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Original Research Article

# A Hospital-Based Cross-Sectional Assessment & Correlation of Gestational Age in Newborns with Head Circumference

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**Conflict of interest: Nil**

## Abstract

**Objectives:** This study aimed to evaluate the relationship between gestational age (GA) and neonatal anthropometric parameters, namely head circumference and crown heel length.

**Method:** A cross-sectional study in Darbhanga Medical College and Hospital Darbhanga, Bihar, India for 14 months. with 300 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.

**Result:** Amongst 300 newborns, 71% were term and 29% 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 = 0.526)]. 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:** circumference, length, gestational age, newborn



## Introduction

Neonatal survival has improved worldwide, albeit at a slow pace. This is especially true for developing countries which still account for almost all neonatal deaths (99%) in the world [1]. Amongst the 193 member states of WHO, for whom the statistics for neonatal deaths are available, India has the highest number of annual neonatal deaths. Out of the

3.072 million Neonatal deaths reported worldwide by the World Health Organization (WHO) in 2010, nearly one-third (875,000) occurred in India [2]. India, Nigeria, Pakistan, China, and Congo

together account for more than 50% of all neonatal deaths globally.[3]

During the past two decades, there has been a sustained reduction in infant and child mortality rate but the reduction in neonatal mortality rate (NMR) is far from satisfactory [1,4]. The contribution of newborn deaths to the under-5 mortality has grown from 37% in 1990 to 41% in 2011 [5].To bring about a decrease in NMR, there is a need to curtail the three most important causes of neonatal deaths, *viz*. preterm delivery (29%), asphyxia (23%), and severe infections, such as sepsis and pneumonia (25%). An estimated 1 million babies die globally every year because of prematurity, of which about 375,000 neonatal deaths due to prematurity and low birth weight occur in India alone [6,7].

An estimated one million babies die globally annually due to prematurity, of which approximately 375 000 neonatal deaths due to prematurity and low birth weight occur in India alone.[6,7] Only about half of these newborns are weighed at birth and for a proportion of them the gestational age (GA) is known. [8] Conventionally, GA is computed based on Naegele's formula or by ultrasonic evaluation. GA estimates based on Naegele's formula tend to have lower accuracy in settings with low literacy. [9] In India, one study has estimated that only 24% of pregnant women undergo ultrasonic evaluation during pregnancy. [10] Reliability of the New Ballard Score (NBS) as an assessment tool to determine GA is uncertain as its accuracy depends on the skill of the examiner and the neonate's condition. [11] Therefore, an inexpensive and practical method is needed to identify at-risk preterm newborns soon after birth. [12, 13]

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 center.[14]

**Materials and Method:**

It is a cross-sectional study conducted in Darbhanga Medical College & Hospital, Darbhanga, Bihar, India for 14 months

**Inclusion Criteria:**

All newborns delivered in Darbhanga Medical College & Hospital, Darbhanga, Bihar, India in the defined duration.

**Exclusion Criteria:**

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

**Data collection procedure:**

Total 300 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
3. 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 study was started after taking due permission from Institutional Ethics Committee.

**Statistical analysis:**

Data was compiled using Microsoft excel and analyzed using SPSS version 20.0 software. Percentage and mean were calculated. To investigate the linearity between two continuous variables, Pearson correlation was performed.

**Results:**

The present study enrolled 300 newborns; 71% were term and 29% were preterm babies. Out of 300 newborns, the range of gestational age is 30-43 weeks with a mean gestational age of 31.3 weeks. Descriptive statistics of anthropometric variables of the recruited newborn are tabulated in Table 1.

The r-value between gestational age and anthropometric parameters ranged from 0.458 to 0.526. Anthropometric parameters had a positive statistically significant correlation with gestational age ($p < 0.001$). The highest correlation was observed with Head circumference ($r$=0.526). Linear regression analysis for GA with all anthropometric measurements is also shown in Table 2.

The identification of preterm newborns with HC <32.65 cm had a sensitivity of 74.7%, which means that 74.7% of preterm newborns can be detected by an HC measurement. For Birth weight, the positive likelihood ratio (+ LR) value was 2.54, indicating that the probability of preterm newborns having a birth weight < 2.52kg was 2.54 times greater than birth weight >2.52kg. (Table 3)

The maximum positive predictive value was noted for MAC (95.7%), which means that for newborn MAC < 10.55 cm, the possibility of preterm gestational age was 95.7% as shown in Table 3.

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**Table 1. Descriptive statistics of anthropometric variables of study population (n = 300)**

| Variables | Minimum | Maximum | Mean | Std. Deviation | 95 % CI |
|---|---|---|---|---|---|
| GA | 25.00 | 40.00 | 33.6578 | 2.15281 | 35.34 to 32.78 |
| Birth weight (grams) | 1.5 | 3.6 | 2.4112 | .50996 | 2.21 to 2.11 |
| Head circumference (cm) | 30.1 | 31.8 | 29.1207 | 1.54833 | 30.34 to 33.78 |
| length | 40.00 | 49.8 | 41.3887 | 2.50648 | 41.77 to 43.89 |
| Mid arm Circumference | 6.21 | 11.8 | 9.817 | 1.16071 | 9.22 to 10.12 |

**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 (grams) | .452 | .000* | .201 | Y= 29.12 +2.21 A |
| Head circumference (cm) | .526 | .000* | .321 | Y= 13.23 + .321 B |
| length | .458 | .000* | .287 | Y= 15.32 +.298 C |
| Mid arm Circumference | .514 | .00* | .221 | Y= 21.65 +.875 D |

**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 (grams) | <2.21 | 73.2 | 14.3 | 2.54 | 1.32 | 80.2 | 10.2 | .778 | <0.0001 |
| Head circumference (cm) | <30.21 | 74.7 | 15.6 | .782 | 0.13 | 93.1 | 3.2 | .721 | <0.0001 |
| length | <40.78 | 75.8 | 20.2 | .134 | 0.025 | 94.7 | 3.1 | .789 | <0.0001 |
| Mid arm Circumference | <11.26 | 74.1 | 24 | .001 | 0.001 | 95.7 | 1.8 | .723 | <0.0001 |

**Discussion:**

Prematurity is a major determinant of neonatal survival. Estimation of GA by methods like recall of LMP is prone to error, and ultrasonic assessment is often difficult to use in resource-poor countries. In developing countries, less than half of neonates undergo any evaluation within 24 hours of birth. [15]

The NBS score used for GA assessment has both physical and neuronal criteria. It has fallacies as it requires a person trained in pediatrics and furthermore it is a subjective test. Neurological examination requires both skill and training. In contrast, anthropometric measurements collected by health workers have been shown to be more reliable than clinical examination. [16, 17].

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 [18, 19]. The present study enrolled 300 newborns; 71% were term and 29% 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 grams for newborns in India [20].

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 [3]. 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 [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 [24,25].

**Conclusion:**

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. Newborn clinical assessment of GA is challenging at the community level in low-resource settings.

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