Original Research Article

Interdependency of anthropometric parameters of newborn with variable period of gestational age

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Abstract

Background: An important factor in determining whether a specific low birth weight neonate is preterm or has growth retardation is the estimated gestational age. So, this study was an attempt to determine the correlation between anthropometric parameters of newborns with a period of gestational age.

Material and Methods: A hospital based cross sectional study was done among 200 consecutive live births delivered at tertiary care centre. The anthropometric parameters like birth weight, length, foot length, head circumference, chest circumference, mid upper arm circumference were recorded and analysed with gestational age using correlation and regression analysis.

Results: At p value of 0.05, the neonatal anthropometric measures showed a positive correlation with GA in completed weeks. The multiple linear regression analysis showed that Birth weight, length and head circumference had significant linear relationship and the regression equation derived as follows: GA = $[41.325 + 1.603\ (Birth\ weight)] + 0.125\ (Length) - 0.437\ (Chest\ circumferance)$.

Conclusion: The anthropometric parameters had a positive correlation with gestational age and there was an increase in all parameters of birth weight, length, head circumference, chest circumference, foot length, and MUAC with respect to gestational age. So, these measurements can be used as a better screening tool for the assessment of prematurity in low resource settings.

Keywords: Anthropometry, gestational age, preterm, cross-sectional study

Introduction

The most vulnerable stage in a baby's life is known as the neonatal period, which is generally regarded to start at birth and finish at 28 full days of life. The World Health Organization (WHO) defines neonatal death as "mortality among live births within the first 28 completed days of life [1].In 2020, 2.4 million neonates worldwide lost their lives in the first month of life. The common causes of neonatal deaths were preterm birth, intrauterine growth retardation and low birth weight [2].

Due to the fact that the global rate of under-5 mortality is dropping more quickly than that of neonatal mortality, in 2020, nearly half (47%) of all fatalities in children under the age of five happened during the newborn period (the first 28 days of life), up from 40% in 1990. With 43% of all newborn deaths worldwide, Sub-Saharan Africa has the highest neonatal mortality rate (27 deaths per 1000 live births), followed by central and southern Asia (23 deaths per 1000 live births), which accounts for 36% of all newborn fatalities worldwide [3].

Foetal growth restriction was an independent significant factor for early neonatal mortality[4].Birth weight in relation to gestational age is a crucial sign of adequate foetal growth[5].Traditionally, the gestational age of newborns is determined using Naegele's formula, ultrasound evaluation during pregnancy, or New Ballard evaluation and scoring after birth[6].It was anticipated that variations in ovulation and lactation will have an impact on the accuracy of gestational age estimates based on Naegele's formula in low literacy contexts.

The use of ultrasound as a method to determine gestational age is limited, especially in underdeveloped nations where prenatal consultations were less frequent[7].It is challenging to diagnose IUGR because it necessitates a reliable estimation of gestational age (GA), regular foetal weight assessments to detect declining foetal growth, and Doppler flow measurements to detect abnormal placental function. Due to delayed and irregular access to antenatal care, as well as the occasional and restricted availability of ultrasound examinations, this is frequently problematic in low- and middle-income countries [8].

The New Ballard Score (NBS), which determines a newborn's gestational age based on the examination and the state of the infant, may not be an accurate method of measurement. Therefore, it is necessary to create an easy, affordable, and useful technique to recognise these extremely fragile preterm neonates as soon as they are delivered. So, the purpose of this study was to determine relationship between anthropometric parameters of newborns with a period of gestational age.

Objective

- To determine the correlation between anthropometric parameters of newborns with a period of gestational age.

Material and Methods

This cross-sectional study was conducted among newborns of natal mothers belonged to 36-40 weeks gestation admitted to the postnatal ward, Trichy SRM medical college Hospital and Research centre for safe confinement during the period of six months duration from July 2023-December 2023.

The newborns were recruited using a consecutive sampling method with a sample size of 200 estimated using 50% of proportion and 7% of absolute precision. The study excluded newborns of multiple gestations, hypertensive disorders of pregnancy, gestational diabetes mellitus, chronic infections like STI, gross congenital anomalies, and newborns whose gestational age could not be accurately determined, such as those with a difference of more than two weeks between the gestational age determined by an obstetrician and the gestational age determined by a clinical assessment. The natal mothers who were unaware of the Last Menstrual Period (LMP), irregular menstrual cycles before pregnancy and antepartum haemorrhage were also excluded from the study.

The protocol was presented to Institutional Ethics Committee of Trichy SRM medical College Hospital, Trichy before the start of the study. Data was collected in Post-natal ward of Department of Obstetrics using semi structured questionnaire among postnatal mothers along with their live new born babies by interview method after getting their consent. A clinical evaluation utilizing the New Ballard Score was used to confirm the gestational age, which was determined starting on the first day of LMP and it was calculated by Naegele's formula (addition of nine months and seven days). During 48 hours of birth, newborns were measured anthropometrically for their birth weight, foot length, head circumference, chest circumference, abdomen circumference, thigh circumference, calf circumference, mid arm circumference, and crown heel length.

The babies underwent a complete anthropometric evaluation within 24 hours following birth. Using a digital infant weighing scale on a naked newborn, birth weight was calculated and recorded in grammes (g) to the nearest 5 g. using an infantometer, the newborn's length was calculated from the vertex to the heel of the right foot. Using a firm, transparent plastic ruler, the length of the right foot was calculated from the heel to the tip of the longest toe and recorded in centimetres.

A flexible, non-stretchable tape measure was used to measure the MUAC and the chest circumference. On a calm infant (mid-expiration), the chest circumference was measured to the nearest 0.1 cm by circumnavigating the area just above the nipples. At the midpoint of the right upper arm, which is halfway between the olecranon of the ulna and the acromion of the scapula, the MUAC was measured to the nearest 0.1 cm. Every measurement was made twice. When two measurements diverged by more than 50 g for birth weight, 7 mm for length, 5 mm for chest circumference, and 2 mm for foot length or MUAC, a third measurement was taken, and the two measurements that were closest to one another were recorded.

Data was entered in Microsoft excel 2019 and analysed using software SPSS (Statistical Package of Social Sciences) version 21. Continuous variables and categorical variables were interpreted using frequencies (mean±SD) and proportions (%). The Pearson correlation was used to assess the relationship between gestational age and other anthropometric measurements. The regression equation was predicted using multiple linear regression analysis.

Results

This cross sectional study was conducted among 200 newborns to assess the relationship between gestational age and anthropometric measurements.

The mean age of natal mothers was 22.3±3.29 years with a minimum age of 18 to maximum of 31 years. The range of gestational age included in this study was 36 weeks to 40 weeks. 62 (31%) of them were primiparas and 138 (69%) of them were multiparas. 22 (11%) of the newborns were preterm and 178 (89%) were term neonates. Figure 1 shows the maturity of new born as term or preterm.

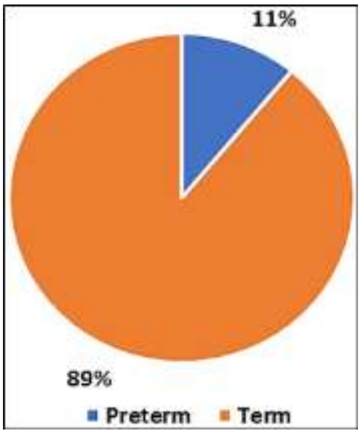

Fig 1: Maturity of newborn

115 new born babies were AGA babies (57.5%) and 85 were SGA babies (42.5%). Figure 2 shows gestational age of participants.

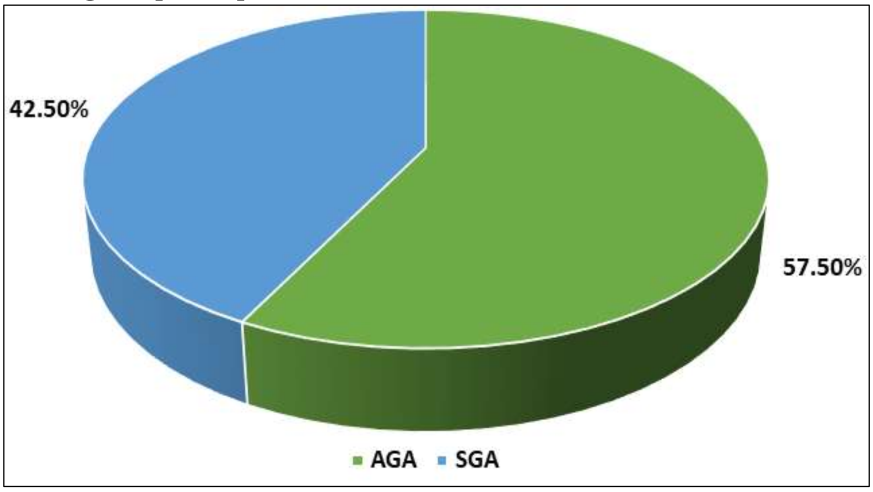

Fig 2: Gestational age of participants (n = 200)

Table 1 describes the anthropometric measurements of new born. The mean birth weight, length, head circumference, foot length, chest circumference and mid upper arm circumference was 2.37±0.464, 47.48±2.62, 31.43±1.28, 6.98±0.55, 29.11±1.09 and 8.93±0.721 respectively.

Table 1: Anthropometric measurements of new born (n = 200)

S. No.	Anthropometry	Mean	Standard deviation	Range
1.	Gestational age	38.35	1.21	36-40
2.	Birth weight	2.37	0.464	1.5-3.5
3.	Length	47.48	2.62	41.5-52
4.	Head circumference	31.43	1.28	29-35
5.	Foot length	6.98	0.55	6.12-7.54
6.	Chest circumference	29.11	1.09	27-31
7.	Mid upper arm circumference	8.93	0.721	8.1-9.9

Table 2 describes correlation between gestational age with anthropometric measurements of new born. Birth weight, Length, Head circumference, Foot length, Chest circumference and mid upper arm circumference had significant positive correlation with gestation age.

Table 2: Correlation of gestational age with anthropometric measurements (n = 200)

S. No.	Anthropometry	R value	P value
1	Birth weight	0.471	0.001
2	Length	0.471	0.001
3	Head circumference	0.233	0.001
4	Foot length	0.318	0.001
5	Chest circumference	0.282	0.001
6	Mid upper arm circumference	0.171	0.015

Table 3 describes univariate regression analysis for all significant variables and the derived regression equation.

Table 3: Regression equation anthropometric measurements (n = 200)

S. No.	Anthropometry	Regression equation
1.	Birth weight	GA = 35.442+1.226 (Birth weight)
2.	Length	GA = 28.975+0.197 (Length)

3.	Head circumference	GA = 31.461+0.219(Head circumference)
4.	Foot length	GA = 33.520+0.692 (Foot length)
5.	Chest circumference	GA = 29.246+0.313 (Chest circumference)
6.	Mid upper arm circumference	GA = 35.787+0.287 (Mid upper arm circumference)

The multiple linear regression analysis showed that the birth weight, length and chest circumference had significant linear positive correlation (R = 0.542) with gestational age. So, the regression equation for gestational age was derived as follows

$$Gestational\ age = [41.325 + 1.603\ (Birth\ weight)] + 0.125\ (Length) - 0.437\ (Chest\ circumferance)$$

Discussion

This cross-sectional study showed that positive linear correlation of anthropometry with gestational age. The combined birth weight, Length and head circumference had a significant linear positive correlation with gestational age.

An Ehtiopian study by Tiruneh*et al*. [9] among 420 live births found that all neonatal measurements were positively correlated as similar to our study. Birth weight, HL and MUAC had significant linear relationship and the regression equation was derived by Tiruneh*et al*. [9]as follows: GA (weeks) = 28.12 – [0.393×HL (cm)] + [1.07×BW (kg)] + [0.87×MUAC (cm)] (r= 0.458).

Thawani R *et al*. [10] research in New Delhi among 1000 new borns found that the Birth weight and GA correlated most favourably (R=0.72), while the addition of HC, HC2, and MUAC greatly increased the correlation (R=0.76). This result was similar to our study results that birth weight correlated significantly and addition with HC which increases the significance. The researchers proposed the equation as Gestational age=5.437 W-0.781 W2+2.815 HC-0.041 HC2+0.285 MUAC–22.745. The predictability of this equation after validation is 46% (less than one week), 75.5% (+2 weeks), and 91.5% (+3 weeks) and the researchers concluded that this mathematical approach might be applied to the detection of premature newborns.

Narendra KS *et al*. [11] also found that neonatal anthropometric measurements had significant positive correlation with gestational age which was similar to our study.

A cross sectional study by Das NK *et al*. [12]in Kolkata among 530 live new borns in 28-41 weeks gestation found that Head circumference (r = 0.863) and crown heel length (0.859) had a significant correlation and the regression equation was proposed GA (weeks) = 4.0244 + [0.4058 × HC (cm)] + [0.4249 × CHL (cm)]. This result had some varying results that HC had significant correlation along with crown heel length, and this variation might be due to sample size (n = 530), sample population (28-41 weeks) and variation in anthropometric measurements.

The study done at Puducherry among 270 newborns by Raj AA *et al*. [13] found that foot length (r = 0.905), birth weight (r = 0.905), length (r = 0.786), head circumference (r = 0.719) and chest circumference (r = 0.603) had significant positive correlation with GA. This was similar to our study results and the variation in correlation coefficient could be due to varying sample population.

Conclusion

This study concluded that there was a significant positive correlation of gestational age with anthropometric parameters such as birth weight, length, head circumference, chest circumference, foot length and mid upper arm circumference. Anthropometric measurements are simple to use, can be used to determine the gestational age of newborns, can be a crucial first step in standardising anthropometric measurements in the future, which will aid in accurate newborn assessment, development and maturity, as well as the recognition of newborns who are at risk and good management.

Limitations

- The larger sample size might be considered for generalising results.
- The validation of prediction equation can be done to use this equation as the predictor.
- This was a single centred study and multicentric studies could be helpful for better results.

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