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Original Article

Relationship between newborn mid-upper-arm circumference and birth weight

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Abstract

Background Recording an accurate birth weight by primary health care workers has been a problem in rural areas, leading to a search for an alternative, inexpensive, age independent and noninvasive method to predict neonatal well being. Mid-upper-arm circumference (MUAC) might be an alternative anthropometric measurement useful to estimate the state of nutrition.

Objective To evaluate the relationship between MUAC and birth weight in low birth weight (LBW) and normal birth weight (NBW) infants.

Methods We measured birth weight and MUAC of newborn babies of various gestational ages at Siti Fatimah Maternity and Children's Hospital and Dr. Wahidin Sudirohusodo General Hospital, Makassar, South Sulawesi, Indonesia. Correlation tests and diagnostic accuracy using different cut-off points were performed

Results There were 892 live birth newborns (117 LBW and 775 NBW) included in the study. The sensitivity, specificity, positive predictive value, and negative value for MUACs of < 10.3 cm were 94.9 %, 99.9%, 99.1%, and 99.2%, respectively. The sensitivity, specificity, positive predictive value, and negative value for MUAC < 10.4 cm were 99.1 %, 99.6%, 97.5%, and 99.9%, respectively. The sensitivity, specificity, positive predictive value, and negative value for MUAC <10.5 cm were 100%, 99.4%, 95.9%, and 100%, respectively.

Conclusion There is a strong correlation between MUAC and birth weight. Birth weight can be predicted with the following equation: *Birth weight = -1776.383 + (416.95 newborn MUAC value)*. The optimal cut-off point for the newborn MUAC value for LBW infants is <10.5 cm. **[Paediatr Indones. 2009;49:11-4]**.

Keywords*: mid-upper-arm circumference, birth weight*

Birth weight is an important indicator of infant growth and survival.[1-8] In developing countries, low birth weight (LBW) is strongly related to infant mortality and morbidity.[4-7] Neonatal death is more likely among LBW or very-low-birth-weight (VLBL) especially in developing countries.[5,9-11]

Birth weight has been most widely used as the anthropometric measurement of choice for risk identification in newborns. However, recording of accurate birth weight by primary health care workers has been a problem in rural areas, leading to a search for an alternative, inexpensive, age independent and noninvasive method to predict neonatal well being.[1,3,7,10-13]

Some investigations have shown that mid-upper-arm circumference (MUAC) can be very useful to estimate the state of nutrition. MUAC covers the muscular and fat compartments. Indirectly, the muscular compartment represents the protein reserves, while the fat compartment estimates the energy reserves. A low MUAC may therefore reflect either a

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reduction in muscle mass, a reduction in subcutaneous fat tissue, or both, which correlates positively with changes in weight.[14-16] In the Perinatology Division, Pediatric Department, Medical School, University of Hasanuddin, MUAC is routinely measured in the newborn. A study to evaluate the value of MUAC as a diagnostic tool to identify intrauterine growth retardation (IUGR) in term babies has been carried out previously.[13] However, a study to determine the accuracy of MUAC as a diagnostic tool to identify LBW infants and to reveal the correlation between MUAC and birth weight, has never been conducted before, leading us to conduct this study.

Methods

This prospective cross-sectional study was conducted at Siti Fatimah Maternity and Children's Hospital and Dr. Wahidin Sudirohusodo General Hospital, Makassar, South Sulawesi, Indonesia from February 1st 2007 to June 5th 2007. The target population was live birth newborns of various gestational ages.

We included all live birth newborns either with spontaneous vaginal delivery, caesarean section or vacuum extraction whose parents agreed to participate in the study. We excluded newborns with congenital anomaly of the left upper-arm, and those with birth injury on the left upper-arm.

Results

During the period of February 1st until June 5th 2007, data on the MUAC and birth weight of 892 live birth newborns were recorded. These 892 infants comprised 117 LBW and 775 normal newborns.

The subjects' characteristics are shown in **Table 1**. The comparison of MUAC values between male is female newborns is presented in **Table 2**.

Statistical analysis revealed no significant differences in MUAC values between genders using the t-test (P = 0.203). The comparison between MUAC values between the LBW and NBW groups was shown in **Table 3.**

There was a significant difference of mean MUAC values between the LBW and NBW groups (P < 0.001). The Pearson correlation test showed a highly positive linear correlation between MUAC value and birth weight with a correlation coefficient of 0.966.

Table 1. Characteristics of study subjects

Characteristic	Particulars
Mother 's age, years	Mean
Mean (SD)	28.0 (6.0)
Range	13-47
Gender	Male
	Female
Birth weight, grams	
Mean (SD)	2965.4 (532.7)
Range	(760 – 4800)
MUAC, cm	
Mean (SD)	11.4 (1.2)
Range (6 - 14)	6 -14
Gestational age (weeks)	
Mean (SD)	40 (1.5)
Range	30 – 44

Table 2. Comparison of MUAC values of newborns based on gender

Characteristic	Groups	
	Male	Female
Gender, n	515	377
Mean MUAC, cm	11.4	11.3
Std deviation MUAC, cm	1.4	1.7
Minimum MUAC, cm	6	6.2
Maximum MUAC, cm	14	14

t test t = 1.274 P = 0.203

Table 3. Comparison of MUAC values for LBW and NBW groups

MUAC of newborn (cm)	Groups	
	LBW	NBW
Frequency	117	775
Mean (SD) - cm	9.1 (1.1)	11.7 (0.8)
Range – cm	6 – 10.4	10.2 - 14
Percentile 2.5	6.5	10.5
Percentile 97.5	10.3	13.3

t = 25.118 P < 0.001

A simple regression test to predict the correlation between birthweight and MUAC was performed (**Figure 1**) and resulted in the following linear equation:

$$BW = -1776.383 + (416.95 \times \text{newborn MUAC value}).$$

The lowest and highest cut-off point values between LBW and NBW MUAC distributions were 10.3 cm and 10.5 cm, respectively (**Figure 2**).

Further assessment was performed to determine the most accurate MUAC cut-off point value in order to distinguish LBW from NBW newborns by using sensitivity and specificity test (**Table 4**).

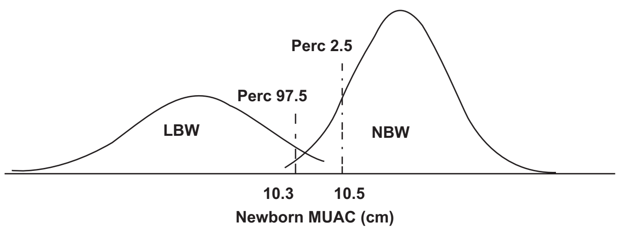

Figure 1. The cut-off point values of MUAC distributions between LBW and NBW newborns.

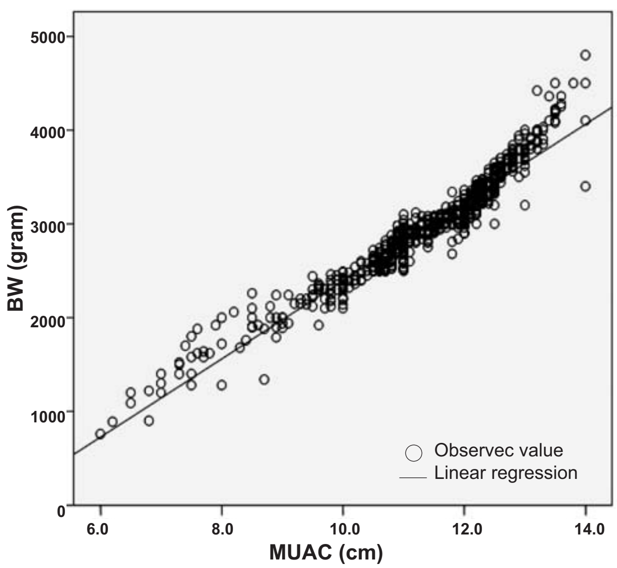

Figure 2. Linear regression based on correlation between newborn MUAC and BW

Table 4. Sensitivity, specificity, positive predictive and negative predictive values of MUAC cut-off points

MUAC (cm)	Sensitivity value (%)	Specificity value (%)	Positve predictive value (%)	Negative predictive value (%)
<10.3	94.9	99.9	99.1	99.2
<10.4	99.1	99.6	97.5	99.9
<10.5	100	99.4	95.9	100

Discussion

The mean MUAC value of 11.4 (SD 1.2) cm in our recent study was greater than previous studies. Studies in Brazil, India, and Bangladesh,[1,12,17] found mean values of 10.76 (SD 0.68) cm, 9.2 (SD 0.37) cm and 10.4 (SD 1.0) cm, respectively. These differences may be due to several factors, including ethnicity, genetics and nutritional status of the population, as well as possible differences in measurement procedures. There was no significant difference between genders in relation to MUAC values which was similar to findings of these studies.

Correlation tests revealed a highly significant positive correlation between newborn MUAC values and birth weights ($r = 0.966$, $P < 0.001$). Regression test signified a linear regression equation in which *BW= -1776.383 + (416.95 X newborn MUAC value)*. Therefore, this equation can predict birth weight if the newborn MUAC value has been measured with a simple tape.

Figueira, Sood and Dhar[16-18] found a correlation between newborn MUAC values and birth weights with r= 0.66, r= 0.76 and r= 0.84, respectively. Figueira and Sood excluded preterm newborns, whereas this study included term and preterm babies. Systematic random sampling for preterm and term babies, which were performed by Dhar[12] and Sasanow[13] had noted a highly positive correlation between newborn MUAC values and birth weight (r= 0.93) with the exclusion of term babies suffering from hypoglycemia, hypocalcemia, polycytemia, placental insufficiency or IUGR, and those with maternal diabetes. The range of gestational age in Sasanow's study was 25–42 weeks.[16-18]

Based on the lowest cut-off point of 10.3 cm at 97.5 percentile of the MUAC distribution of LBW group, and the highest cut-off point of 10.5 cm at 2.5 percentile of the MUAC distribution of NBW group, three points can be analyzed to identify LBW. Evaluation on the sensitivity and specificity of the 3 points revealed that the best MUAC value to distinguish LBW from NBW newborn was at < 10.5 cm.

The limitation of this study was associated with the fact that assessment of MUAC was performed after body weight had been measured. However, evaluation of intra and extra-examiner coefficient of variation showed a minimal bias.

In conclusion, there is a high positive correlation between birth weight and MUAC. Our data allowed us to determine that the following equation can be used to predict birth weight from MUAC: *Birth weight = -1776.383 + (416.95 MUAC)*. The optimal cut-off point value of newborn MUAC value for LBW identification is < 10.5 cm.

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