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Research Article

Assessment

Assessment & correlation of gestational age in newborns with head circumference: A Hospital-based cross-sectional study in Central India

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Introduction: Preterm birth is the leading cause of death in children younger than 5 years worldwide. Although preterm survival rates have increased in high-income countries, preterm newborns still die because of a lack of adequate newborn care in many low-income and middle-income countries. This study was aimed to find out the effectiveness of anthropometric measurement, a simple and inexpensive method, for identifying premature babies at birth. **Method:** We conducted a cross-sectional study in a tertiary care hospital with 350 consecutively live-born newborns. Their birth weight, mid-arm circumference, length and head circumference were measured and compared with gestational age assessed by New Ballard score. We summarized the variables using descriptive statistics, and the strength of association was determined through correlation analysis. The correlation was strong for head circumference. Linear regression analysis was done to develop predictive equations. **Result:** Amongst 350 newborns, 76% were term and 24% were preterm. Pearson's correlation coefficient between gestational age as assessed by New Ballard score and head circumference, birth weight, mid-arm circumference and length all showed a significant positive correlation in the decreasing order [maximum with head circumference (r = 0.566)]. Linear regression analysis was done to develop predictive equations. **Conclusion:** Head circumference measurement can be a surrogate marker to predict prematurity as a significant correlation is seen between it and gestational age assessed by the New Ballard score. Further studies are needed to cross-validate our result.

Keywords: Gestational age, Neonatal anthropometry, Prematurity

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Introduction

Preterm is defined as babies born alive before 37 weeks of pregnancy are completed. Prematurity is a significant contributor to morbidity and mortality in India and other developing countries. Every year, an estimated 15 million babies are born preterm (before 37 completed weeks of gestation), and approximately 1 million children die each year due to complications of preterm birth [1].

India is amongst the top 5 countries with the greatest number of preterm births [2]. Preterm birth complications are the leading cause of death among children under 5years of age, Community based studies indicate that LBW weight infants are at 11 to 13 times increased risk of dying than normal birth weight infants and more than 80% of total neonatal deaths occur among preterm neonates and LBW babies [3].

Only about half of these newborns are weighed at birth and for a proportion of them the gestational age (GA) is known [4]. As prematurity is the leading cause of neonatal death, early accurate estimation of gestational age is important for the early identification of infants in need of specialised care. Thus, estimation of accurate gestational age at birth and identification and prompt care of preterm/premature babies provides us with an opportunity to not only reduce neonatal mortality but also under-five mortality rate.

During pregnancy, ultrasonic measurement and Naegele's formula using the first day of the last menstrual period (LMP) are being used for gestational age estimation while the new Ballard score is used after birth [5]. These approaches have their pros and cons. In developing countries like India where LMP estimates become unreliable due to illiteracy, poor availability of antenatal ultrasound and specialist for newborn care whereas only 24% of pregnant women undergo ultrasonic evaluation during pregnancy [6].

The third National Family Health Survey, India (NFHS-3) has reported that less than 40% of mothers received postnatal care from any health personnel within 48 hours of delivery. Because of operational difficulties in the field in India and other similar settings, postnatal care within 48 hours of birth though important is not generally being widely carried out. All the above problems warrant the need for an alternative measurement that can predict gestational age.

These alternative measurements should not only be reliable but should also have a good correlation with gestational age in new-born. Identifying these premature babies with a simple, inexpensive and easy to use screening tool by peripheral health workers in remote areas will lead to early referral of such babies to higher centre.

Method

Setting: It is a cross-sectional, observational and analytical study conducted in Peoples Hospital, Bhopal.

Duration: 1st February 2014 to 30th April 2015 Sampling Method: All live births delivered were examined by the investigator within 24-48 hours of birth. Data was recorded and entered in MS excel.

Sample size: 350 newborns

Inclusion Criteria: All newborns delivered in Peoples Hospital in the defined duration.

Exclusion Criteria: Newborns with structural deformities, suspected or confirmed genetic abnormalities, neuromuscular conditions and congenital infections.

Data collection procedure: All newborns were enrolled after written parental consent. Then the principal investigator recorded gestational age by New Ballard score and anthropometric parameters of newborns using standard techniques.

1) Gestational age was assessed by New Ballard score.

2) Birth weight – babies were weighed naked on the electronic weighing scale (after standardisation) to the nearest of 5g. The electronic weight machine used is shown in the figure.

3) Head Circumference –measured by non-stretchable measuring tape to the nearest of 0.1 cm along the maximum occipitofrontal diameter over occiput & eyebrow.

4) Mid arm circumference - measured by non-stretchable measuring tape to the nearest of 0.1 cm of left arm at the midpoint between the tip of acromion process and olecranon process.

5) Length– measured by infantometer recording to nearest of 0.1 cm with the baby supine, knees fully extended & soles of feet held firmly against the footboard & head touching the fixed board. The infantometer used is shown in the figure.

Ethical consideration: The study was started after taking due permission from Institutional Ethics Committee.

Statistical analysis: Data was compiled using Microsoft excel and analysed using SPSS version 20.0 software. Percentage and mean were calculated. To investigate the linearity between two continuous variables, Pearson correlation was performed. Receiver operating characteristics curve (ROC - curve) analysis was used to define the cutoff value. Sensitivity, specificity and likelihood ratio for positive and negative tests were calculated at all cut-points for anthropometric variables.

Results

The present study enrolled 350 newborns; 76% were term and 24% were preterm babies. Out of 350 newborns, the range of gestational age is 30-43 weeks with a mean gestational age of 37.5 weeks. Descriptive statistics of anthropometric variables of the recruited newborn are tabulated in Table 1.

Table 1. Descriptive statistics of anthropometric variables of study population (n = 350)

Variables	Minimum	Maximum	Mean	Std. Deviation	95 % CI
GA	30.00	43.00	37.5086	2.15281	37.2822 to 37.7349
Birth weight (gm)	1.05	4.65	2.5971	.50996	2.5435 to 2.6507
Head circumference (cm)	26.90	35.70	32.6106	1.54833	32.4478 to 32.7733
length	40.00	53.80	48.4594	2.50648	48.1959 to 48.7229
Mid arm Circumference	6.10	13.20	10.3720	1.16071	10.2500 to 10.4940

Correlation Between Gestational Age and Neonatal Anthropometric Measurements

Pearson's correlation coefficient (r) between gestational age and anthropometric measurements are provided in Table 2. The r-value between gestational age and anthropometric parameters ranged from 0.458 to 0.566. Anthropometric parameters had a positive statistically significant correlation with gestational age ($p < 0.001$). The highest correlation was observed with Head circumference (*r*=0.566). Linear regression analysis for GA with all anthropometric measurements is also shown in Table 2.

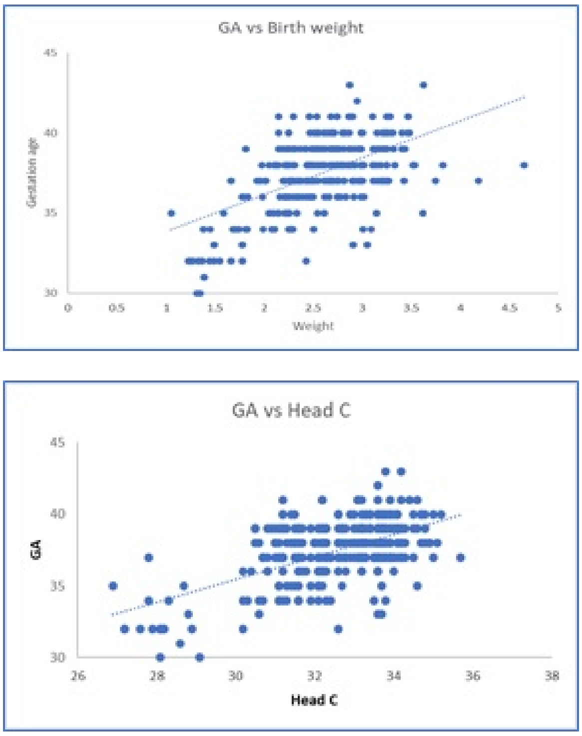
Coefficient of determination (R2) with birth weight, HC, MAC & length means that in 29%, 32%, 21% & 27% cases respectively, GA can be predicted by the equation. The model had maximum coefficient of determination R2 = 0.321 ($p < 0.001$) with HC. Change in GA due to one cm change in HC is predicted to be 0.407 week.

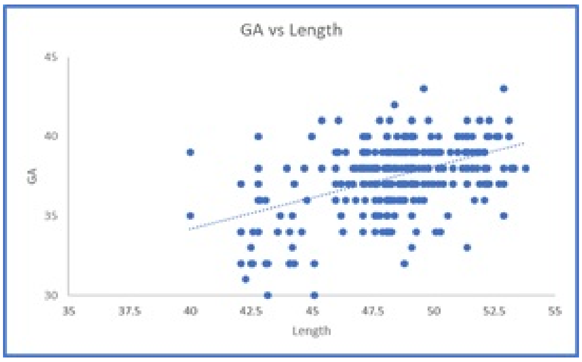
Table 2. Pearson correlation and regression analysis between GA and anthropometric variables for the study population

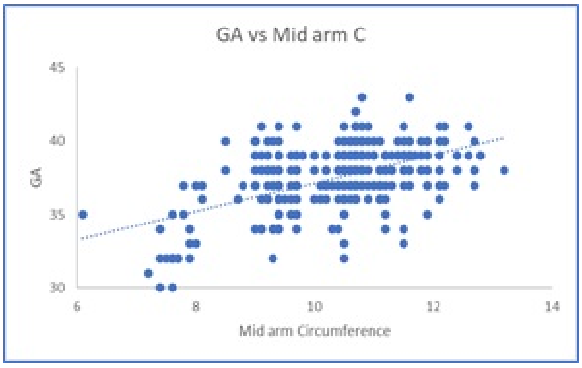
	Correlation measurement		Regression measurement	
GA vs Anthropometric Variables	Correlation Coefficient (r)	P value	R2 Value	Regression equation (y)
Birth weight (gm)	.545	.000 *	.297	Y= 31.54 +2.292 A
Head circumference (cm)	.566	.000 *	.321	Y= 17.337+.407 B
length	.458	.000 *	.210	Y= 18.425 +.390 C
Mid arm Circumference	.519	.000 *	.270	Y= 27.52+.961 D

* Correlation is significant at the 0.01 level.

Figure 1. Scatter plot of GA and various anthropometric variables showing linear relationship







Sensitivity, specificity, predictive values (negative and positive), as well as likelihood ratios (negative and positive) were also determined (Table 3). The identification of preterm newborns with HC <32.65 cm had a sensitivity of 75.8%, which means that 75.8% of preterm newborns can be detected by an HC measurement, and a specificity of 15.8% means that there is a 15.8% improbability of full-term gestational age in newborns who have HC < 32.65 cm. For Birth weight, the positive likelihood ratio (+ LR) value was 2.97, indicating that the probability of preterm newborns having a birth weight < 2.52kg was 2.97 times greater than birth weight >2.52kg.

The maximum positive predictive value was noted for MAC (98.9%), which means that for newborn MAC < 10.55 cm, the possibility of preterm gestational age was 98.9%.

Table 3: Sensitivity, specificity, predictive values (negative and positive), as well as likelihood ratios (negative and positive) were also determined.

Measurement	Cut off value	Sensitivity	Specificity	+ LR	-LR	+PV	-PV	AUC	P Value
Birth weight (gm)	<2.52	74.3	15.5	2.97	1.87	81.6	10.7	.798	<0.0001
Head circumference (cm)	<32.65	75.8	15.8	.823	0.16	94.0	3.6	.785	<0.0001
length	<47.65	75.6	21.4	.054	0.023	95.9	3.6	.753	<0.0001
Mid arm Circumference	<10.55	75.6	25	.002	0.001	98.9	1.2	.778	<0.0001

The Receiver Operating Characteristic (ROC) curve analysis was carried out to estimate gestational age through the best possible cut-off of the newborn's anthropometric parameters. Since Birth weight with cut-off < =2.52kg has a higher AUC than other variables it is a good marker for predicting prematurity.

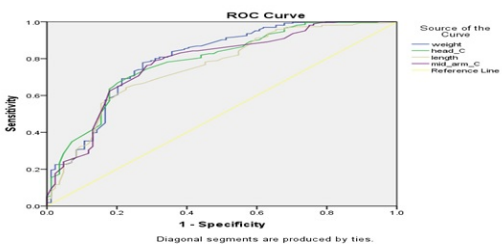


Figure 2: ROC curve analysis for GA and various anthropometric variable

Discussion

Prematurity is a major determinant of neonatal survival. Estimation of gestational age by recalling LMP is prone to error, and ultrasonic assessment is often difficult to use in resource-limited countries. In developing countries, less than half of neonates undergo any evaluation within 24 hours of birth [7]. The New Ballard score used for GA assessment requires a person trained in pediatrics and it is a subjective test. In contrast, anthropometric measurements collected by health workers are more reliable than clinical examination [8,9]. The present study enrolled 350 newborns; 76% were term and 24% were preterm babies. The mean birth weight of the newborns in the present study is found 2.59 kg which is similar to the average birth weight reported by the WHO multicenter study which was 2630 gms for newborns in India [10].

Male to female ratio

In the present study, 50.9% were males as compared to 49.1% females. It is comparable to a study done by Ashish KC et al which showed 53.1% males and 46.9% females [11]. In a study done by Singhal S et al 56.5% were males and 43.5% were females [12].

Description of birth weight

In our study, 46% of total new-born were of low birth weight (<2.5 kg) which is comparable to a study done by Mukherjee et al in 2013 which showed the prevalence of 51% of LBW new-born [13]. The mean birth weight in our study is 2.59 kg which is comparable to the mean birth weight of 2.67 kg in a study by Hugue et al but is less as compared to other studies done such as by Chandrashekhar T Sreeramareddy et al and Sajjadian et al which had to mean by 3.029 kg and 3.195 kg respectively [14,16].

Description of head circumference

In the current study, head circumference, birth weight, mid-arm circumference and length had a positive significant correlation with gestational age. This finding was in agreement with a study conducted in India by Thawani et al [17]. Moreover, this study had in agreement with a study conducted by Yadav et al in India which explained that birth weight, head circumference, and length had a positive correlation with gestational age [18].

Concerning the strength of association in the current study, head circumference (r=0.566) had a relatively strong correlation with gestational age on complete weeks followed by birth weight (r=0.545). This finding was consistent with a study conducted by Gandhi et al on a Western Indian population with a strong correlation (r=0.977) between gestational age and head circumference [20]. Sasanow et al also reported a strong linear correlation (r=0.95) between them [21].

Das et al conducted a cross-sectional study in a tertiary care hospital with 530 consecutively live-born newborns of 28–41 weeks gestation reported a significant correlation(r=0.86) [22]. A similar correlation of gestational age with head circumference(r=0.581) and birth weight(r=0.629) was noted by Kapoor et al [23]. A study from rural parts of India enrolled over 1000 newborns concluded a similar result of the significant correlation of HC (0.766) and birth weight (0.799) with gestational age[24].

Description of mid arm circumference & length

Mid arm circumference (r=0.519) and length (r=0.458) correlated poorly in our study. These findings are consistent with the study conducted in a developing country by Tiruneh et al where MAC(r=0.406) and length (r=0.115) [25]. Rajesh et al found a strong correlation of gestational age with mid-arm circumference(r=0.845) [26]. which may be due to the geographical and genetic variation of a sample taken.

Contrary to our result, Lee et al showed that neonatal anthropometry had poor performance to classify preterm newborns [27]. The strength of our study is that the entire examination was conducted by a medical person trained in examining the newborns and not by any peripheral health worker or traditional birth attendant. This study also has its share of limitations. This sample may not be a true representation of community settings as we conducted the study in a tertiary care centre. Finally, we did not do a longitudinal follow-up of the babies to determine whether the associations hold at a later age.

Limitation

In situations where community health workers cannot visit the mother until a few days after the birth, it is important to know whether the relationship between gestational age and other surrogate marker remains the same. The study was not able to answer this question comprehensively and further research is therefore necessary.

Conclusion

Newborn clinical assessment of GA is challenging at the community level in low-resource settings. HC measurement is simple and quick parameters that can be used as an anthropometric surrogate for estimation of GA by peripheral health care workers and traditional birth attendants. This can help in the identification of high-risk newborn at the primary care level and timely referral.

What does the study add to the existing knowledge?

Regression equations and cut off values for various anthropometric parameters to calculate the gestational age of newborns in Central India. Though further studies are needed to cross-validate our result.

Authors Contribution

Dr.Purnendu Lohia: Topic selection, Study design, data collection & entry.

Dr Vishal Shrivastava: Study design, data analysis.

Ms Anita Sahu: Data Analysis

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