Anthropometric measurements for detecting low birth weight

Kusharisupeni, Wahyu Kurnia Y. Putra, Engkus Kusdinar Achmad

Abstract

**Background** In several provinces of Eastern Indonesia, the majority of births take place at home (60%) and are assisted by traditional birth attendants. Most of these newborns do not have their birth weight recorded, due to lack of available weighing scales or lack of skill to perform the measurement, especially in rural areas. As such, an early identification of low birth weight cases is needed to prevent infant morbidity and mortality.

**Objective** To assess anthropometric measurements including calf, chest, and head circumferences as a method of choice for detecting low birth weight, as substitute for actual weighing.

**Methods** This cross-sectional study was performed at Banjar Baru, South Kalimantan, Indonesia, from January to March 2012. Subjects were full term, singleton, and live-born infants during the study period, and obtained from private clinics by a purposive sampling procedure. Calf, chest, and head circumferences were measured to identify the most suitable substitute for birth weight using Pearson’s correlation, ROC, sensitivity, and specificity.

**Results** In this study, a correlation was shown between birth weight and all anthropometric measurements. Optimal calf, chest, and head circumference cutoff points to identify low birth weight infants were 10.3 cm, 30.7 cm, and 31.2 cm, respectively. The area under the curves (AUC) showed good accuracy for all measurement types. Calf circumference had the closest estimated true prevalence to the true prevalence (8.52% and 8.6%, respectively) compared to the other measurement types.

**Conclusion** Calf circumference is the most suitable measurement as a substitute for birth weight, due to its estimated true prevalence. [Paediatr Indones. 2013;53:177-80.]

**Keywords:** calf circumference, birth weight, surrogate, anthropometric measurements
with the aim of using them as a substitute for birth weight.3,4 In Indonesia, these types of studies have been limited. Therefore, we aimed to assess potential anthropometric measurements as a method of choice for detecting LBW, as well as to determine cutoff points of these measurements to identify LBW infants shortly after birth.

Methods

This cross-sectional study was performed in an urban region of Banjar Baru, South Kalimantan, Indonesia, from January to March 2012. The required minimum sample size was calculated from the correlation coefficient hypothesis test equation to be 66 subjects.5 We included infants who were full term, singleton, and live born during the study period. Subjects were obtained from private clinics with a purposive sampling procedure. Data collection was performed by trained midwives. Gestational age was calculated based on the mother’s last menstrual period (LMP).3 Infants were weighed naked in a supine position to the nearest 0.1 kg using an infant scale (One Med®). Calf circumference was measured at the most prominent point with the leg in a semi-flexed position to the nearest 0.1 cm using a non-elastic, flexible, coloured tape (Ministry of Health).4 Chest circumference was measured by placing the tape along nipples and encircling the body.6 Head circumference was taken by placing the tape along the largest occipitofrontal diameter encircling the occiput and the eyebrows.6 Two consecutive measurements were taken within 24 hours of birth and the means were calculated. The receiver operating characteristic (ROC) curve analysis was carried out to calculate 95% confidence interval of the area under the curve (AUC) and to evaluate the accuracy of different anthropometric measurements to predict LBW.7 The sensitivities and specificities were calculated at all cutoff points for all anthropometric measurements. We noted the highest ratio of sensitivity and specificity to determine the optimum cutoff point.8 For selecting the method of choice from among calf circumference, chest circumference, and head circumference, the apparent prevalence and estimated true prevalence were analyzed.9 A P value of <0.05 was considered to be statistically significant.

Results

A total of 209 newborns (52.6% boys and 47.4% girls) were included in our study. Eighteen infants (8.6%) had LBW (<2,500 grams). Table 1 shows the mean and standard deviation, minimum and maximum of all measurements.

Pearson’s correlation analysis revealed a correlation between calf circumference and birth weight (r = 0.65; P<0.01), between chest circumference and birth weight (r = 0.73; P<0.01), as well as between head circumference and birth weight (r = 0.61; P<0.01).

Sensitivity, which refers to the ability of the test to correctly identify LBW infants, and specificity, which refers to the ability of the test to correctly identify normal BW infants (≥2500 grams), were

| Measurements | Cutoff point (cm) | Sensitivity (%) | Specificity (%) |
|--------------|------------------|----------------|----------------|
| Calf circumference | 10.3 | 94 | 66 |
| Chest circumference | 30.7 | 83 | 85 |
| Head circumference | 31.2 | 94 | 66 |

Table 1. Description of birth weight and anthropometric measurements

| Measurements | n=209 | Max | Min |
|--------------|-------|-----|-----|
| Mean birth weight (SD), grams | 3,123.4 (496.2) | 4,600 | 1,350 |
| Mean calf circumference (SD), cm | 10.8 (1.4) | 18 | 7 |
| Mean chest circumference (SD), cm | 32.2 (2.3) | 38 | 22 |
| Mean head circumference (SD), cm | 32.6 (2.0) | 39 | 20 |
calculated for all cutoff points of head, chest, and calf circumferences. Cutoff points were calculated based on the highest sensitivity-specificity ratios. Table 2 shows the optimal cutoff points of head, chest and calf circumferences to identify LBW, 31.2 cm, 30.7 cm, and 10.3 cm, respectively.

The area under the curve (AUC) can be used to determine the overall accuracy of the test. A rough guide for classifying accuracy is: 0.9 (excellent), 0.8-0.9 (good), 0.7-0.8 (fair), 0.6-0.7 (poor) and 0.5-0.6 (fail). Based on the above results, we found that the results for test accuracy could be classified as good for calf and head circumference and excellent for chest circumference for all three measurements.

Table 3 shows that chest circumference had the highest AUC value (0.93; 95% CI 0.87 to 0.98) compared to those of calf and head circumference. However, calf circumference had the estimated true prevalence closest to the true prevalence (8.52% and 8.6%) as shown in Table 4.

**Discussion**

In this study, subjects’ mean birth weight [3,123.4 (SD 496.2) g] was lower than the results of a study performed in Sumatera (3,143.0 grams), but higher than those of two studies in West Kalimantan (3,003.3 grams and 3,001.0 grams). Compared to WHO multicenter reports, our finding was also higher than the mean birth weights in India (2,630 grams) and Nepal (2,730 grams), but lower than that of Sri Lanka (3,840 grams). Nevertheless, Banjar Baru, South Kalimantan has a high prevalence of LBW (8.6%), which gives us a representative picture of the high national LBW prevalence in Indonesia (7.14%).

All three alternative measurements in our study had significant correlations with birth weight. Based on the AUC analysis, we found that all anthropometric measurements (calf, chest and head circumferences) had good accuracies, of 0.93, 0.89, and 0.88, respectively. These values were higher than those of other Indonesian studies. Cutoff points were determined by calculating sensitivities and specificities, and were higher than the values reported by Samal et al., with the exception of calf circumference (9.9 cm). Good accuracy with 95% CI was performed in this study, thus subjects’ racial differences may have influenced the results.

Another factor that should be considered in determining the most suitable substitute for birth weight is the estimated true prevalence compared to true prevalence. We found calf circumference to be the most suitable measurement to substitute
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for birth weight, since its estimated true prevalence was closest to its true prevalence (8.52% and 8.6%, respectively), compared to chest and head circumference measurements.

In conclusion, we suggest calf circumference to be the most suitable and simplest substitute parameter to identify LBW infants, especially in remote areas where no weight scale is available. Newborns with calf circumference < 10.3 cm should be considered as LBW, while those with ≥ 10.3 cm calf circumference should be considered as normal BW. Color-coded tape indicating a calf circumference of < 10.3 cm could be used to make measurement-taking easier. In addition to the significant association between calf circumference and birth weight, calf circumference measurement is easy to learn, easy to perform and causes little discomfort to infants.

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