

Assessment of Crown-Heel length, Head Circumference, and Mid-Arm Circumference for Estimation of Small for Gestational Age in Rural Area

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Abstract

Background:

The burden of having small for gestational age (SGA) children is high in low- and middle-income countries, mainly in South Asia. Identifying these low birth weight and SGA infants and referring them to higher centers for effective intervention will help reduce neonatal mortality and morbidity. Anthropometric measurements of the neonatal population, especially birth weight measurements, constitute an important scientific research tool for studying the determinants and consequences of impaired or excessive fetal growth.

Objective:

To find an alternative anthropometric procedure, the present study was done to measure and compare birth weight with crown heel length (CHL), head circumference (HC), and mid-upper arm circumference (MUAC) as predictors of birth weight in small for gestational age (SGA).

Methods:

This cross-sectional, analytical study was done in the Department of Anatomy, Rangpur Medical College, Rangpur from July 2020 to June 2021 on 200 newborns of both sexes with gestational age between 37 and 42 weeks. The newborn was selected and measured within 24 hours of birth. 100 term newborns weighted <2.5 kg regarded as SGA were the subjects of the study. Another 100-term newborns weighted >2.5 kg regarded as AGA served as control. The birth weight, head circumference, mid-upper arm circumference, and crown heel length were measured and a comparison of all the variables was done between AGA and SGA newborns. Data was analyzed by using a statistical package for social sciences (SPSS version 26).

Result:

The mean \pm SD of birth weight in AGA and SGA groups was 2.99 ± 0.31 and 2.10 ± 0.24 respectively; it was observed that the mean \pm SD of crown heel length, head circumference, and mid-upper arm circumference and Ponderal index in AGA group was significantly higher than SGA group; however the MAC/HC ratio was almost similar between AGA and SGA groups. All the above variables were significantly correlated with birth weight in both AGA and SGA groups.

Conclusion:

Some simple and inexpensive measurements of newborns especially the head circumference of SGA newborns are as effective as birth weight measurement; crown heel length, and mid-upper arm circumference could also be used to predict birth weight in SGA newborns.

Keywords: Appropriate for Gestational Age (AGA), Small for Gestational Age (SGA), Birth Weight (BW), Crown Heel Length (CHL), Head Circumference (HC), and Mid Upper Arm Circumference (MUAC)

Introduction:

The neonatal period is the most vulnerable period of life¹. Neonatal deaths account for 45% of all deaths among under-five children². Most of them die at home or at primary health care centers with minimal facilities. About 60% of the low birth

weight (LBW) newborns are born at term due to fetal growth restriction termed as Small for Gestational Age (SGA) newborns, whereas the remaining 40% are born preterm³. The term 'small for gestational age' (SGA) describes newborns who have lower than – expected weight, length, and

head circumference when controlled for gestational age and sex. In 1995, the World Health Organization published recommendations defining SGA as less than the 10th percentile of weight for gestational age and Large for gestational age (LGA, >90th percentile) with those appropriate for gestational age (AGA) using localized and anthropometric newborn curve⁴.

The burden of SGA births is very high in low and middle-income countries mostly in South Asia. Identifying these LBW and SGA newborns and referring them to higher centers for effective interventions would help in decreasing neonatal mortality and morbidity⁵.

Anthropometric measurements of the newborn population specially measurement of birth weight are an important scientific research tool to study the determinants and consequences of impaired or excessive fetal growth⁶. It is a non-invasive and cheap universal technique to assess the body size, proportions, and human composition⁸. The value of anthropometric measurement is the basic gold standard technique to describe the growth of individual and population level⁷.

In Bangladesh, 70% to 90% of births occur in rural areas at home and are conducted by illiterate and often untrained traditional birth attendants⁸. Taking accurate birth weight in such field situations is a problem due to the unavailability of weighing scales, ultrasonography, and trained personnel⁹. The identification and evaluation of low-cost tools to accurately identify small newborns in primary health care and community settings has been ranked as the number one research priority to reduce global mortality from LBW¹⁰. A few studies in a variety of settings have shown that different anthropometric measurements at birth are highly predictors of LBW¹⁰. Different workers suggested crown-heel length, head circumference, and mid-upper arm circumferences are the best anthropometric surrogates of LBW among different populations^{11,12}.

So, this study was done to measure crown heel length, head circumference, and mid-upper arm circumference of newborns and to compare and correlate these measurements with BW thus identifying among this anthropometric measurement which would be used as an alternative to birth weight for predicting SGA newborns.

Materials and Methods:

This was a cross-sectional, analytical type study, done in the Department of Anatomy, Rangpur Medical College, Rangpur from July 2020 to June 2021. The study population consisted of 200 Bangladeshi newborns of both sexes with gestational age between 37 and 42 weeks. The subjects were collected by convenient purposive sampling and were divided into two groups: The appropriate for gestational age (AGA) group and the Small for gestational age (SGA) group. Group AGA consisted of 100 term newborns weighted >2.5 kg who were born in the department of Gynae & Obs and the group SGA consisted of 100 term newborns weighed <2.5 kg who were admitted to the SCANU of the Department of Pediatrics of Rangpur Medical College Hospital. Subjects of both groups were studied within 24 hours of delivery. Newborns delivered by cesarean section and Normal vaginal delivery were included. However, neonates with any congenital abnormality-microcephaly, macrocephaly, any identifiable neurological disorder, any H/O birth injury, and obstructed labor with maternal DM, and HTN disorders were excluded from the study. Permission was taken from the Chairperson of the Ethical Committee of Rangpur Medical College and permission was also taken from proper guardians of the subjects.

Variables of the study:

The Birth weight (kg), Crown heel length (cm), Head circumference (cm), and Mid upper arm circumference (cm) were measured and the Ponderal index and MAC/HC ratio were calculated.

All the measurements were taken thrice and the mean of these three was taken. Birth weight was measured on an undressed newborn using a digital weighing scale and noted in grams to the nearest 5g. Crown heel length (CHL) was measured by an infantometer in cm. Head circumference and MUAC were measured by a non-stretchable measuring tape in cm. All the measurements were performed according to NHANES, anthropometry procedures manual¹³.

The ponderal index and MAC/HC ratio were calculated. The most commonly used index of neonatal body proportionality relates birth weight to birth length: Ponderal index = 100 times the birth weight (in grams) divided by the cube of birth length (cm). MAC/HC ratio = mid-upper arm circumference (in cm) divided by head circumference (in cm).

The statistical analysis was carried out using the statistical package for social sciences (SPSS version 26.0). Mean and standard deviation were calculated for each group. The statistical significance of the difference in quantitative variables between the Group - AGA Group and SGA Group was evaluated by independent sample t-test. Correlation of birth weight with other variables was done by Pearson's correlation coefficient test. In the statistical analysis, the significance level was set at p-value <0.05 with a 95% confidence interval.

Results:

In this anthropometric study, in the AGA group, the range of birth weight was 2.5 to 4 kg and the mean \pm SD was 2.99 \pm 0.31 kg. In the SGA group, the range of birth weight was 1.5 to 2.4 kg and the mean \pm SD was 2.10 \pm 0.24 kg.

Table-I showed the range, mean \pm SD of the measured variables in AGA and SGA group newborns. It was observed from Table-I that the CHL, head circumference, and mid-upper arm circumference in the AGA group were significantly higher than the SGA group (p<.001).

Table-I: Comparison of crown heel length, Head circumference and Mid arm circumference between AGA and SGA Groups (n=100 in each group)

Variables	AGA	SGA	p-value
Crown heel length	51.3 \pm 3.05 43-59	46.5 \pm 2.32 40-50	<.001
Head circumference	35.09 \pm 1.70 30-38	31.40 \pm 1.25 27-37	<.001
Mid arm circumference	12.76 \pm 1.59 8-15	11.43 \pm 1.48 8-14	<.001

Comparison of Ponderal Index and MAC/HC ratio between AGA and SGA groups

Table-II showed that the Ponderal index was significantly higher in AGA group than SGA group. However the MAC/HC ratio was almost similar between AGA and SGA groups.

Table-II: Descriptive statistics of Ponderal index and MAC/HC

Variables	AGA		SGA		p-value
	Range	Mean \pm SD	Range	Mean \pm SD	
Ponderal Index	1.22-4.02	2.26 \pm .46	1.36-3.24	2.11 \pm .32	.009
MAC/HC ratio	.03-.42	.36 \pm .05	.26-.44	.36 \pm .04	.46

A correlation test was done between birth weight and the anthropometric measurements in AGA and SGA group newborns. It was observed that in the AGA group, the HC and Ponderal index was significantly correlated with birth weight but in SGA group, a significant positive correlation was found between birth weight with all three anthropometric measurements and the Ponderal index.

Discussion:

The Millennium Development Goal 4- to reduce deaths of children of under-5 years by 2/3rds- may be unattainable without halving newborn deaths, which now comprise 38% of all under-5 deaths globally¹¹. A major risk factor for neonatal mortality is LBW. Nearly all the newborns who die are LBW, and mostly in rural communities¹⁴. In the present study, the term new-borns weighted <2.5 kg was regarded as SGA & \geq 2.5 was regarded as AGA. Mullany et al.¹⁵ stated that <2000 gm was a very low birth weight. In the present study, in the AGA group, the mean \pm SD of birth weight was 2.99 \pm 0.31kg and in the SGA group, the mean \pm SD was 2.10 \pm 0.24kg.

Crown heel length is widely used for the evaluation of prenatal growth and identification of infants requiring detailed assessment and close monitoring during the neonatal period⁷. In the present study, in the AGA group, the range of CHL was 43 to 59 cm and the mean \pm SD was 51 \pm 3.05cm. In the SGA group, CHL was 40 to 50 cm and mean \pm SD was 46.5 \pm 2.32cm. The CHL in the AGA group was significantly higher than the SGA group (p<.001). It was observed that in AGA newborns highest mean value of CHL was found by the present study (51.30cm) and the lowest value was found by Srinivasa et al.¹⁹ in India (48.38cm). In the SGA group, the highest mean value of CHL was found in Verma and Sharma¹⁸ which was 48.15cm, and the lowest mean value was found by Srinivasa et al.¹⁹ in India (29.12cm). It was found by workers that CHL as height was attained in the 2nd trimester but weight attained completed at 3rd trimester so it was less affected than body weight by intrauterine malnutrition and was a better guide to fetal age than the later as it has been said in the literature. It is probable that paternal height and maternal height have more influence in determining an infant's crown heel length. According to Yudkin et al.²² HC may give important diagnostic and prognostic information beyond that provided by birth weight alone. In the present study, in the

AGA group, the mean \pm SD was 35.05 \pm 1.70cm, and in the kiSGA group, the mean \pm SD was 31.40 \pm 1.25 cm. The HC in the AGA group was significantly higher than the SGA group ($p < .001$). It was observed that in AGA newborns highest mean value of HC was found by Kokku et al.²¹ in India which was 43.65cm and the lowest value was found by Rakappan and Kuppusamy¹⁶ in India which was 32.16cm. In the SGA group, the highest mean value of HC was found in the Verma and Sharma¹⁸ in India which was 33.15cm, and the lowest mean value was found by Alia et al.⁹ in Bangladesh that was 28.63cm.

Many previous investigations have reported the associations between lower birth weight and head circumference and adverse neurodevelopmental outcomes in early childhood. Between 7 and 9 months of age, substantial growth in head circumference is accompanied by rapid cerebral growth, myelination of the limbic system, enhanced associative pathways, and improved inhibitory control.²³ Poor physical growth may be a marker for disruption of these important steps in brain development. The MUAC is easy, cost-effective, and reliable for identifying risk neonates and has a better correlation with birth weight²⁵. In the present study, in the AGA group, the range of MUAC was 8 to 15 cm and the mean \pm SD was 12.76 \pm 1.60cm. In the SGA group, the range of MUAC was 8 to 14 cm and the mean \pm SD was 11.43 \pm 1.48cm. The MUAC in the AGA group was significantly higher than the SGA group ($p < .001$). It was observed that in AGA newborns highest mean value of MUAC was found by the present study (12.76cm) and the lowest value was found by Kokku et al.²¹ in India (9.83cm). In the SGA group, the highest mean value of MUAC was found in the present study (11.43cm) and the lowest mean value was found by Alia et al.⁹ in Dhaka, Bangladesh (7.62cm). In the AGA group mean \pm SD of the Ponderal Index was 2.26 \pm .46. In the SGA group mean \pm SD of the Ponderal Index was 2.11 \pm .32. In the AGA group mean \pm SD of MAC/HC was .36 \pm .05. In the SGA group mean \pm SD of MAC/HC was .36 \pm .04. The Ponderal index was significantly higher in AGA group than SGA group. The MAC/HC ratio was almost similar between the AGA and SGA groups. Shastry et al²⁶ showed PI was 2.07-2.54 in gestational age >37 weeks and suggested that it may be used to classify intrauterine growth retardation. As, in the present study,

BW showed a significant positive correlation with the anthropometric variables and Ponderal index in the SGA group, these variables could be used as an alternative to BW measurement in a rural setup.

Conclusions:

The neonatal mortality rate is very high in Bangladesh because of resource-poor settings. This study has shown that the simple and inexpensive measurement of newborns like head circumference, crown heel length, and mid-upper arm circumference of newborns play similar roles in predicting SGA newborns. These measurements are easy to learn and can conveniently be introduced into the existing systems of health care in the community of developing nations like Bangladesh, Asia, and Africa for use by paramedical workers to detect neonates who are at risk. For use in low-resource settings, any anthropometric device must be inexpensive and easy to maintain. Color-coded insertion tapes for measurement of variables can easily be made using locally available materials. However, it was a single-centered study in a tertiary care hospital, which may not focus on the actual status of the country. So, a multicenter study in rural areas of Bangladesh with a larger sample would focus on the actual status of the country.

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