Paediatrica Indonesiana

VOLUME 49 January • 2009 NUMBER 1

Original Article

The somatic growth pattern of preterm infants until term age

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Abstract

Background Preterm infants contribute substantially to neonatal morbidity and mortality rates. Somatic growth is considered to be an important indicator of an infant's health status. The measurement parameters include body weight (BW), body length (BL), head circumference (HC), and ponderal index (PI). Specific data on the somatic growth pattern of preterm infants in Indonesia are unavailable.

Objectives To identify the somatic pattern of preterm infants until term age and the influence of gender, nutrition, and nursing method on BW, BL, HC, and PI growth during the first week of life.

Methods We recruited premature infants born in Sanglah Hopsital, Denpasar, Bali, and collected data on BW, BL, HC, and PI> All data were presented as mean (SD) and plotted in curves. The relationships among several factors and the somatic growth parameters were analyzed with ANOVA. The level of significance was set at $P < 0.05$.

Results Among 100 infants, significant differences were detected in the mean of BW, BL, HC, and PI, particularly in early preterm infants. Breastfed infants had the highest values with BW 2199 grams (SD 198), HC 31.4 cm (SD 1.71), and PI 2.48 grams/cm^3 (SD 0.36). Infants nursed with the kangaroo method had the highest values of BW [2450 grams (SD 259)] and BL [48 cm (SD 2.34)].

Conclusion A significant difference was detected in somatic growth according to some parameters, particularly in the early preterm infants group. Thus, breast feeding and the kangaroo method contribute to better somatic growth, and specifically BW. **[Paediatr Indones. 2009;49:39-47]**.

Keywords*: preterm infants, somatic growth, breast-feeding, kangaroo method*

Premature baby delivery (PBD) is an important problem in human reproduction. The prevalence rate of premature babies with low birth weight in Indonesia is approximately 14-20%; the figure in Cipto Mangunkusumo Hospital in 1998 was 17.8%.[1] PBD plays an important has become a common cause of perinatal death, as well as short-term and long-term neonatal morbidity.[1,2] In developing countries, the first week after delivery is a critical period for the mother and her baby. Approximately 25%-50% of babies less than one year old died in the first week of life (early neonate).[3] Premature babies are members of a high-risk group that requires continuous evaluation of growth and development. Medical problems that arise include growth retardation, failure to thrive, cerebral palsy, mental retardation, hearing problems, ophthalmologic problems, behavior problems, learning disorders, the risk of developing an organic disorder.[4] The earlier the gestational age (GA), the higher the risk of developing a growth and developmental disorders.

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With the recent advances in premature and low birth weight baby management, many more babies will be able to survive; it is our responsibility to make those premature babies grow and develop as optimal as possible. Many studies have reported that for premature babies, the lower the birth weight, the higher is the risk for developing growth and developmental disorders. Hendarto[7] reported that the incidence of growth and development disorders in low birth weight babies was 38.4%. One of the important clues for detecting problems in health status of premature babies is somatic growth from birth time. The normal standard values for premature baby growth are available from the intrauterine somatic growth curve. If that curve is applied to premature babies (extrauterine), there may be different somatic growth patterns.

This study aimed to identify the somatic growth pattern of preterm infants until term age and the influence of gender, nutrition, and nursing method on body weight, body length, head circumference, and ponderal index growth during the first week of life.

Methods

This study was conducted between July and December 2005 for all premature babies in the neonatal ward of Sanglah Hospital. The babies were selected consecutively. The study protocol and the permission letter addressed to parents were approved by the local committee for Ethics Research Committee of the Medical School, Udayana University. Written informed consent documents were obtained from the parents. We included all newborn preterm infants at 32 to 37 weeks gestation, birth weight less than 2500 grams, and resided in Denpasar, and excluded newborn preterm infant with major congenital anomaly, severe asphyxia, sepsis, or twin pregnancy.

We measured the BW, BL, HC, and PI at birth for all babies. The same measurements were then performed every day for the first seven days. After this period, the examination was performed every week to obtain physical measurement difference patterns from the babies until they were term or 40 weeks gestational age. Associated factors, such as sex, nutrition, and care method, were also recorded for correlation analysis with BW, BL, HC, and PI.

The next measurement was performed by two previously trained medical staff members in the baby's room. The measurement was performed every day at 8.00 am before the babies were given milk for the first seven days. Weekly measurement was performed until the baby reached a gestational age of 40 weeks. If the baby was already discharged before 40 weeks gestational age according to discharge criteria, the parents were asked to bring their babies for follow-up in the outpatient clinic weekly. If the parents and the baby did not come to the clinic, they were home-visited in the next two days.

BW measurement was performed as soon as possible after birth. The baby was weighed without any clothes or by using flannel cloth only with a radiant heater (the weight of any wrapping clothes would be measured). The BW measurement tool was a non-digital scale (Infant Scale type RGZ-20) that had previously been imprinted, with an accuracy of 50 grams. The measurement was conducted based on the study protocol. The length measurement was performed as soon as possible after birth. The baby position was supine, and the length was measured using an infantometer with an accuracy of 0.1 cm. One member of the medical staffs held the baby's head so that the equipment was touching the baby's fontanel, while the other staff member held and straightened baby's legs so that the baby's soles touched the infantometer. The baby was held tightly for a few seconds so that he or she could stay still and the staff was able to read the measurement result well. The measurement was performed based on the study protocol. HC measurement was performed as soon as possible after birth using the occipitofrontalis circumference as a measurement of head and brain growth. The average of three separate measurements was used as the standard. The measurement was done using the largest circumference of the head. A plastic ribbon meter (linear measure) with an accuracy of 0.1 cm was used to measure HC. The measurement was performed based on the study protocol. PI in units of grams/cm^3 was calculated by using the following formula: [body weight (in grams)/ height (in cm)^3 x 100].

Statistical analysis was performed using computer software. The data on BW, BL, HC, and PI are presented as mean (1 SD) – mean (2 SD) and plotted in curves. The relationships among several factors and the somatic growth parameters were analyzed with ANOVA. The level of significance was set at $P<0.05$.

Results

During the study period, 1115 babies were born, and 141 of these (12.65%) were included as subjects based on the study criteria. Forty-one babies were excluded (3 twin babies); 5 babies with congenital disorders including gastroschisis (2 babies), atresia ani (1 baby), and multiple congenital disorders (2 babies); 8 babies with gestational age less than 32 weeks; 11 babies with severe asphyxia; 5 babies with sepsis; and 9 babies living outside Denpasar (of these, 4 babies had severe asphyxia and 1 baby had sepsis). The study diagram plot is shown in **Figure 1**.

Table 1 shows the baseline study subjects characteristics. Of the 100 subjects, there were 48 boys (48%) and 52 (52%) girls. There were 27 (27%) subjects with gestational age (GA) of 32 to less than 34 weeks, 37 (37%) subjects with GA of 34 to less than 36 weeks, and 36 (36%) subjects with GA of 36 to less than 37 weeks. Mean birth weight was 1928 (SD 253) grams, mean length at birth was 43.96 (SD 2.52) cm, mean HC at birth was 30.09 (SD 2.03) cm, and mean PI at birth was 2.82 (SD 0.34)g/cm^3. Approximately 35 (35%) subjects received parenteral nutrition early in life, and 47 (47%) subjects were cared for using an incubator. Most of the mothers were Balinese (77%).

Figure 2 shows the somatic growth curve of the 32 to 34 weeks GA group (early preterm). There was a significant difference in the mean values of BW, BL, HC, and PI every week from birth until term age.

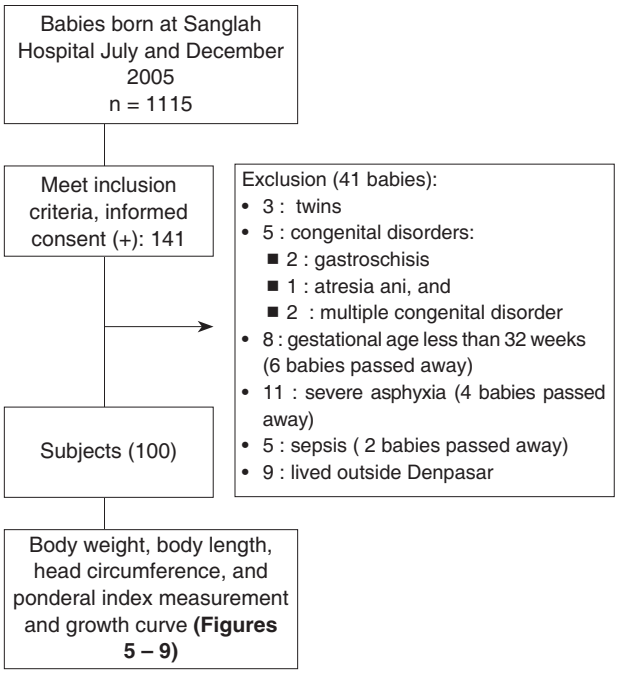

Figure 1. Study profile.

Table 1. Baseline study sample characteristics.

Characteristics	n (100)	Boy	Girl
Sex, n (%)		48 (48%)	52 (52%)
Gestational age, n (%)			
32 to < 34 weeks	27	10 (10%)	17 (17%)
34 to < 36 weeks	37	20 (20%)	17 (17%)
36 to < 37 weeks	36	18 (18%)	18 (18%)
Birth weight, grams, mean (SD)	1928 (253)	1765 (317)	1541 (246)
Birth height, cm, mean (SD)	44 (2.5)	42.5 (2.9)	40.8 (2.1)
Birth head circumference, cm, (SD)	30.1 (2.0)	29.5 (1.4)	28.1 (2.3)
Ponderal index, g/cm3, mean (SD)	2.3 (0.3)	2.3 (0.4)	2.2 (0.2)
Nutrition in the first 7 days, n (%)			
Parenteral	35 (35)		
Breast milk	8 (8)		
Formula milk	30 (30)		
Breast milk and formula milk	27 (27)		
Care method in the first 7 days, n (%)			
Incubator	47 (47)		
Kangaroo	3 (3)		
Kangaroo occasionally	21 (21)		
Without incubator or kangaroo	29 (29)		
Mother's race, n (%)			
Balinese	77 (77)		
Javanese	19 (19)		
Others	4 (4)		

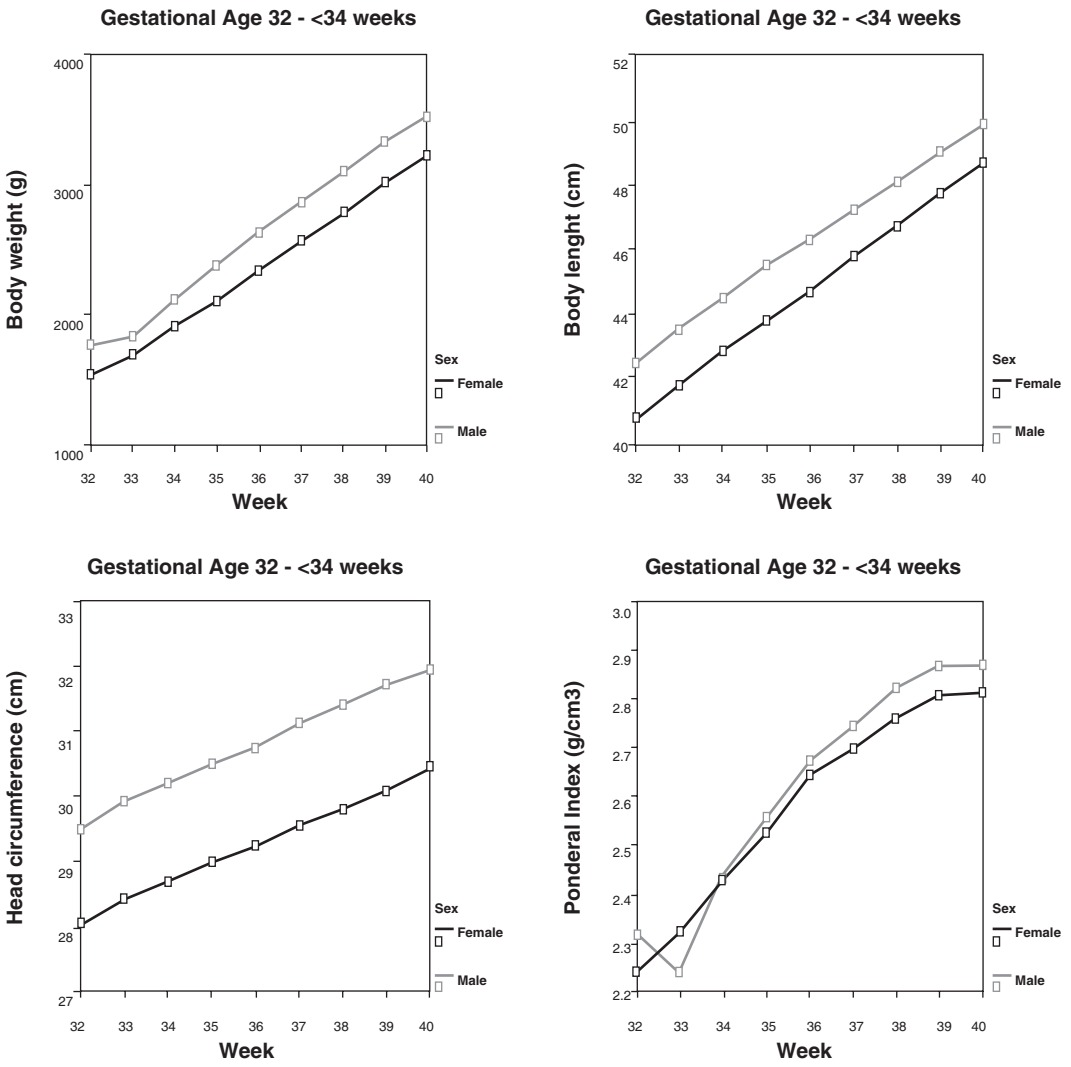

Figure 2. The somatic growth curve of the 32-34 weeks gestational age group.

Figure 3 shows the somatic growth of the 34 to 36 weeks GA group (middle preterm). A significant difference in mean value of BL and PI every week was found in this group.

A significant difference in mean value of length every week was also shown in the 36 to 37 weeks GA group (late premature), as presented in **Figure 4.** In the 36 to 37 weeks GA group (late premature), there was significant difference between sexes in the mean value of BL.

In this study, the premature babies who were breastfed had the highest mean values of BW and HC, and the difference from the other groups was statistically significant in the first seven days of life. The premature baby group given formula milk had the highest mean values of BL and PI, and the difference from the other groups was statistically significant in the first week of life (**Table 2**).

Table 3 shows the influence of different nursing methods on the somatic growth of preterm infants during the first week of life. It is evident that the mean increase in BW and BL was highest in the premature babies cared for using kangaroo method. O the other hand, the mean values of HC and PI were the highest in the group who did not receive any nursing method.

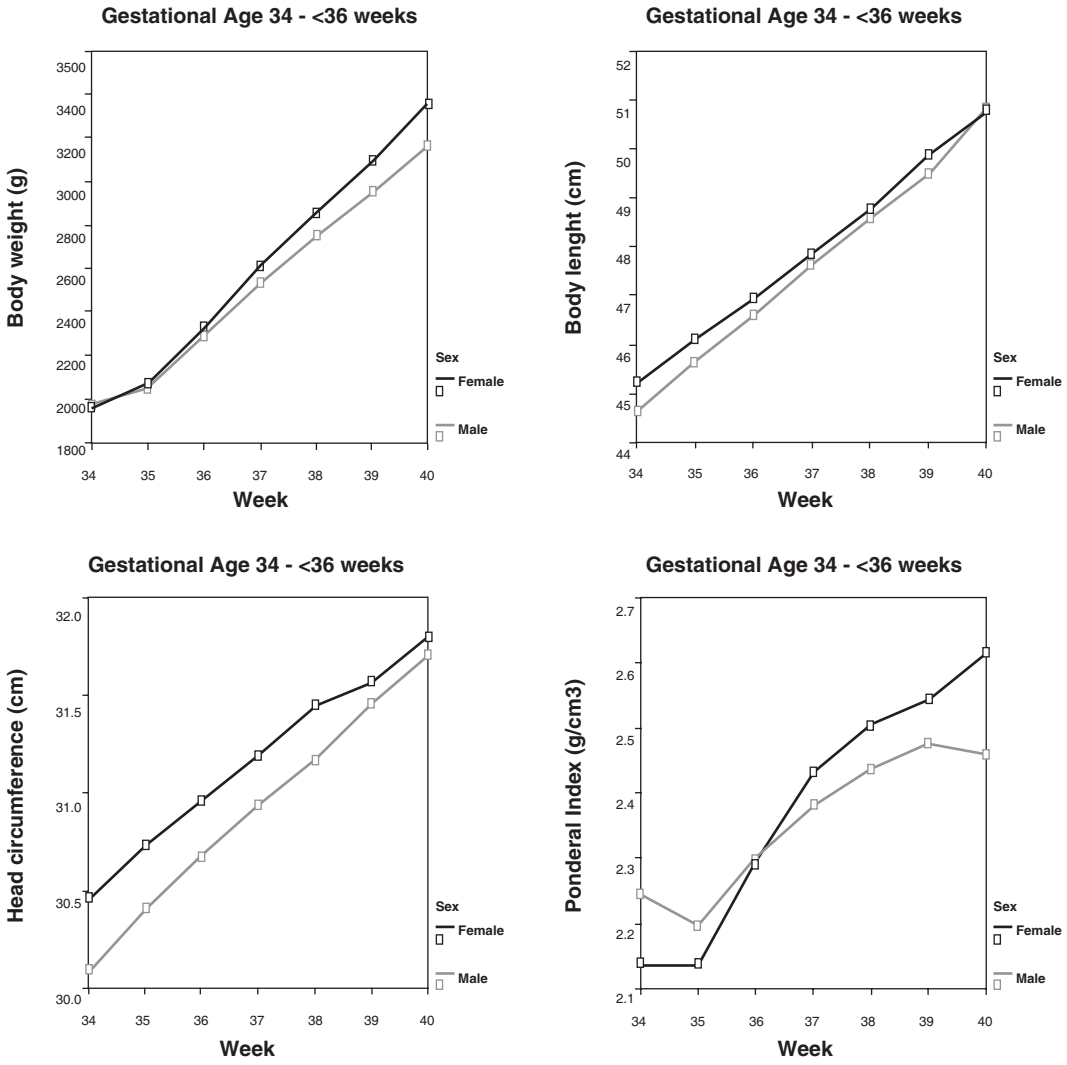

Figure 3. The somatic growth curves of the 34 to < 36 weeks gestational age group.

Table 2. The influence of nutrition on somatic growth during the first week of life

	Parenteral (n=35)	Breast milk (n=8)	Formula milk (n=30)	Breast milk + Formula milk (n=27)	F	P
BW, g mean (SD)	1746 (360)	2199 (198)	2098 (252)	2074 (300)	10.977	<0.001
BL, cm mean (SD)	43.12 (3.05)	44.73 (2.32)	45.38 (2.85)	45.33 (3.03)	4.229	<0.001
HC, cm mean (SD)	29.38 (2.23)	31.41 (1.71)	30.96 (2.35)	30.60 (2.33)	3.484	<0.001
PI, g/cm3 mean (SD)	2.16 (0.29)	2.48 (0.36)	2.27 (0.35)	2.24 (0.36)	2.041	<0.001

Table 3. The influence of nursing method on somatic growth during the first week of life

	Incubator (n=47)	Kangaroo care (n=3)	Kangaroo sometimes (n=21)	Without method (n=29)	F	P
BW, g mean (SD)	1748 (324)	2450 (135)	2165 (259)	2180 (169)	21.845	<0.001
BL, cm mean (SD)	43.1 (3.15)	48.00 (2.34)	45.56 (2.35)	45.81 (2.56)	7.493	<0.001
HC, cm mean (SD)	29.50 (2.23)	30.00 (1.85)	30.99 (1.95)	31.19 (2.45)	4.255	0.007
PI, g/cm3 mean (SD)	2.18 (0.33)	2.22 (0.23)	2.29 (0.28)	2.30 (0.39)	1.060	0.370

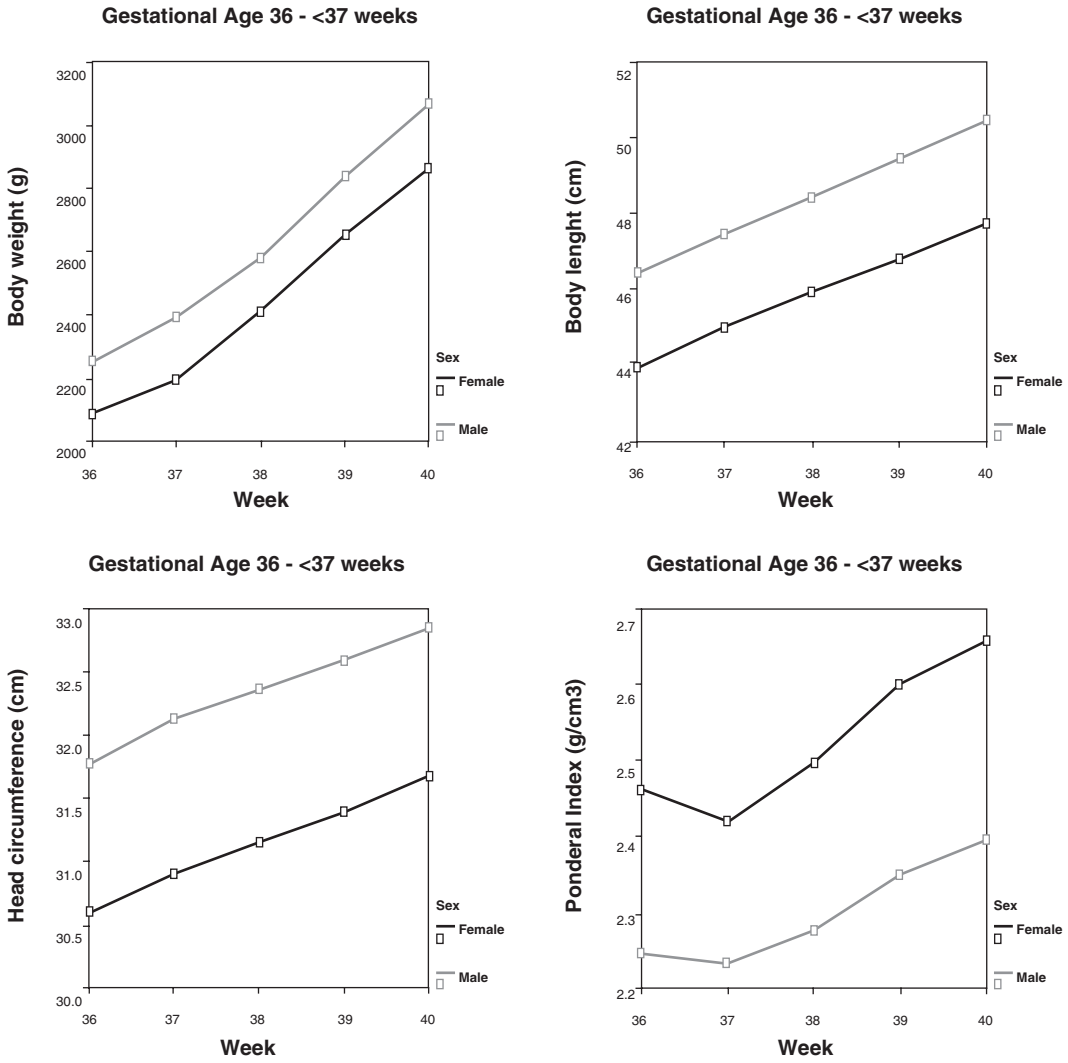

Figure 4. The somatic growth curve of the 36 to < 37 weeks gestational age group.

Discussion

All babies had a physiological decrease in BW after birth because of diseases and low calorie intake. The first week in the neonatal period is the critical period for baby and mother. Approximately 25-50% of babies less than one year of age die in the first seven days of their life. However, following this critical period, they somehow catch up in growth. Catch-up growth signs are an increase in HC, followed by BW and BL. Premature babies with no serious disease will catch up in growth at 36-40 weeks post-conception.[1,2]

Body weight is a combination of increasing bone mass, muscle, fat, body fluid, etc. Premature babies with very young GA had a slow increase in BW and HC. Medical complications or recurrent disease can have a negative effect on the increase in BW, BL, and HC of premature babies. For very small babies (<1500 grams), heat loss from evaporation is critical in the first day of the life; this is due to their very thin skin and its permeability to water. Transepithelial fluid loss depends on GA, skin and stratum corneum thickness, and skin vascularization. The percentage of insensible water loss is higher in premature babies. All of the above factors can increase water and heat loss.[6-8]

In this study, we found there was a significant difference in mean increase in BW, length, HC, and PI every week from birth until term age, especially in the 32 to 34 weeks GA group (early premature). There was also a significant difference in mean length and PI every week in the 34 to 36 weeks GA group (middle premature). We found a significant difference between genders in mean BL in the late preterm group.

Ehrenkranz observed that premature babies born between 24 and 29 weeks GA (early preterm) could not increase their BW consistent with intrauterine fetal growth at the same GA.[9] They also found that sex did not affect the increase in BW. They found that a significant difference between sexes in mean BL in the 36 to 37 weeks GA group (late premature). Several studies regarding growth hormones in premature babies (GA 32-33 weeks) found there was no significant difference between sexes in maximal frequency and amplitude growth hormone production.[10]

In this study, it was observed that during the first seven days of the life, there was a statistically significant difference in the highest mean values of increase in BW and HC between premature babies who received breast milk and the other groups. This result indicates that breast milk was better for increasing somatic growth in premature babies. There was also a statistically significant difference in the highest mean values of increase in BL and PI between premature babies who received formula milk and the other groups.

Agostoni *et al*[11] found babies who were exclusively breastfed had statistically significantly better anthropometric growth compared with a formula-fed group. Breast milk has the most complete composition, and it is appropriate to meet the needs of babies at all times. Breast milk contains immune substances that are able to protect babies from many diseases, and it promotes optimal growth of the baby.

Victoria *et al*[12] who compared the growth of babies who received exclusive breast feeding and those who received a combination of breast feeding and formula milk from birth to one month of age, showed a faster increase in BW and BL in the exclusive breast feeding group of 930 grams (SD 415), while the increase was 907 grams (SD 405) in the combination breast feeding and formula milk group. There was an accelerated height increase in the exclusive breast-feeding group of 4.33 cm (SD 1.85), while the increase in those who received combination breast-feeding was 4.22 cm (SD 1.66).

O' Connor *et al*[13] who compared anthropometric growth in premature babies who received various kinds of formula milk in the first 72 hours of life, did not find a consistent difference in the increase in BW, BL, and HC in each group. BL has special characteristics. The value always increases, although growth can accelerate in early childhood and then progress slowly until a growth spurt again in adolescence.

Cockerill *et al*[14] showed that the BW of premature babies slowly increased, but there was an increase in HC measurement that was statistically significant. It was hypothesized that the increasing head circumference was facilitated by breastfeeding. They suggested further evaluation of optimization of breastfeeding for premature babies. HC is used to predict brain growth. There is a growth spurt in the first six months, but the increase decelerates beyond one year of age. The growth spurt in HC was occurs at 30-40 weeks of GA.

In this study, the premature baby group who received the kangaroo care method had the highest mean values of BW and BL growth. The highest mean values of HC and PI growth were also found in the group who did not experience any care method. The group who were cared for by incubator had the lowest mean growth. This result indicates that the kangaroo method was clinically better than the other care methods in increasing somatic growth in premature babies.

Feldman *et al*[15] observed that growth of premature babies who experienced the kangaroo care method was statistically significantly better than that of premature babies cared for in incubator. This was thought to be due to a direct effect of the kangaroo care method on the baby's growth, such as neurophysiological system formation. The indirect effects of this care method include an increase in mood, perception, and interaction between the baby and parents.[16]

Meyer *et al*[17] compared the increases in BW of premature babies who received radiant warmer care and incubator care. The results were better in the radiant warmer group, although the difference was not statistically significant.

The Indonesian Perinatology Association/Perinasia and Health Study of Medicine Faculty-UNPAD and the Health Department studied the acceptance of the kangaroo method in rural women in Ogan Komering Ulu Propinsi Sumatera Selatan. They found that mothers of low birth weight babies reported that the kangaroo method caused their babies to become calm, sleep, and breastfeed more. The authors of the study concluded that the kangaroo method is suitable for rural women who must care for their low birth weight babies in an easy low-cost and efficient.[18]

There were also differences in the intrauterine and extrauterine growth patterns in this study. This was due to differences in nutrition quality and the better quality of the intrauterine environment.

The results of this study might be able to provide information to aid in the understanding of the postnatal development of premature babies, may help to identify disorders that may be associated with particular growth patterns, and can be used as baseline data for the next study.

In conclusion, this study suggested that there was a significant difference in the mean values of somatic growth parameters every week from birth until term age, especially in the 32 to 34 weeks GA group (early premature). In addition, in the 36 to 37 weeks GA group (late premature), there was significant difference between sexes in the mean value of BL. Breast-feeding and the kangaroo method were clinically better than other nutrition and care methods in increasing somatic growth in preterm babies during the first week of life.

Acknowledgments

We express the highest gratitude to I Gde Raka Widiana, MD for his help in constructing the methodology and statistical analysis used in this study. We thank the nursery staff of the Neonatal Unit at Sanglah Hospital for their support in this study.

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