Correlation of Birth Weight/Length Ratio to Skinfold Thickness in Full-Term Newborns

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ABSRTACT The determination of child/neonatal nutritional status based on their skinfold thickness has been widely known and accepted, but its daily implementation is quite difficult since this procedure needs specific tools and skills. Although still debatable, some anthropometric measurements, i.e., birth weight/length ratio were currently used as a mean to determine one's nutritional status. To find out the correlation of birth weight/length ratio to skinfold thickness of newborn babies based on gender, a cross-sectional study was conducted on 352 full-term infants (194 males, 158 females) born at the Cipto Mangunkusumo Hospital between June 14 to July 17, 1998. Of the male infants, their birth weight/length ratio showed a strong correlation to triceps and subscapular thickness ($r=0.65$ and 0.68, respectively); while the females revealed a strong correlation of birth weight/length ratio to the triceps thickness ($r=0.51$) and a moderate correlation to the subscapular skinfold thickness ($r=0,49$). It was also found that the triceps and subscapular skinfold thickness in male infants were significantly lesser than the females, with p values of 0.02 and 0.04, respectively. This study revealed that the birth weight/length ratio can be used as a mean to assess neonatal nutritional status. **[Paediatr Indones 1999; 39:259-267]**

Introduction

The assessment of nutritional status of the newborn babies bears a very important meaning, since it has a significant interrelation with infants' morbidity and mortality rate. So far, the well-known mean to determine such nutritional status is the Battaglia-Lubchenco method, which is based on the birth weight to gestational age.[1]

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In developing countries this method has a significant drawback, since there are still a lot of mothers who often forget or paid no attention to their menstrual cycle. Other method which has also been used to assess nutritional status in adult, child,[2,3] and the neonate[4,5] is the measurements of skinfold thickness of the triceps and subscapular. This method also bears difficulties since it needs special tool and skill to perform. Some other anthropometric indexes have been used to assess nutritional status such as birth weight to length ratio, upper arm to head circumference ratio, etc. Even though these last two methods still invite controversy, birth weight to length ratio has been used in some clinics to assess newborn's nutritional status.[4-6] A study of Yau and Chang (1992) concerning 375 newborn babies with gestation of 26-42 weeks showed that the birth weight/length ratio had a significant, strong correlation to skinfold thickness in full-term and premature infants (r=0.69).[6]

The purpose of our study was to find out how significant is the relationship of birth weight/length ratio to skinfold thickness of full-term newborn babies, and the characteristics of such relationship by gender.

Methods

This cross-sectional study was conducted at the Division of Perinatology, Department of Child Health, University of Indonesia, Cipto Mangunkusumo Hospital, Jakarta. Criteria of inclusion were: (1) all live-birth, singleton babies with gestational ages of 37-42 weeks, born at Cipto Mangunkusumo Hospital during the period of June 14 - July 17, 1998; (2) no clinically detectable anomaly at birth. Any infants was subject to excluded from this study if parent refused to participate. All consecutive subjects meeting the criteria were included in the study. Estimation of the number of study subjects was calculated using a single sample for estimating means.[7]

Gestational age in this study was calculated using the Ballard method.[8] Furthermore, at the age of 2-3 days triceps and subscapular skinfold thickness was measured using the Holtain caliper. The site of triceps measurement was the posterior border of the upper arm, midway between the acromion and the tips of olecranon process.[2] Subscapular skinfold was measured at the lower angle of scapula with the fold in a vertical line, and the arm by the side of the body.[2] Measurement of skinfold thickness were done three times on the left side of the body. Each measurement took 15-60 seconds or until the hand's of the caliper's watch stood still. The recorded measurement is the mean of the three estimation done.

Birth weight was measured in 1 hour after birth, using Berkel pediatric scale. Birth length was measured from crown to heel and taken by skilled nurses. Birth weight/length ratio was the relative weight which expresses the weight of a given subject as a percentage of the average weight of persons of the same height. The average weight of persons of the same height was calculated at percentile 50 of standard

Alisyahbana measurement.[9] Data were recorded and analyzed by Epi info 6 program. Statistical comparison for variable anthropometric measurements of male and female infants were calculated using the independent t test. Linear regression analyses were used to evaluate the birth weight/length ratio to the skinfold thickness of male and female infants. A p value of <0.05 was considered to be statistically significant.

Results

Subject characteristics

During the period of June 14 - July 17, 1998, 352 newborn babies (males 194 or 55.1% and females 158 or 44.9%) were registered. Even though mean values of the birth weight and birth length of male infants were larger than females, statistically this difference was not significant. On the other hand, mean value of the triceps and subscapular skinfold thickness were significantly larger in female infants than that in males. (Table 1)

Table 1. Subject characteristics birth weight, birth length, triceps and subscapular skinfold thickness and sex

Variable	Sex		p
	Male (n=194)	Female (n=158)	
Birth weight (g)			
▪ mean	3216.6	3159	0.17
▪ SD	394	386.4	
Birth length (cm)			
▪ mean	49.3	3.8	0.02
▪ SD	1.5	0.6	
Triceps skinfold thickness (mm)			
▪ mean	3.6	3.8	0.02
▪ SD	0.7	0.6	
Subscapular skinfold thickness (mm)			
▪ mean			
▪ SD	3.2	3.3	0.04
	0.7	0.6	

SD = standard deviation; p = probability

Distribution of skinfold thickness and gestational age

According to gestational age, the female newborn infants have greater mean of the triceps and subscapular skinfold thickness compared to the male newborn infants. The male and female newborn infants have greater triceps skinfold thickness than subscapular. (Table 2).

Table 2. Means of skinfold thickness by getational age

Skin fold thickness	Gestational age (weeks)					
	37	38	39	40	41	42
Male						
▪ triceps	-	3.0	3.2	3.8	3.9	4.2
▪ subscapular	-	2.6	2.9	3.4	3.5	3.7
Female						
▪ triceps	2.8	3.3	3.4	3.9	4.0	4.3
▪ subscapular	2.4	2.9	3.0	3.5	3.7	3.6

Correlation of birth weight/ length ratio in male triceps skinfold thickness

Figure 1 shows scatter diagram of birth weight/length ratio in male triceps skinfold thickness. An equation , y = - 1.5 + 0.05 X, n = 194, revealed strong correlation coefficient (r = 0.65) between birth weight/length ratio to the male triceps skinfold thickness. This was statistically significant ($p < 0.001$).

Correlation of birth weight/length ratio in male subscapular skinfold thickness

Figure 2, shows scatter diagram of birth weight/length ratio in male subscapular skinfold thickness. An equation, y = - 2.1 + 0.05 X, n = 194, revealed strong correlation coefficient (r = 0.68) between birth weight/length ratio to the male subscapular skinfold thickness. This was statistically significant ($p < 0.001$).

Correlation of birth weight/length ratio in female triceps skinfold thickness

Figure 3 shows scatter diagram of birth weight/length ratio in female triceps skinfold thickness. An equation, y = 0.4 + 0.03 X, n = 158, revealed strong correlation coefficient (r = 0.51) between birth weight/length ratio to the female triceps skinfold thickness. This was statistically significant ($p < 0.001$).

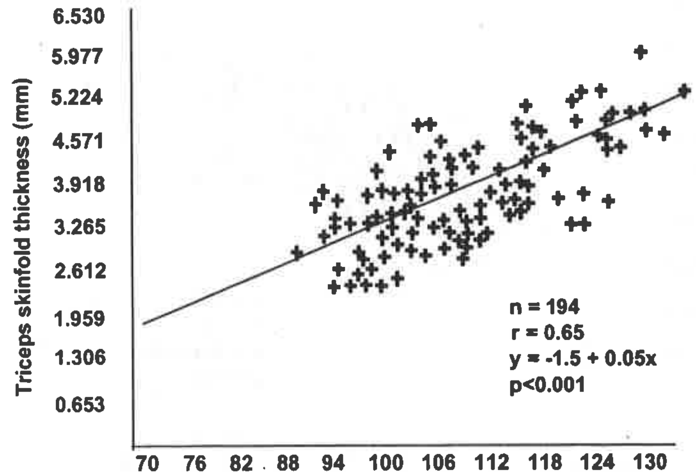

Figure 1. Scatter diagram of birth weight/length ratio in male triceps skinfold thickness.

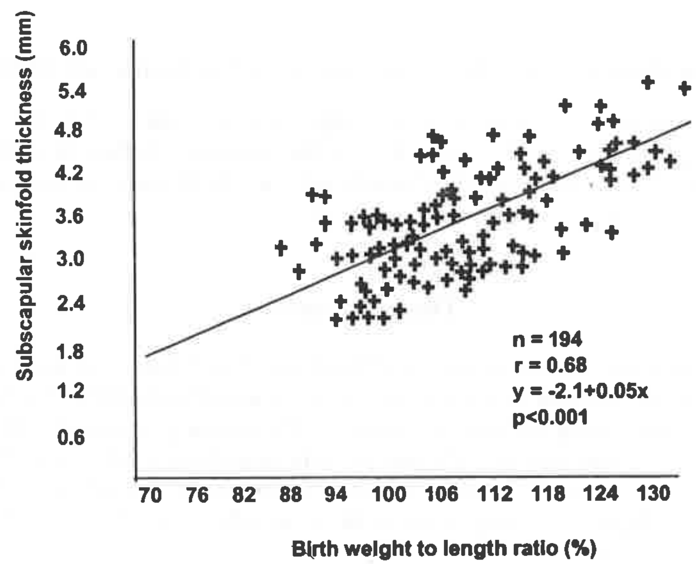

Figure 2. Scatter diagram of birth weight/length ratio in male subscapular skinfold thickness.

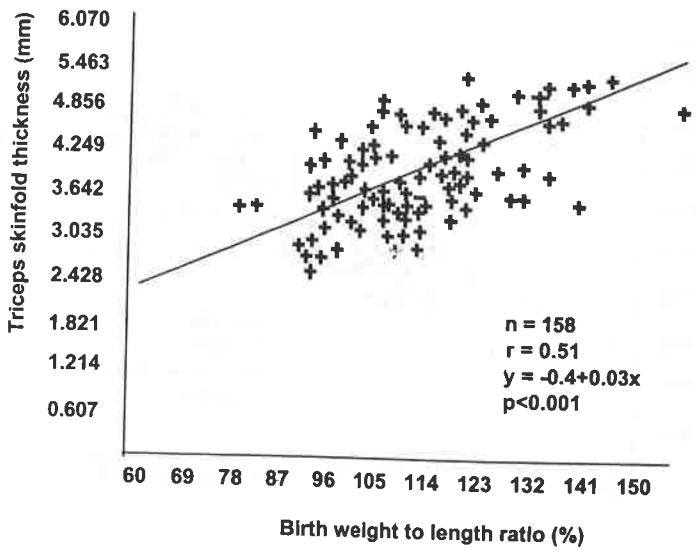

Figure 3. Scatter diagram of birth weight/length ratio in female triceps skinfold thickness.

Correlation of birth weight/length ratio in female subscapular skinfold thickness

Figure 4 shows scatter diagram of birth weight/length ratio in female subscapular thickness. An equation, y = 0.18 + 0.03 X, n = 158, revealed sufficient correlation coefficient (r = 0.49) between birth weight/length ratio to the female subscapular skinfold thickness. This is statistically significant ($p < 0.001$).

Discussion

In this study, the mean birth weight and birth length of male subjects were greater than those of female. However, the skinfold thickness measurement in male was significantly smaller than that in female (Table 1). This finding approved the theory that body weight does not necessarily indicate the amount of body fat in a particular baby. The heavier of the baby might be due to heavy bones, large muscle or water retention in male infants. In female infants, despite being smaller, they have more subcutaneous fat than male infants.[10]

The greater birth weight and length of male newborns were also reported by Farr et al (1966), who studied 300 infants with 29-44 weeks gestation.[11] So far the real cause

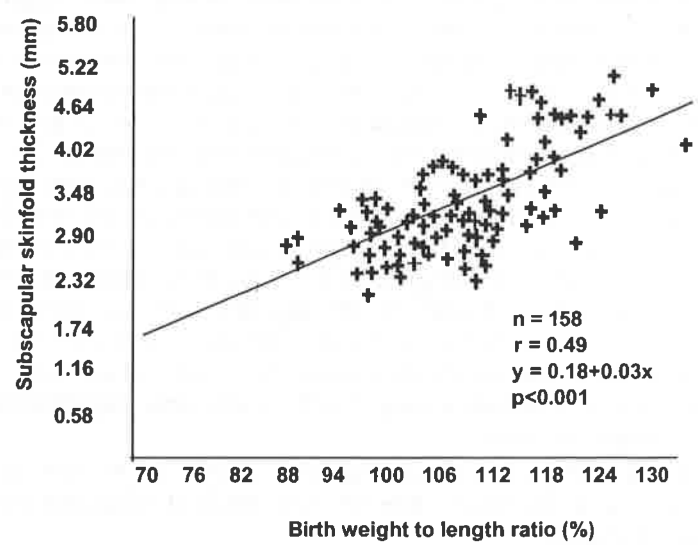

Figure 4. Scatter diagram of birth weight/length ratio in female subscapular skinfold thickness.

of this phenomenon is still unknown. Some studies find that the sex difference has strong correlation with the increase of fat free mass in male newborns. This condition might be due to the high level of testosterone found in gonad an amniotic fluid of male infants compared to females.[12-14] The real role and mechanism of testosterone in increasing production of fat free mass remains speculative.

In female infants the greater skinfold thickness is caused by more subcutaneous fat stores. The reason of increase fat stores in female compared to male infants is also unknown, but it might be related to androgen production in male fetus which influence the fat enhancing effect of circulating maternal and placental estrogens.[10] In this study it was also found that the skinfold thickness both in male and female subjects seemed to increase with gestational ages (37-40 weeks). Since gestational age was calculated using the Ballard method, in this study we did not find any babies with a gestational age more than 40 weeks. This is the reason we could not find declining thickness reported by other[5] in infants more than 40 weeks of gestation. The declines of the skinfold thickness found in other studies usually due to the aging of placenta and the fall of nutritional supply to the fetus.

It is generally accepted that skinfold thickness is a useful mean in assessing fetal growth in newborn infants. This method is technically difficult and impractical. To assess nutritional status of intrauterine growth, some clinic choose a ratio of some routine antrophometric measurement included body weight, body length or head circumference. The antropometric ratio was used because it is not only correlated well with perinatal mortality and morbidity,[15] but also had close correlation with skinfold measurement.[6,16,17] Yau and Chang reported that weight/length ratio is the one that have best correlation with skinfold measurement in both full-term and premature infants. No one of the studies reported the correlation base on gender. In our study the ratio of birth weight and length of male infants increase linearly with the increase triceps and subscapular skinfold thickness which have strong correlation (Figures 1 and 2). Correlation coefficient between birth weight/length ratio in female triceps skinfold thickness have strong correlation (Figure 3) but with subscapular skinfold thickness has only moderate correlation (Figure 4). We also observed that birth weight/length ratio to skinfold in female newborn had lower correlation coefficient (triceps 0.51 and subscapular 0.49) than male newborn (triceps 0.65 and subscapular 0.68). Is this finding cause by fact that female's weight and length were significantly lower than male is still need further studies.

From data of this study we conclude that birth weight/length ratio in male and female full-term infants is not much different with skinfold thickness for determining neonatal nutritional status.

References

1. Battaglia FC, Lubchenco LO. A practical classification of newborn infants by weight and gestational age. J Pediatr 1967;71:159-63.
2. Tanner JM, Whitehouse RH. Revised standards for triceps and subscapular skinfold in British children. Arch Dis Child 1975;50:142-5.
3. Zerfas AJ, Shorr IJ, Neumann CG. Office assessment of nutritional status. Pediatr Clin North Am 1977;24:253-72.
4. Dauncey MJ, Gandy G, Gairdner D. Assessment of total body fat in infancy from skinfold thickness measurement. Arch Dis Child 1977;52:223-7.
5. Oakley JR, Parson RJ, Whitelaw AGL. Standard for thickness in British newborn infants. Arch Dis Child 1977;52:287-90.
6. Yau KIT, Chang MH. Weight to length ratio: A good parameter for determining nutritional status in preterm and fullterm newborns. Acta Pediatr 1992;82:427-9.
7. Madiyono B, Moeslichan S, Sastroasmoro S, Budiman I, Purwanto SH. Perkiraan besar sampel. In: Sastroasmoro S, Ismael S, eds. Dasar-dasar metodologi penelitian klinis. Jakarta:Binarupa Aksara; 1995.p.187-212.
8. Ballard JL, Khoury JC, Wedig K, et al. New Ballard Score, expanded to include extremelly premature infants. J Pediatr 1991;119:417-23.
9. Alisjahbana A, Chaerulfatah A,Usman A,Sutresnawati S. Anthropometrry of newborn infant in 14 teaching centers in Indonesia. Pediatr Indones 1994;34:62-123.

10. Copper RL, Goldenberg RL, Cliver SP, et al. Anthropometric assessment of body size differences of fullterm male and female infants. Obstet Gynecol 1993;81:161-4.
11. Farr V. Skinfold thickness as an indication of maturity of the newborn. Arch Dis Child 1966;41:301-8.
12. Catalano PM, Drago NM, Amini SB. Factors affecting fetal growth and body composition. Am J Obstet Gynecol 1995;172:1459-63.
13. Gibson M, Tulchinsky D. The maternal adrenal. In: Tulchinsky D, Ryan KJ, eds. Maternal-fetal endocrinology. Philadelphia: Saunders; 1980. p.129-293.
14. Griffin JE, Wilson JD. Disorders of the testes and the male reproductive tract. In: Wilson JD, Foster DW, eds. Williams textbook of endocrinology. 8th ed. Philadelphia: Saunders; 1992.p. 799-852.
15. Dombrowski MP, Berry SM, Johnson MP, Saleh AA, Sokol RJ. Birth weight-length ratios, ponderal indexes, placental weights, and birth weight-placenta ratio in large population. Arch Pediatr Adolesc Med 1994;148:508-12.
16. Wolfe AM, Brans YW, Gross TL, Bhatia RK, Sokol RJ. Correlation commonly used measures of intrauterine growth with estimated neonatal body fat. Biol Neonate 1990;57:167-71. (Abstract)
17. Sumners JE, Findley GM, Ferguson KA. Evaluation method for intrauterine growth using neonatal fat stores instead of birth weight as outcome measures: fetal and neonatal measurements correlated with neonatal skinfold thickness. J Clin Ultrasound 1990;18:9-14. (Abstract)