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Original Article

Estimation of Gestational Age Using Neonatal Anthropometry: A Cross Sectional Study

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ABSTRACT

Background: Neonatal mortality rate accounts for 20.3 per 1000 live births in India. One of the significant predictors of neonatal mortality is low birth weight. Weight is the most extensively used parameter. However, there are alternate anthropometry parameters, such as mid-arm circumference, mid-thigh circumference, and mid-calf circumference, which can be used to assess newborns' growth and identify the newborns at risk. The current study aimed to determine the correlation between limb anthropometric measurements and gestational age and to derive the mean and standard deviation for all limb anthropometric measurements of the newborn with gestational age.

Methods: The study included 400 live newborn babies admitted to the NICU/PNW at the Aarupadai Veedu Medical College and Hospital for routine observation from December 2020 to October 2022. Within 48 hours after birth, newborns were evaluated for anthropometric measures using standard techniques.

Results: All limb anthropometric measurements increased as gestational age increased to 39-40 weeks, which began to decline after 40 weeks. There was a strong correlation between limb anthropometric measurement with gestational age ($p < 0.001$), with mid-thigh circumference exhibiting the highest correlation ($r=0.652$).

Conclusion: The findings of the current study suggest that besides birth weight, other basic anthropometric parameters, such as limb anthropometry (e.g., mid-thigh circumference), can be effectively used to quantify prenatal development and identify infants at risk.

Conducting an analysis of anthropometric measures after delivery allows for a rapid assessment of infants with atypical growth patterns, making them more susceptible metabolic complications.

Keywords: Gestational age, Limb anthropometry, Mid thigh circumference, Newborns

Introduction

According to UNICEF, 2.5 million newborns die worldwide in the first month of life, with an alarming daily average of 6,500 newborn deaths (1). Neonatal mortality rate accounts for 20.3 per 1000 live births in India. Generally, birth weight is a significant indicator of fetal and neonatal health in both individuals and populations (2). Newborn mortality can be predicted based on low birth weight (LBW), with LBW infants constituting over 80% of all newborn mortality in developed and developing countries (3). Typically, LBW infants are often preterm and small for gestational age. These neonates with abnormal fetal development must be recognized and monitored regularly because they exhibit a greater developing risk of morbidity and mortality, compared to infants of that same gestation.

Newborns with abnormal fetal development are often more vulnerable to metabolic derangements involving hypoglycemia and polycythemia throughout the early years of life. The alternate anthropometry parameters like the mid-upper arm, mid-thigh, and mid-calf circumference can be used to assess newborn

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growth and identify at-risk infants. Some previous studies have established a substantial relationship between mid-upper arm and thigh circumference with gestational age (2,4). The primary objective of this present research was to determine the correlation between limb anthropometric measurements and gestational age and to calculate the mean and standard deviation for all limb anthropometric measurements of the newborn with gestational age. While this study contributes valuable insights, further research in India is required to investigate other birth measures and their cut-off value that may also be equally predictive of newborn morality.

Methods

The current research was a hospital-based analytical cross-sectional study with all the live newborn babies admitted to NICU/PNW for routine observation in Aarupadai Veedu medical college and hospital from December 2020 to October 2022 (1 year and 10 months). The study included all live newborn babies born in hospitals. The excluded infants were newborns with congenital limb anomalies, Multiple gestation pregnancy (twins, triplets, quadruplets, etc.), intrauterine growth restriction births and stillbirths, gestational diabetes mellitus, and pregnancy complications, such as anaemia and eclampsia. The sample size of 400 was determined based on the mid-arm circumference mean difference following a study conducted by Rajat Thawani et al. (4), with a 95% confidence limit and 5% alpha error. Consecutive sampling was employed as the sampling technique to select the newborns who met the inclusion criteria. Within 48 hours of delivery, the selected newborns were screened using standardized procedures to measure the limb anthropometric measures. Gestational age was determined considering the previous menstrual cycle and was later verified by the New Ballard Score. Newborns with a difference of more than 2 weeks between the last menstrual period (LMP) and the new ballard score (NBS) were excluded from the study. The data were collected using pre-designed and pre-tested proforma after obtaining informed consent.

Statistical analyses

The data were entered in Microsoft Excel, and analysis was performed using SPSS (28 version). Frequency and percentages were used for categorical variables. Mean ± standard deviation was used to summarize continuous variables after the normality assumption was satisfied using the Kolmogorov-Smirnov test. The Pearson correlation coefficient was calculated to evaluate the association between limb anthropometric measurements with gestational age. P value less than 0.05 was considered statistically significant.

Ethical approval

Institutional Ethical Committee approval (Aarupadai Veedu Medical College) was obtained before the study. IEC No: AV/IEC/2020/186.

Results

The general characteristic of the participants is shown in Table 1. As indicated, 50.75% of newborns were male (n=203). Most participants had an average birth weight of > 2500 g 81% (n=324), and the LBW infants (< 2500 g) were about 19% (n = 76). The prevalence of the preterm was 35.5% (n = 255).

Table 1. General characteristics of the participants (n = 400)

Gender	Frequency (%)
Male	203 (50.75)
Female	197 (49.25)
Birth weight	
LBW	76 (19)
Normal	324 (81)
Gestational age	
Preterm	142 (35.5)
Term	255 (63.8)
Post term	3 (0.8)
Total	400 (100)

Correlations between limb anthropometry measurement with gestational age are shown in Table 2. The mid-arm circumference anthropometry had the least correlation (r=0.537), while the mid-thigh circumference anthropometry had the highest correlation (r=0.652) with gestational age.

P-value tested by Pearson correlation analysis.

Anthropometry showing mean (SD) is shown in Table 3. The findings revealed that the mean values of (SD) of mid-arm, calf, and mid-thigh circumference were 9.09 (0.92), 10.00 (1.25), and 15.09 (1.41), respectively. The anthropometric measurements demonstrated a consistent increase with advancing gestational age until 39-40 weeks. However, beyond 40 weeks of gestation, these measurements started to decline.

Table 2. Correlations between limb anthropometry measurement with gestational age

Anthropometric parameters	Correlation	P value *
Mid arm circumference	0.537	<0.0001
Calf circumference	0.539	<0.0001
Mid thigh circumference	0.652	<0.0001

* P value <0.005 is considered significant.

Table 3. Anthropometry measurement according to gestational age

Gestational age (weeks)	Birth weight (kg)	MAC (cm)	CfC (cm)	MTC (cm)
	Mean (Standard deviation)			
30	1570 ± 97.46	6.60 ± 0.54	7	10
31	1683.33 ± 160.72	6.67 ± 0.57	7	11
32	1450 ± 141.42	6.50 ± 0.70	7	11 ± 1.41
33	1862.50 ± 213.60	7.50 ± 0.57	7.7 ± 0.50	12.2 ± 0.50
34	1887.50 ± 184.68	8	8.1 ± 0.35	12.7 ± 0.46
35	2080 ± 127.36	8	8.4 ± 0.51	13.5 ± 0.97
36	2143.33 ± 308.14	8.13 ± 0.64	8.47 ± 0.83	13.40 ± 1.12
37	2869.06 ± 339.73	9.2 ± 0.76	10.1 ± 1.02	15.23 ± 0.97
38	2887.25 ± 401.15	9.1 ± 0.80	10.1 ± 1.14	15.28 ± 1.08
39	3042.51 ± 337.792	9.4 ± 0.72	10.4 ± 0.98	15.7 ± 0.98
40	3082.56 ± 369.35	9.3 ± 0.74	10.4 ± 0.96	15.6 ± 0.82
41	3500	9	10	15
42	3000 ± 70.71	9	10	15

Discussion

Correlation between a limb anthropometric measurement with gestational age

The current study indicated that mid-arm circumference, calf circumference, and thigh circumference correlated significantly with gestational age ($p<0.0001$). These findings align with a study conducted by Narendra et al. (5) in Bangalore, reporting the highest correlation was found with mid-thigh circumference (5). Moreover, the obtained results of the present study suggest that mid-thigh circumference can be used as a proxy for birth weight. Similar to mid-arm circumference with easily accessible limbs, anthropometry measurements can assess preterm birth, as previously confirmed by Hirudayakanthi et al (6).

Comparison of the mean and standard deviation of limb anthropometric parameters with gestational age

In the present study, the birth weights of the newborns were found to fall within normal limits, with mean (SD) values. These findings were consistent with the results reported in studies conducted by Doddamani et al. in South India (7) and Sreeramareddy et al. in Nepal (8). However, it is worth noting that the study conducted by Kokku et al. (9) in Hyderabad indicated that the mean and standard deviation of birth weight were smaller than those of the present study. Regarding other anthropometric measures (mid-upper arm circumference, calf circumference, thigh circumference), their mean and SD values were similar to the study conducted by Das et al. in Bangladesh (7). On the contrary, Sreeramareddy et al. in Nepal (8) reported smaller mean values of the anthropometry measurement.

The discrepancies in these findings might be influenced by several factors, including differences in methodology, the inclusion of LBW infants, as well as genetic, economic, and prenatal nutritional variations among Indian mothers.

Prematurity and Low Burth Weight

In the present study, the incidences of preterm birth and LBW were 35.5% and 19%, respectively.

A previous study found that preterm occurred in 10-35% of births, and LBW occurred in 19-70% of births (5, 10).

The prevalence of preterm (35.5%) in the current study was similar to that of the study by Annigeri et al. in Bangalore (10). However, it contrasts with the study by Narendra et al. in Bangalore (5), indicating a lower prevalence of preterm birth at 10.12%.The discrepancy in preterm birth rates between the studies might be due to the inclusion criteria in the present study, which may have allowed for the inclusion of more preterm babies. Compared to the previous study conducted in India, the prevalence of LBW is lower in the current study. Evidence for this includes excluding pregnant participants with conditions like anemia, hypertensive disorders, or gestational diabetes mellitus or those with persistent infections or illnesses that are known to impact newborn health.

Conclusion

The current study indicated that basic anthropometric parameters other than birth weight, such as limb anthropometry, could effectively quantify prenatal development and identify at-risk infants.

Analyzing anthropometric measures after delivery allows a quick assessment of infants with unusual growth more vulnerable to metabolic complications.

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Conflicts of interest

The authors declare that they have no competing interests.

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