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Correlation between several anthropometric measurements to birth weight

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ABSTRACT Perinatal mortality remains one of the factors leading to child mortality, even for crude death as a whole. Therefore, good perinatal care is considered to be useful for reducing this mortality. Low birth weight is one of neonatal morbidity cause; previous studies reported correlation between birth weight to several anthropometric measurements and their predictive value. We aimed to evaluate the correlation between birth length, head, chest, abdominal, calf and mid arm circumferences as well as to foot length to birth weight. A cross sectional study was conducted in Adam Malik Hospital Medan between November 1st 1998 to January 31st 1999. All babies without clear moulage, caput succedaneum or cephal hematoma were studied. Birth weight was measured by TANITA weighing scale within the first 24 hours after delivery. Birth length by somatometer and head, chest, abdominal, calf and mid arm circumferences as well as foot length were measured 3 times by using plastic measuring tape. It was evident a positive correlation of birth weight to all such anthropometric measurements with the highest correlation coefficient for calf circumference (r : 0.92). Calf circumference of 9,8 cm is predictor of low birth weight. **[Paediatr Indones 2001; 41:288-291]**

***Keywords**: anthropometric, measurements, low birth weight, neonatal morbidity.*

PERINATAL MORTALITY IS THE SECOND CAUSE OF UNDERFIVE death (21.6%) after respiratory disease (30.8%),[1] while as a whole, it is one of leading cause of death in Indonesia for all age groups, besides infection, cardiovascular disease, and neoplasms.[2] Identifying high risk newborn babies is one of aspect to reduce neonatal morbidity and mortality.

Several factors increase the morbidity and mortality of newborn babies, that can be categorized as social demography factors, maternal health and previous pregnancy history, recent pregnancy problems, delivery problems and newborn baby problem. Birth weight less than 2500 grams or more than 4000 grams, small for gestational age (SGA) or large for gestational age (LGA) and congenital anomalies, are amongst the newborn baby problems.[3]

Low birth weight is the main contributor to neonatal mortality, combined with lethal congenital anomaly influence the fetal mortality and child morbidity rate.[3-5] Low birth weight infant is a newborn baby weighing less than 2500 grams,[6,7] consists of premature baby, namely they are delivered before 37 weeks of gestation, and SGA baby, a group of babies suffering from intrauterine growth retardation.[3,4,7]

Limited health facility, high delivery rate, rapid turn over rate of newborn care and limited staff of perinatal ward in the developing countries, affected low coverage of babies weighed at birth.[8-9] Therefore an alternative modality to evaluate low birth weight newborn is needed; anthropometric measurement is one of them.

Some observers reported the simple anthropometric measurement could be used to predict birth

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weight, then it could explain the possibility of intrauterine growth retardation and metabolic risk of newborn babies.[3,7,9-15]

This study evaluated the correlation between birth length (BL), head circumference (HC), chest circumference (ChC), abdominal circumference (AC), mid arm circumference (MAC), calf circumference (CC) and foot length (FL) to birth weight (BW), determined the anthropometric parameter correlation to birth weight and determined the cut of value of such anthropometric parameter reflecting low birth weight.

Methods

A cross sectional study was conducted in Departement of Child Health, Adam Malik Hospital from November 1998 to January 1999. Study population was babies born within study period. Newborn babies with clinical evidence of congenital anomaly, hydrops fetalis, clear moulage, caput succedaneum, or cephal hematoma were excluded.

Body weight was measured by using Tanita, a digital infant weight scale with the sensitivity of 50 grams, BL was measured using somameter with the sensitivity of 0.1 cm. Measurement of BL, HC, ChC, AC, CC, MAC and FL were taken thrice by single observer and the average value were taken as observational result. HC, ChC, AC, CC, MAC and FL were measured by using plastic measuring tape with sensitivity of 0.1 cm, each anthropometric parameters was measured by placing the measuring tape at this subsequent position: HL: through occipital process and glabella; ChC: through the nipple; AC: through umbilicus; CC: around the right leg approximating at maximum bulk of gastrocnemius muscle; MAC: at point half-way between acromion and olecranon process of ulna on the right arm flexed 90 degrees; FL: from the tip of big toe to the back of heel on the right foot. To estimate gestational age, Dubowitz criteria was used.[3]

The mean difference of birth weight and anthropometric measurements among male and female newborn babies were evaluated by using t-test. Correlation between birth weight and such anthropometric measurements were determined using correlation test, and presented by scatter diagrams. Regression analysis was performed to evaluate the functional relation of birth weight to each anthropometric parameter.

Results

Two hundred twenty five newborn babies were born at Adam Malik Hospital within the study period. Three newborn babies who have congenital anomaly (two meningoencephalocele and one anencephaly) were excluded.

There were 115 male babies (51.8%) and 107 female ones (48.2%), most of whom were grouped into 3000-4000 grams birth weight (**Table 1**), with the mean value 3143.0 (SD 520.2) grams for male and 3090.6 (SD 525.6) grams for female. Low birth weight accounted for only 14 babies (6.3%), among the remainder, 2 babies were born prematurely. For all anthropometric parameters, mean value show no difference among male and female babies (**Table 2**) and one another positively correlated with the correlation coefficient vary from 0.46 to 0.95 (**Table 3**). The strongest correlation coefficient between birth weight to anthropometric parameters was noted for calf circumference (**Table 4**), either for male, female or both of groups.

The cut off value for predicting of low birth weight using each anthropometric parameters as follows birth length 39.8 cm; head circumference 31.4

TABLE 1. DISTRIBUTION OF SUBJECTS ACCORDING TO BIRTH WEIGHT

BW	Male		Female		Total	
(grams)	n	%	n	%	N	%
< 2000	3	1.4	4	1.8	7	3.2
2000 –	4	1.8	3	1.4	7	3.2
2500 –	32	14.4	31	14.0	63	28.4
3000 –	46	20.7	52	23.4	98	44.1
3500 –	24	10.8	15	6.8	39	17.6
> 4000	6	2.7	2	0.9	8	3.6
TOTAL	115	51.8	107	48.2	222	100

TABLE 2. MEAN VALUE OF ANTHROPOMETRIC PARAMETERS.

Parameter	n	Mean	(SD)	p
Birth length	M	115	49.4 (3.0)	.591
	F	107	48.8 (2.0)	
Head circumference	M	115	34.2 (2.0)	.591
	F	107	34.0 (1.6)	
Chest circumference	M	115	32.2 (2.0)	.448
	F	107	32.0 (1.9)	
Abdominal circumference	M	115	30.2 (1.9)	.691
	F	107	30.1 (2.0)	
Calf circumference	M	115	11.3 (1.1)	.568
	F	107	11.2 (1.0)	
Mid arm circumference	M	115	10.6 (1.1)	.396
	F	107	10.5 (1.1)	
Foot length	M	115	8.1 (0.6)	.868
	F	107	8.1 (0.8)	

TABLE 3. CORRELATION COEFFICIENT BETWEEN ANTHROPOMETRIC PARAMETERS

BL	HC	ChC	AC	CC	MAC	FL
BL	0.48	0.50	0.46	0.53	0.53	0.47
	HC	0.81	0.78	0.70	0.68	0.67
		ChC	0.89	0.74	0.73	0.69
			AC	0.73	0.69	0.72
				CC	0.95	0.71
					MAC	0.65
						FL

TABLE 4. CORRELATION COEFFICIENT BETWEEN BIRTH WEIGH TO ANTHROPOMETRIC PARAMETERS BY SEX

No.	Parameter	Male (n = 115)	Female (n = 107)	Combined (n = 222)
1.	Birth length	0.54	0.72	0.58
2.	Head circumference	0.75	0.84	0.79
3.	Chest circumference	0.86	0.87	0.87
4.	Abdominal circumference	0.81	0.85	0.83
5.	Calf circumference	0.91	0.92	0.92
6.	Mid arm circumference	0.88	0.91	0.89
7.	Foot length	0.77	0.82	0.79

cm; chest circumference 29.4 cm; abdominal circumference 26.2 cm; mid arm circumference 8.9 cm and foot length 6.8 cm. Further, Figure 1 shows the scatter diagram of correlation between birth weight to calf circumference.

Discussion

Previous studies reported lower mean value of birth weight in community based than in hospital based studies.[16,17] Many factors influence birth weight, they are categorized as fetal, maternal and placental factors,[8] where the final performance of such factors are also influenced by genetic and environmental factors, including maternal nutrition, social and cultural state, as well as the altitude factor.[7,18] Yip reported that mothers residing at the highest altitude in USA had a 10% reduction of birth weight compared with infants born at sea level, as well as three fold increase of low birth weight rate over the expected.[18] The lowest risk for neonatal mortality occurred at birth weight 3000-4000 grams with the gestational age 38-42 weeks.[3]

The present study shows that 61.7% subjects were born with the birth weight of 3000-4000 grams and 80.2% of them with gestational age of 38-42 weeks. The mean birth weight did not differ between male and female in this study, in contrast to other investigators which reported the different mean birth weight among male to female group.[15,19, 20] Low birth weight in this study (6.3%) is less than reports by Alisyahbana (14%)[16] or Gazali (19.8%).[21] Of all the subjebts, no one is small for gestational age (SGA). Alano found 43.2% low birth weight on her study were SGA,[9] while other study stated that in the developing countries 70% of low birth weight will be SGA. [3]

Magzoub and Hamid did not find different mean values of anthropometric parameters between male and female newborn babies in terms of BL, HC, ChC and MAC,[15,22] while Bafak noted the different values at the observation of BL, head length and width as well as face length and width between different sexual groups.[14] All anthropometric parameters in this study revealed no different mean value among male and female, one another present positive correlation with the correlation coefficient varied from 0.46 (BL to AC) to 0.95 (CC to MAC), $p < 0.001$.

There is different type of strongest predictors of low birth weight that reported by previous observers. Gozal and Sasanow noted MAC strongly correlated to birth weight,[10.12] Magzoub found ChC correlated well to birth weight.[15] Our present study found four anthropomoteric parameters correlated strongly to birth weight ($r > 0.81$), namely ChC, AC, CC and MAC with the highest correlation coefficient is noted for CC ($r = 0.92$, $p < 0.001$).

By using regression formula BW = -3,11 + 0.19 ChC (BW in Kg, ChC in cm), Magzoub recommended ChC value 29.34 cm as cut off point for predicting of low birth weight. Gozal and Alano suggested MAC $\leq$ 9.5 cm and CC 10.1 cm might be used for predicting low birth weight. This study noted CC value 9.8 cm which was derived from regression formula BW = -1938 + 450.57 CC (BW in gram, CC in cm), can be predictor of low birth weight.

High incidence of home delivery (± 80%) in the developing countries and small numbers of them weighed within first 24 hours (16.6%).[4] contributes to so many high risk newborn babies undetected. Results of this study suggest a simple and cheap method for detecting and screening low birth weight babies by using plastic measuring tape, a widely distributed simple equipment. We conclude that birth weight is significantly correlated to seven observed anthropometric parameter, calf circumference present the highest value of correlation coefficient and CC value 9.8 cm is a strong predictor of low birth weight.

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