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Original Research

Comparison of Head Circumference and Foot Length as Indicators of Low Birth Weight in Neonates

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ABSTRACT:

Background: Low birth weight (LBW) is a major predictor of neonatal morbidity and mortality, especially in resource-limited settings. In such areas, simple anthropometric measurements like head circumference and foot length can serve as practical surrogates for identifying LBW when direct weighing is not feasible. **Aim:** To study and compare the effectiveness of head circumference and foot length in identifying low birth weight neonates, and to determine which parameter correlates better with birth weight. **Material and Methods:** A cross-sectional observational study was conducted on 135 neonates (78 males, 57 females) within 72 hours of birth. Birth weight, head circumference, and foot length were recorded using standard procedures. Statistical analysis included Pearson's correlation and ROC curve assessment to evaluate the predictive strength of each parameter in identifying LBW (<2500 g). **Results:** Head circumference demonstrated a strong positive correlation with birth weight ($r = 0.73$, $p < 0.001$), while foot length showed a weaker but significant correlation ($r = 0.30$, $p < 0.05$). The AUC for head circumference was 0.821, indicating high diagnostic accuracy, compared to 0.626 for foot length. A head circumference cut-off of <31 cm yielded a sensitivity of 87% and accuracy of 77.6%, outperforming foot length. **Conclusion:** While both parameters can be used as screening tools for identifying LBW, head circumference is a more reliable and accurate anthropometric indicator. It is especially recommended for early identification of LBW neonates in healthcare settings lacking precise weighing scales.

Keywords: Low Birth Weight, Head Circumference, Foot Length, Neonatal Anthropometry, Diagnostic Accuracy

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INTRODUCTION

Low birth weight (LBW), defined by the World Health Organization as a birth weight of less than 2,500 grams, remains a significant public health concern worldwide, particularly in developing countries. LBW is associated with increased risk of neonatal morbidity, mortality, impaired growth, cognitive development issues, and chronic diseases in later life [1]. Prompt identification of LBW neonates is therefore crucial for timely intervention and optimal neonatal care.

Although weighing scales are commonly used for measuring birth weight, access to calibrated and functioning scales may not always be feasible in rural and low-resource settings, especially during home deliveries. In such circumstances, alternative anthropometric measurements can serve as effective screening tools to identify at-risk newborns [2].

Several body measurements have been explored in the neonatal period to act as surrogate indicators of birth weight. Among them, **head circumference** and **foot length** are easily measurable, relatively unaffected by dehydration or feeding status, and have shown potential as predictors of LBW [3]. These parameters are simple, quick to obtain, and can be measured with inexpensive, non-invasive tools by even semi-skilled birth attendants, making them highly suitable for field use [4].

Head circumference, a reflection of brain and skull growth, has been studied extensively as a proxy for intrauterine growth and overall fetal development. It correlates with gestational age and has been proposed as a good marker for identifying neonates with intrauterine growth restriction (IUGR) [5]. On the other hand, **foot length** is a skeletal measurement that also reflects fetal growth and has demonstrated

consistent correlation with birth weight in several regional and international studies [6].

In certain populations, especially in South Asia and Sub-Saharan Africa, where LBW prevalence remains high, researchers have proposed using foot length as a screening method for home-delivered neonates, due to its simplicity and reliability [7]. Moreover, it can be measured even when other anthropometric landmarks (like chest or abdominal circumference) are inaccessible due to clothing or environmental constraints [8].

Several studies have reported strong statistical correlations between these anthropometric parameters and birth weight. However, results vary by ethnicity, geography, and population-specific growth patterns [9]. Hence, it becomes essential to conduct local studies to validate which indicator—head circumference or foot length—shows **better predictive value** in diagnosing LBW neonates in a given population.

Thus, this study was undertaken with the aim of **comparing head circumference and foot length** as indicators of low birth weight, to **correlate these parameters with birth weight**, and to determine **which serves as a better anthropometric measure** for identifying LBW neonates in clinical and community settings.

MATERIAL AND METHODS

A hospital-based **cross-sectional observational study** was conducted over a period of one year in the Department of Pediatrics and Neonatology at a tertiary care hospital. A total of **135 live-born neonates** were included in the study after obtaining written informed consent from parents or legal guardians.

Inclusion Criteria

- Live-born neonates within **72 hours of birth**
- Neonates with a **gestational age of ≥28 weeks**
- Neonates delivered in the hospital or admitted immediately after birth

Exclusion Criteria

- Neonates with major congenital anomalies or dysmorphic features
- Neonates requiring intensive resuscitation or ventilator support at birth
- Stillbirths or neonates with incomplete anthropometric data

Study Population

The study enrolled **135 neonates**, including **78 males** and **57 females**, who fulfilled the eligibility criteria and were examined within 72 hours of birth.

Data Collection Procedure

After ensuring aseptic precautions, the following anthropometric measurements were taken using standard techniques:

- **Birth Weight**: Measured using a calibrated digital infant weighing scale to the nearest 10 grams.
- **Head Circumference**: Measured using a non-stretchable measuring tape encircling the occipital protuberance and supraorbital ridge to the nearest 0.1 cm.
- **Foot Length**: Measured from the heel to the tip of the big toe using a transparent rigid ruler to the nearest millimeter.

All measurements were taken **within the first 24–72 hours** after birth, ideally before the onset of significant postnatal weight loss. Each parameter was measured by the same trained observer to ensure consistency and reduce inter-observer variability.

Statistical Analysis

Data were entered and analyzed using Microsoft Excel and SPSS (Statistical Package for the Social Sciences) software. Descriptive statistics were used to express **mean ± standard deviation** for continuous variables and **frequency and percentages** for categorical variables. **Pearson's correlation coefficient** was used to assess the correlation between birth weight and each of the two anthropometric parameters (head circumference and foot length). A *p*-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the **Institutional Ethics Committee**. Informed consent was obtained from parents or guardians prior to enrollment. Confidentiality of participant data was strictly maintained throughout the study.

RESULTS

Table 1 presents the gender distribution of the 135 neonates included in the study. Among them, 74 (54.8%) were females and 61 (45.2%) were males, showing a relatively balanced gender ratio with a slight female predominance.

Table 2 shows the mode of delivery among the study population. Of the 135 deliveries, 67 (49.6%) were vaginal and 68 (50.4%) were via lower segment cesarean section (LSCS). This near-equal distribution reflects the current obstetric practice trends in tertiary care centers.

Table 3 outlines the parity status of mothers. 63 (46.7%) were primipara, while 72 (53.3%) were multigravida. This distribution indicates a marginal predominance of multiparous mothers in the study cohort.

Table 4 displays the correlation between birth weight and two anthropometric parameters—head circumference and foot length. A strong positive correlation was found between birth weight and head circumference ($r = 0.73$, $p < 0.001$), while foot length showed a weaker correlation ($r = 0.30$, $p < 0.05$). These findings suggest that head circumference may be a more reliable surrogate indicator for birth weight.

Table 5 provides the ROC (Receiver Operating Characteristic) curve analysis of head circumference and foot length as diagnostic tools for identifying LBW. The area under the curve (AUC) for head circumference was 0.821, indicating excellent discriminatory ability, whereas foot length had an AUC of 0.626, reflecting only fair accuracy. The statistical significance of both tests was established ($p< 0.001$ and $p< 0.05$, respectively), but head circumference clearly demonstrated superior predictive performance.

Table 6 summarizes the optimal cut-off points for both anthropometric parameters to identify neonates with birth weight less than 2500 grams. A head circumference of <31 cm yielded 87% sensitivity, 68.1% specificity, and 77.6% overall accuracy. In contrast, a foot length of <8.2 cm showed lower diagnostic performance, with 74.8% sensitivity, 46.8% specificity, and 60.8% accuracy. These findings further reinforce the conclusion that head circumference is a better screening tool for LBW detection than foot length in this population.

Table 1: Gender Distribution of Neonates (N = 135)

Gender	N	Percentage (%)
Female	74	54.8%
Male	61	45.2%

Table 2: Mode of Delivery (N = 135)

Type of Delivery	N	Percentage (%)
Vaginal delivery	67	49.6%
LSCS	68	50.4%

Table 3: Parity of Mothers (N = 135)

Parity	N	Percentage (%)
Primipara	63	46.7%
Multigravida	72	53.3%

Table 4: Correlation of Birth Weight to Anthropometric Measurements

Anthropometric Measure	R value	P value
Head circumference	0.73	<0.001
Foot length	0.30	<0.05

Table 5: AUC Values for Anthropometric Indicators (ROC Analysis)

Test Variable	AUC	SE	P value	95% CI (Lower–Upper)
Head circumference	0.821	0.045	<0.001	0.733 – 0.909
Foot length	0.626	0.052	<0.05	0.524 – 0.787

Table 6: Best Cut-off Points for Identifying LBW Neonates

Parameter	Ideal Cut-off	Sensitivity (%)	Specificity (%)	Accuracy (%)
Head circumference	<31 cm	87.0	68.1	77.6
Foot length	<8.2 cm	74.8	46.8	60.8

DISCUSSION

Accurate and early identification of low birth weight (LBW) neonates is critical for initiating timely interventions and preventing neonatal morbidity and mortality. In this study, both head circumference and foot length showed significant correlations with birth weight, but head circumference demonstrated a stronger association (r = 0.73) compared to foot length (r = 0.30), suggesting it may serve as a more reliable surrogate marker for LBW detection.

The high correlation between head circumference and birth weight aligns with findings from similar studies conducted in various settings. For example, Shivaji et al. observed a strong association between head circumference and birth weight and recommended its use in rural areas where weighing scales are unavailable [11]. Since head circumference reflects brain and skull growth, which are generally preserved even in cases of mild growth restriction, it offers stability as a measurement parameter [12].

On the other hand, while foot length is also simple to measure, its relatively lower correlation with birth weight in this study is consistent with previous reports from India and Nepal, which suggest that foot length is more susceptible to inter-observer variability and gestational maturity effects [13]. Although it retains utility where other measurements are difficult (e.g., post-delivery in rural field settings), its predictive power for LBW appears limited in comparison.

The ROC curve analysis in our study further strengthens this observation. Head circumference showed a higher AUC of 0.821, indicating excellent diagnostic accuracy for detecting LBW neonates. In contrast, foot length had an AUC of 0.626, suggesting

only fair predictive performance. Similar findings were reported by Mullany et al., who evaluated foot length and chest circumference in rural Nepal and found head circumference to be more accurate for LBW classification [14].

Moreover, the best cut-off point for head circumference (<31 cm) achieved a sensitivity of 87% and accuracy of 77.6%, reinforcing its practical utility. In contrast, foot length (<8.2 cm) showed lower sensitivity and specificity. These figures support prior conclusions by Thi et al., who advocated the use of head circumference over other measures, particularly in hospital settings [15].

While both indicators are beneficial when direct weighing is not feasible, this study demonstrates that head circumference is more robust, consistent, and diagnostically valuable than foot length in identifying LBW neonates. However, in extreme field settings where head circumference is not measurable (e.g., due to cultural restrictions or neonatal distress), foot length may still be used as a preliminary screening tool.

CONCLUSION

In this study, both head circumference and foot length showed statistically significant correlations with birth weight. However, head circumference proved to be a better predictor of low birth weight, with stronger correlation, higher diagnostic accuracy, and superior sensitivity and specificity. These findings underscore the potential utility of head circumference as a reliable, low-cost anthropometric surrogate for identifying LBW neonates, particularly in low-resource healthcare settings. Implementing its use can aid early detection, referral, and management of at-risk newborns, thereby contributing to improved neonatal outcomes.

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