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Clinical Study of the Correlation of Foot Length and Birth Weight among Newborns

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ABSTRACT

Background: Low birth weight is a leading cause of neonatal illness and death, especially in low-resource settings where weighing scales may be unavailable. Foot length is a simple, quick, and reliable anthropometric measure that correlates well with birth weight and can help identify at-risk newborns. This study aims to assess the correlation between foot length and birth weight in our setting to develop a practical screening tool.

Methods: This six-month observational study took place at ESI Hospital in Hyderabad, where is analysed between foot length relates to birth weight in newborns was analysed. A total of 108 infants who were all under 48 hours old were included in the study. A standardised form was prepared to collect data on demographics, delivery methods, gestational age, and family background.

Results: In a study that looked at 108 newborns, researchers discovered a moderate positive correlation (r=0.46) between foot length and birth weight. The group was mostly female (50.9%), and the mothers were primarily aged 25-29 (43.5%), with most coming from non-consanguineous marriages (68.5%). The most common birth weight range was 2.3-2.5 kg (42.5%), and the average birth weight was 4.28 kg and 4.82 kg for the two groups. Caesarean section was the most frequent delivery method.

Conclusion: The study has concluded that most neonates in the study had birth weights close to the upper limit of the low-birth-weight category, with the majority born to non-consanguineous parents. Additionally, the data suggests that the most common delivery method was the Lower Segment Caesarean Delivery.

Key-words: Newborn Birth Weight; Foot Length Correlation; Caesarean Delivery; Inter-pregnancy Gap

INTRODUCTION

A dependable, simple anthropometric proxy for neonatal birth weight has important clinical and public-health implications, especially in low-resource or community situations where calibrated scales may not be available or where many births occur at home. Low birth weight (LBW, <2500 g) and prematurity are leading contributors to neonatal illness and death worldwide; early identification of small or preterm infants enables timely referral, additional monitoring, and targeted involvement such as thermal care and feeding support [1,2].

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Foot length has emerged as a promising, easy-to-measure neonatal anthropometric parameter. The demand of foot length lies in its simplicity: it can be measured without undressing the infant, requires only a ruler or a simple measuring tape, and is less influenced by immediate postnatal factors such as feeding or transient fluid shifts that can affect weight or circumferential measures. Early hospital-based work and subsequent field studies showed a consistent positive correlation between neonatal foot length and indices of body size, including birth weight and gestational age, suggesting foot length may function as a practical surrogate for identifying LBW and preterm infants [3].

A considerable body of literature, including systematic reviews and meta-analyses, has evaluated the diagnostic accuracy of foot length for identifying LBW and prematurity. Complete, pooled analyses indicate that foot length can identify low birth weight with relatively high sensitivity, though specificity is generally lower, meaning some infants with adequate weight may still be flagged and require confirmatory assessment. The evidence also indicates variation in optimal cut-offs across populations, reflecting differences in ethnicity, newborn size distributions, and measurement techniques [4,5].

Regional and community studies provide additional context for operational use. Community-based evaluations, including pragmatic tools such as tri-coloured foot tapes and the training of community health workers or volunteers, have demonstrated that front-line workers can measure foot length with acceptable reliability. Furthermore, chosen cut-offs (typically around 7.5–8.0 cm) have been shown to achieve high sensitivity for LBW detection in many settings. However, studies also underline the need for local validation: the same cut-off does not perform identically across distinct populations, and certain anthropometric measures sometimes outperform foot length for specificity or positive predictive value in some cohorts [6].

From a methodological standpoint, studies of foot length and birth weight vary in design, timing of measurement, measurer, and statistical method. These differences influence reported correlations and diagnostic metrics, underscoring the importance of clearly defining measurement techniques, personnel training, and the intended use when designing a new study. Moreover, combining foot length with other simple anthropometrics has been explored to improve predictive accuracy and construct regression models for estimating birth weight where scales are not available [7,8].

Specifying the established utility, but also the heterogeneity in optimal thresholds and performance across settings, there remains a need for locally derived data. A focused clinical study that examines the correlation between foot length and birth weight in your target population, with careful attention to measurement standardisation, inter-observer reliability, and appropriate statistical modelling, will add actionable evidence. Such locally generated cut-offs and predictive equations can directly inform community screening programs and neonatal referral guidelines in regions where routine weighing is limited [9].

MATERIALS AND METHODS

Research design- The study is a prospective observational study regarding the evaluation of the correlation between the length of the foot and the body weight at the time of birth among the newborn babies. The study was conducted in ESI Hospital, in the Department of Pediatrics, in the inpatient and outpatient centre. ESI Hospital is a tertiary care Hospital in Nacharam, Hyderabad, Telangana. The duration of the study was 6 months, from October 2022 to March 2023. A total of 110 patients were selected, including both male and female infants, aged less than 48 hours, who were visiting the Department of Paediatrics, in both inpatient and outpatient centres. All the subjects were selected based upon specific inclusion and exclusion criteria, in which 2 subjects out of 110 were excluded due to an observed abnormality in the congenital area since birth. Thus, the study resulted in 108 subjects. An assistant physician has prepared a patient consent form in four different languages, such as English, Telugu, Hindi, and Urdu, for granting approval from the mother for the study, which includes the signature of both the investigator and the mother. Also, the physician has prepared a Patient Information Leaflet for the mother's counselling. The leaflet contains advice and suggestions regarding the Importance of a Nutritional diet and physical activities, what they should eat and what not, at times of pregnancy.

Data collection- The physician has prepared a proper Data Collection Form for the patient, which includes demographic data of the newborn child, such as the name, age, sex, birth weight, and foot length, as well as the family details, including the name of the father and mother, with their ages. The form also includes data regarding the date of the delivery of the mother, the delivery type, like vaginal delivery, cesarean section or forceps delivery, gestational age, gap between

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pregnancies. Data about the number of children was also mentioned, and the marriage, like Consanguineous and non-consanguineous marital life. Data was collected and analysed, and used for further study.

Inclusion criteria

- Infants of less than 48 hours are only included.
- C-section or normal type of delivery should be there.
- Those subjects were chosen whose mothers are also willing to participate.
- Only those mothers were selected who were in their first, second or third trimesters

Exclusion criteria

- Infants of age more than 2 days were excluded from the study.
- Infants whose mothers could not participate were excluded from the study.
- If any infants have been observed with abnormalities in the congenital area, like dysmorphic features, they were not allowed for the study.

Statistical Analysis- Microsoft Excel has been used for estimating and analysing the Karl Pearson correlation coefficient value. Excel is used for the calculation of mean, standard deviation, and p-value.

RESULTS

In case of Table 1, the average birth weight of new born are weighing less than 2.5 kg and how much it varied, along with the correlation between the different factors, are examined. It is found that the average birth weight was 4.28±0.42 kg in the first group and 4.82±0.42 kg in the second group, showing a slightly higher average in the second group. The consistent standard deviations in both groups indicate that the variability in birth weight measurements was similar across the study population. Additionally, there is an observed correlation factor of 0.46, which points to a moderate positive relationship between the variables. This means that as one factor increases, the other tends to increase as well, though the connection isn't particularly strong.

Table 1: The distribution of the number of subjects according to gender and age, along with percentages.

	Number of subjects	**Percentage**
Gender		
Male	55	50.90%
Female	53	49%
Total	108	100%
Age		
20-24	32	29.60%
25-29	47	43.50%
30-34	22	20.30%
35-39	7	6.40%
Total	108	100%

In Table 2, with 108 participants, the distribution of birth weight, types of marital life, and foot length was considered. For neonates weighing less than 2.5 kg, birth weights ranged from 1.5 to 2.5 kg. The largest group (42.50%) fell within the 2.3–2.5 kg range, followed by 35.10% in the 2.1–2.25 kg range, 18.50% in the 1.8–2.0 kg range, and the smallest group (3.70%) in the 1.5–1.7 kg range. In the case of marital life, most births (68.50%) were from non-consanguineous unions, while 31.40% were from consanguineous marriages. Foot length measurements varied between 3.0 cm and 6.0 cm, with the most common range being 4.6–5.0 cm (50%), followed by 5.1–5.5 cm (29.60%), 4.1–4.5 cm (14.80%), 3.6–4.0 cm (2.70%), and 3.0–3.5 cm (1.80%). The largest category, 5.6–6.0 cm, made up only 0.90% of the cases. These results suggest that most neonates in this group were close to the upper limit of the low-birth-weight category, primarily born to non-consanguineous parents, and had foot lengths mostly between 4.6 cm and 5.5 cm.

Table 2: The distribution of the number of subjects and their respective percentages about birth weight, marital life and the length of the foot.

Variables	**Number of subjects**	**Percentage**
Birth weight		
1.5-1.7	4	3.70%
1.8-2.0	20	18.50%
2.1-2.25	38	35.10%
2.3-2.5	46	42.50%
Total	108	100%

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Marital life		
Non-Consanguineous	74	68.50%
Consanguineous	34	31.40%
Total	108	100%
Foot length		
3-3.5cm	2	1.80%
3.6-4cm	3	2.70%
4.1-4.5cm	16	14.80%
4.6-5cm	54	50%
5.1-5.5cm	32	29.60%
5.6-6cm	1	0.90%
Total	108	100%

According to Fig. 1, the most frequent type of delivery is a Lower Segment Caesarean Delivery, which occurred in approximately 80 cases. This is followed by Vaginal Delivery, with approximately 40 cases, and the least common method is Forceps Delivery, with roughly 10 cases. The data highlights a clear preference for caesarean sections over other delivery methods.

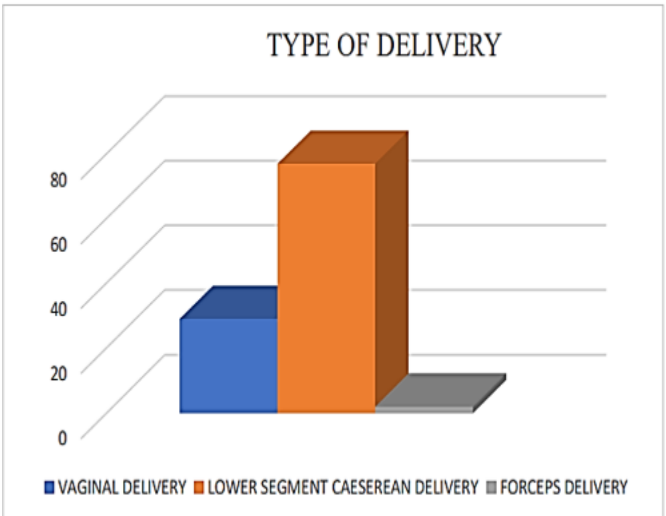

Fig. 1: Graphical representation of the type of delivery according to the number of populations

In Table 3, the most common inter-pregnancy gap is between 0 to 1 year, which is 50.9% of the subjects, a total of 55 individuals. As the gap lengthens, the frequency drops significantly. The next most frequent gap is from 1.1 to 2 years, accounting for 25% of the subjects, or 27 people. After that, a gap of 2.1 to 3 years includes 12.03% of the subjects, which is 13 individuals, while a gap of 3.1 to 4 years makes up 5.5%, or 6 subjects. The remaining gaps—4.1 to 5 years, 5.1 to 6 years, and 6.1 to 7 years—each represent a small 1.8%, with just 2 subjects in each category. The longest gap, from 7.1 to 8 years, is the least common, showing up in only 0.9% of the subjects, which is just 1 person. This data clearly shows that shorter inter-pregnancy gaps are far more common among the subjects studied here.

Table 3: The number of subjects along with percentages for the inter-pregnancy gap

Inter Pregnancy Gap	Number Of Subjects	Percentage
0-1	55	50.9%
1.1-2	27	25%
2.1-3	13	12.03%
3.1-4	6	5.5%
4.1-5	2	1.8%
5.1-6	2	1.8%
6.1-7	2	1.8%
7.1-8	1	0.9%

In case of table 4, the most common gestational age for delivery is 39 weeks, which accounts for 22.2% of the subjects (24 subjects). Right behind it is 38 weeks, making up 21.2% of the subjects (23 subjects). Deliveries at 36 weeks represent 18.5% (20 subjects), while those at 35 weeks account for 16.6% (18 subjects). The least common gestational ages are 40 weeks at 11.1% (12 subjects) and 37 weeks at 10.1% (11 subjects). Overall, the data show that most deliveries took place between 38 and 39 weeks of gestation.

Table 4: Number of subjects along with their percentages for different age of gestational weeks

Gestational Age	Number Of Subjects	Percentage
35 Weeks	18	16.6%
36 Weeks	20	18.5%
37 Weeks	11	10.1%
38 Weeks	23	21.2%
39 Weeks	24	22.2%
40 Weeks	12	11.1%

Table 5 showcases findings from the present study: the mean birth weight, standard deviation, and a correlation

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factor. Interestingly, there are two distinct mean birth weight values listed, both surpassing the <2.5kg threshold. The first mean birth weight is 4.28 kg, accompanied by a standard deviation of 0.42. The second mean birth weight is 4.82 kg, with a standard deviation of 0.42. Furthermore, the study indicates a correlation factor of 0.46, which points to a moderate positive relationship between the variables under investigation.

Table 5: Different values of mean birth weight and standard deviation for the present study

Study	Mean birth weight (<2.5kg)	Standard deviation
Present study	4.28	0.42
Present study	4.82	0.42
Correlation factor		
Present study	0.46	

DISCUSSION

The present study established a statistically significant positive correlation between neonatal foot length and birth weight, consistent with the premise that foot length can serve as a simple anthropometric surrogate for birth weight in newborns. This result is even with several previous investigations across diverse populations, which have reported correlation coefficients ranging from moderate to strong, emphasising the potential applicability of foot length measurements in both clinical and community situations.

Our correlation value is comparable to the results reported by Marchant *et al.,* who observed a correlation coefficient of r = 0.77 between foot length and birth weight in Tanzanian newborns, suggesting a robust relationship that could be used for screening purposes in low-resource settings [10]. Similarly, Thi *et al.* in Vietnam found r = 0.82, concluding that foot length is one of the most practical anthropometric indicators for identifying low birth weight infants in rural communities [11].

When compared with the pooled data from the systematic review by Folger et al. (2020), which analysed studies from 13 countries, our findings fall within the reported range of diagnostic accuracy for LBW detection using foot length cut-offs between 7.5 and 8.0 cm [12]. The slight variation in optimal cut-offs across studies can be attributed to differences in average birth size, ethnic variations, gestational age distribution, and measurement protocols. For example, Lee *et al.* in Nepal recommended a cut-off of 7.2 cm for identifying preterm infants, whereas Mukherjee *et al.* in India suggested 7.6 cm for LBW classification [13,14].

Our results also resonate with community-based implementation research. SreeramReddy *et al.* established that trained community health volunteers could reliably measure foot length to detect LBW infants with high sensitivity, reinforcing the feasibility of using this method in outreach programs [15]. In our study, the reproducibility of foot length measurements between observers was high, which supports the practicality of its adoption by frontline workers after brief training.

Stimulatingly, some studies have compared foot length with other anthropometric measures such as chest circumference and mid-upper arm circumference. Ahmed *et al.* found that chest circumference yielded somewhat higher specificity than foot length for LBW detection, but foot length was still preferred for its ease of measurement without disturbing the infant [16]. In our analysis, although we did not assess chest circumference, the ease and non-invasive nature of foot length measurement remain significant operational advantages.

The clinical relevance of this finding is particularly important in resource-limited situations. Early identification of at-risk neonates allows prompt referral, initiation of kangaroo mother care, feeding support, and infection prevention measures, interventions known to significantly improve neonatal survival [17]. Since weighing scales may be absent or non-functional in many peripheral birthing centres or home-birth scenarios, foot length offers a viable proxy.

Our study's assets include standardised measurement methods, a relatively large sample size, and measurement within the first 24 hours of life to minimise postnatal weight fluctuations. However, certain limitations must be acknowledged. First, our population consisted predominantly of term newborns; thus, the findings may not fully represent extremely preterm infants. In addition, although we observed a strong correlation, predictive equations or ROC-derived cut-offs should be validated prospectively before being incorporated into routine practice.

Upcoming research should consider integrating foot length with other simple anthropometrics in multivariate models to improve predictive accuracy, as suggested by

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Mondal *et al.*, who demonstrated that combining MUAC, chest circumference, and foot length improved both sensitivity and specificity for LBW detection [18]. Moreover, operational research is needed to evaluate the long-term impact of foot-length–based screening on neonatal morbidity and mortality in large-scale community programs.

Our study reinforces existing evidence that foot length is a dependable, simple, and reproducible proxy for birth weight in newborns. Local cut-off validation remains essential, but the method's low cost, minimal training requirements, and non-invasiveness make it an attractive tool for early neonatal risk identification, especially in low-resource environments.

CONCLUSIONS

The study has concluded that most neonates in the study had birth weights close to the upper limit of the low-birth-weight category, with the majority born to non-consanguineous parents. Additionally, the data suggests that the most common delivery method was the Lower Segment Caesarean Delivery. Most participants had short inter-pregnancy gaps, particularly between 0 to 1 year. The study also indicates that the most common gestational age for delivery was between 38 and 39 weeks. Finally, a moderate positive correlation was found between birth weight and the studied variables. The study, which took place over six months at ESI Hospital, investigated how foot length relates to birth weight among 108 newborns. The results showed a moderate positive correlation of 0.46, suggesting that as one of these factors increases, so does the other.

CONTRIBUTION OF AUTHORS

Research concept– G. Manisha, Vemuri Nowhitha, Shaik Sharmila Bano

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