGA newborns. These correlations were stronger in preterm infants than term infants. Notably, term SGA babies exhibited a higher correlation between foot length and all parameters compared to term AGA babies, suggesting foot length's utility in screening for low birth weight.The foot length 7.184 (SD 0.3039) was taken a cutoff for term babies.The strongest correlations were between foot length and gestational age in term SGA ($r = 0.755, p=0.000$) and foot length and birth weight in preterm AGA ($r = 0.628, p=0.001$). The infant with foot length below 6.9cm can be considered high risk group. Thus, foot length is a simple, rapid, and reliable proxy for gestational age and birth weight assessment, especially in sick and preterm neonates, and can be easily utilized by various healthcare providers.

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