Paediatrica Indonesiana

VOLUME 53 May • 2013 NUMBER 3

Original Article

Anthropometric measurements for detecting low birth weight

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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*

Indonesia consists of 34 provinces, most of which do not fulfill the desired outcomes of the National Health Program. For example, in several provinces of Eastern Indonesia, including East Nusa Tenggara, Maluku, North Maluku, West Papua, and Papua, 60% of mothers gave birth at home according to statistics reports. Only 61.7% of delivery services in urban areas are conducted by midwives, while the corresponding percentage in rural area is even lower, only 54.5%.[1] Home services are usually carried out by traditional birth attendants. Birth weight is often not recorded due to the lack of available weighing scales or lack of skill to perform the measurement. Thus, measuring birth weight especially in rural areas is a problem. Indonesia has a high prevalence of low birth weight (LBW, < 2500 grams). National LBW prevalence accounts for 11.5%, and its effect on stunting is 38.6%.[1] Low birth weight babies tend to have high infant morbidity and mortality.[2] Therefore, early identification of low birth weight cases is needed.

In several developing countries, other studies have reported on anthropometric measurements based on calf, chest, and head circumferences

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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 menstsrual 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 ($r = 0.61$; $P<0.01$).

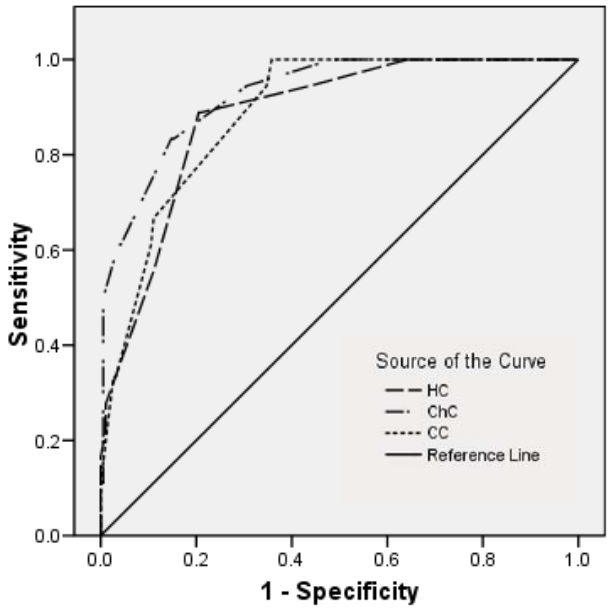
Sensitivity, which refers to the ability of the test to correctly identify LBW infants, and specificity, which refers to the ability of the test to correctly identify normal BW infants (≥2500 grams), were

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

Table 2. Sensitivity and specificity of optimum cutoff points of anthropometric measurements

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



HC = Head circumference
ChC = Chest circumference
CC = Calf circumference

Figure 1. Receiving operator curve (ROC) for each measurement

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).[7] 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**.

Table 3. Best descrimination of LBW detected by ROC

Measurements	AUC (%)	95% CI
Calf circumference	89	0.83-0.95
Chest circumference	93	0.87-0.98
Head circumference	88	0.81-0.95

Table 4. Estimated true prevalence and apparent prevalence

Measurements	TP (%)	AP (%)	P' (%)
Calf circumference	8.6	39.7	8.52
Chest circumference	8.6	21.0	8.39
Head circumference	8.6	26.3	8.47

TP =true prevalence; AP = apparent prevalence; P'=estimated true prevalence

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),[10] but higher than those of two studies in West Kalimantan (3,003.3 grams[11] and 3,001.0 grams[12]). 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).[13] 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%).[1]

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.*,[6] 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

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.

Acknowledgment

Sincere thanks to Ibu Nur Asiah, SKM, and all midwives involved in data collection for their great contribution to this study.

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