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FULL PAPER

Differences in anthropometric status in late preterm babies fed with breastmilk, infant milk, and a combination of both

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Breast milk is recommended to provide to every baby, including late preterm babies. However, some parents or caregivers choose alternative nutrition over breast milk for various reasons. This study aimed to analyze the differences in body weight, body length, and head circumference of late preterm babies at the ages of 1, 3, and 6 months fed with breast milk, infant milk, and a combination of both. It is a retrospective study. The subjects were children aged 6-12 months born at a gestational age of 34 - <37 weeks, who came to the pediatric outpatient and inpatient clinic at Dr. Soetomo General Hospital between March and June 2023. We used a questionnaire to interview the parents or primary caregivers. One-way ANOVA test was used for normally distributed data and Kruskal-Wallis for not normally distributed data. The sample of this study consisted of 70 respondents out of 106. There was no significant difference in the gender. Most subjects were born at 36 –<37 weeks of gestation (41%). The majority of subjects were raised by mothers (94.3%). The statistical analysis showed that late preterm babies who were fed breast milk, infant milk, and a combination of both did not differ significantly in body weight, body length, and head circumference at the ages of 1, 3, and 6 months. No difference was found in the anthropometric status of late preterm babies at Dr. Soetomo General Hospital who were fed with breast milk, infant milk formula, and a combination of both.

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KEYWORDS

Late preterm; infant nutrition; anthropometric status; breast milk.

Introduction

Late preterm babies are unique because, while some physically resemble full-term babies, they face four times the risk of medical complications [1,2]. Some morbidity that can be found in late preterm babies include asphyxia, respiratory distress, hypothermia, hypoglycemia, hyperbilirubinemia, and sepsis [3]. This can be caused by the immaturity of certain body organs or body functions. It can also be related to immaturity of oromotor

development [4-7]. Early in life, they often require medical care and may receive parenteral nutrition or infant formula milk. However, these babies need breast milk to support their immunity [8-10]. In Indonesia, breastfeeding rate was increased from 30.2% in 2013 to 74.5% [11]. After being discharged from the hospital, some babies still do not receive breast milk for any reason based on maternal, baby, and environmental factors (e.g., accessibility, nipple confusion, low milk production, etc) [12-14]. Infant formula milk can be given as the main nutrition for babies if breast milk is inadequate. It has a standardized composition that approaches the nutrition of breast milk as stated in The Codex Alimentarius, which was originally published in 1981 under the name The Codex Standard, and updated in 2008 under the name The Codex Alimentarius. Each of the nutrients from breast milk and infant formula milk has advantages and disadvantages. The macronutrients and micronutrients contained in the nutrition provide support growth and development [15-17]. Late preterm babies take longer to reach the same size as full-term babies [18-20]. According to the research by Kakaroukas *et al.* (2022), feeding methid was associated with fat mass, yhat can affect body weight and body length. Breastfed infant demonstrated greater increasing body weight than formula milk in late and moderate preterm infant [21]. In this study, we intended to look for differences in anthropometric status (body weight, body length, and head circumference) in late preterm babies. This work was performed in Dr. Soetomo General Hospital, Surabaya. It is the largest tertiary hospital in Eastern Indonesia. Sampling was carried out in March-June 2023.

Experimental

Material

Subjects were babies aged 6-12 months born at 34-<37 weeks of gestation who came to the pediatric inpatient and outpatient clinic at our hospital and had signed informed consent for research by the parents or caregivers. From a population of 106 babies, 70 samples were obtained. We excluded infants with birth weights ≤1500 and >3000 grams, any congenital abnormalities that affected measurements, large body masses, seriously ill infants, or infants with medical emergencies.

Methods

This retrospective cohort study was conducted through interviews with parents or primary caregivers regarding age, gender, primary caregiver, and the main nutritional choices provided at the ages of 1, 3, and 6 months using a questionnaire created by the researcher. After that, we checked the anthropometric data obtained from each child's book. This work was approved by Komite Etik Penelitian Kesehatan, Dr. Soetomo General Hospital, Surabaya, Indonesia with the registered number 2050/105/3/III/2023.

We used IBM SPSS 24.0 statistics software. The normality test was carried out using Kolmogorov-Smirnov while the homogeneity test on normally distributed data used Levene. Statistical analysis was carried out using Kruskal -Wallis's test for the not normally-distributed data and the one-way Anova for normally and homogeneously distributed data.

Results and discussion

Demographic characteristics

This work is a retrospective cohort study that analyzes the difference in body weight, body length, and head circumference of late preterm babies fed with breast milk, infant formula milk, and a combination of breast milk and instant formula milk at Dr. Soetomo General Hospital Surabaya.

Late preterm babies are preterm babies born at 34-37 weeks of gestation [20]. The determination of gestational age is based on PMA (Post Menstrual Age) and ultrasound performed by professional health workers. The gold standard is first trimester ultrasound [22] In this study, 70 samples were obtained from a population of 106 late preterm babies who came to the pediatric outpatient and inpatient installation at dr. Soetomo General Hospital from March to June 2023. Babies born at 36-<37 weeks of gestation had the highest percentage (41.4%). Delnord *et al.* in 2019 who researched the epidemiology of late preterm births in several countries on the European, Asian, and American continents, stating that the prevalence of late preterm births aged 36-37 weeks in all countries studied most frequently among births at 34-35 and 35-36 weeks of gestation. In this study, the exact cause of the majority of late preterm births at 36-37 weeks was not definitively explained. [23] Saphiro-Mendoza in 2012, noted that multiple gestation, age of the mother (<20 and > 30 years), congenital malformation, and non-Hispanic black mother had experienced the most of late preterm birth in United States, it possibly caused by socio-economic issues. [22] However, the research indicated that a notable percentage of twin births occurred during this period (37.5%). A gestational age of 36-37 weeks is close to full-term gestational age. This can cause differences in the grouping of babies so that babies who should be in the term category become preterm. Several other studies include gender demographic data, but there is no discussion of gender influence on late preterm births. [Table 1]

Most of the subjects were raised by mothers (93.6%). Four subjects were raised by grandmothers and aunts, two subjects because the mother died, one subject because the mother was seriously ill, and one subject because the mother had a mental disorder. Parenting by mothers and other than parents is related to the maturity of psychosocial development. Nurturing by mothers or biological parents influence children's maturity of psychosocial development. Maternal mood and psychological health can affect infant behavior and successful exclusive breastfeeding [24-27]. Handayani *et al.* in 2018, found that maternal factors were more important than infant factors to establish successful breastfeeding [28]. However, according to research conducted by Breheny et al in 2013, children who are cared for by other than their parents will still have good psychosocial development if the caretaker implements good parenting [29].

The majority of mothers give breast milk to their newborn babies until one month of age (37 babies). The best nutrition for babies less than 6 months is exclusive breast milk [12,30,31]. Breast milk is considered the best nutrition for babies, especially late preterm babies because these babies are considered to have low levels of antioxidants in their bodies. Breast milk contains many immune components. In fact, according to ABM (Academy of Breastfeeding Medicine) recommendations, late preterm babies treated in the NICU should ideally be given breast milk from the mother or donor to optimize their growth and development. Breast milk is a source of bioactive protein, including enzyme activation, increased nutrient absorption, growth stimulation, immune system modulation, and defense against pathogens which is also known as antimicrobial activity [8,9,32-33]. In Indonesia, according to national economic survey in 2017, 55.96% babies fed with exclusive breast milk [34]. To improve exclusive breastfeeding and infant outcomes, mothers may need emotional support to understand how to breastfeed correctly, including techniques and how to obtain breast milk [24,35].

At birth, the most of babies were born with normal birth weight. The baby's weight normally decreases by as much as 10% of birth weight, then increases to normal weight.

Normal weight gain in preterm babies is 15 g/kgBW/day. Babies with normal birth weight, but at a lower limit, can become underweight babies. the early postnatal growth of late preterm infants is characterized by a major deposition of fat mass [12,18,37]. Martin *et al.* (2021), found that severe underweight babies are more common in premature babies than full term babies [37]. Differences in measurements and readings can also be the cause of changes in results. Gianni *et al.* (2012), late preterm babies can reach a weight at the corrected age of 3 months. However, according to Santos et al (2009), late preterm babies tend to experience failure to thrive in the first 2 years of life [18,38].

The analysis of body weight from 1 month to 3 months of age could not be conducted due to the utilization of different growth charts. The Fenton chart was employed at 0 and 1 months of age, whereas at 3 and 6 months of age, we referred to the 2006 World Health Organization (WHO) growth chart (Table 2).

There were 19 babies born with short stature (24.4%), while more babies were born with normal stature, 59 babies (75.6%). According to Brown *et al.* (2016) who studied 1071 premature babies, the average growth in length of babies was 0.12 cm/kgBW/day. At 3 months of age, the data was plotted using the 2006 WHO chart, resulting in 19 babies with severely stunted. There were 12 babies born with small head circumferences (15.4%). The normal growth of a baby's head circumference according to Brown *et al.* (2016) is 0.08 cm/week. According to Hallowell *et al.* (2012), an increase in head circumference is associated with the development of brain nerves/synapses [5,39].

TABLE 1 Demographic characteristics of subjects

Variable	N (subjects) = 70	Percentage (%)
Weeks of gestation		
34-35	23	32.9
35-36	18	25.7
36-37	29	41.4
Sex		
Male	36	51.4
Female	34	48.6
Caregiver		
Mothers	66	94.3
Grand mother	4	5.7
Nutrition at 1 month of age		
Breastmilk	37	52.9
Infant Formula Milk	12	17.1
Combination of Both	21	30
Nutrition at 3 month of age		
Breastmilk	23	32.9
Infant Formula Milk	20	28.6
Combination of Both	27	38.6
Nutrition at 6 month of age		
Breastmilk	18	25.7
Infant Formula Milk	27	38.6
Combination of Both	25	35.7
Birth Weight (BW)		
Underweight	14	20
Normal	56	80
Overweight	0	0
Birth Length		
Severely Stunted	15	21.4
Normal	55	78.6
Tall	0	0

Variable	N (subjects) = 70	Percentage (%)
Birth Head Circumference		.
Microcephaly	8	11.4
Normocephaly	62	88.6
Macrocephaly	0	0

TABLE 2 Anthropometric Status late preterm baby in 0 and 1 month of age using Fenton growth chart

Variable	0 Month (Birth)		1 Month	
	n	%	n	%
Body Weight				
Underweight	14	20	49	70
Normal	56	80	21	30
Overweight	0	0	0	0
Body Length				
Short Stature	15	21.4	23	32.9
Normal Stature	55	78.6	47	67.1
Tall stature	0	0	0	0
Head Circumference				
Small	8	11.4	6	8.5
Normal	62	88.6	64	91.5
Big	0	0	0	0

The World Health Organization (WHO) 2006 growth chart is used for babies at 3 months and 6 months of age. At 3 months of age, 60% of subjects (42 babies) with normal weight, at 6 months of age the subjects with normal weight were increased to 60.3% of subjects (47 babies). At least 58.6% of subjects (41 babies) at 3 months of age were normal stature, but at the 6 months of age, the subjects with normal stature decreased to only 37.2% (26 babies). Based on HCAZ, 87.2% of subjects (61 babies) at 3 months of age were normal head circumference, but at 6 months of age, increased to 91.4% (64 babies) (Table 3).

Differences in body weight of late preterm babies fed with breast milk, infant formula milk, and a combination of both

One-way ANOVA statistical analysis showed that the body weight of late preterm babies aged 1,3, and 6 months at Dr. Soetomo General Hospital was not significantly different. These results mean that babies who were fed with breast milk, infant formula milk, and a combination of both had the same body weight at 1, 3, and 6 months of age. At 3 months of age, it showed that babies who were given breast milk had the highest body weight compared to others, while babies who were given infant formula milk had the lowest body weight (Table 4).

At 6 months of age, babies who were fed with breast milk have the highest body weight compared to others, while babies who were fed with a combination of breast milk and instant formula milk had the lowest body weight. The subjects who were fed with breast milk, infant formula milk, or a combination of both had the same body weight at 6 months of age.

In this study, providing breast milk, infant formula milk, and a combination of both did not affect the weight of late preterm babies. Late preterm babies often appear to be full-term babies, but some babies can experience health problems. Stable or even decreasing body weight is one of the acute signs of nutritional problems in children. Preterm babies have accumulated problems with a lack of energy, proteins, minerals, and other nutrients when they first enter the NICU room. According to Gianni *et al.* (2016), late

preterm babies can lead to normal body weight in the first month of life because there is an accelerated increase in fat-free body mass composition. According to the Indonesian Pediatrician Association, preterm babies can experience weight gain in the normal body 15 g/kg/day. Meanwhile, according to ABM, the weight gain of late preterm babies can reach 20 g/day. According to research by Santos *et al.* in 2009, late preterm is one of the risk factors for growth failure and nutritional problems when the child is more than one year old [9,38,40-42]. This study is located in a tertiary hospital which is a referral hospital for babies experiencing health problems.

Differences in body length of late preterm babies fed with breast milk, infant formula milk, and a combination of both

At 1 month of age, the subjects who were fed breast milk had a higher average body length than babies who were fed with a combination of breast milk and instant formula milk, while babies who were fed with infant formula milk had the shortest body length. The results of the Kruskal-Wallis statistical analysis test showed that the body length at 1 month of age in our hospital was not significantly different. These results mean that babies who are fed with breast milk, infant formula milk, or a combination of breast milk and instant formula milk had the same body length at 1 month of age (Table 5).

At 3 months of age, statistical analysis test showed that the body length of the subjects 3 months of age in our hospital was not significantly different. These results mean that the subjects who were fed with breast milk, infant formula milk, or a combination of breast milk and instant formula milk had the same body length at 3 months of age

At 6 months of age, the subjects who were fed with breast milk had the highest average body length than the subjects who were fed with others, while babies who were fed with a combination of breast milk and instant formula milk had the shortest body length. This shows that giving breast milk can increase the height of late preterm babies at 6 months of age. However, the results of the statistical analysis test showed that providing breast milk, infant formula milk, or a combination of breast milk and instant formula milk did not affect the body length of late preterm babies at 6 months of age.

Giving a combination of breast milk and instant formula milk to babies provides the shortest body length at 1 month, 3 months, and 6 months. Babies who were fed with breast milk had a higher body length than babies who were fed with a combination of breast milk and instant formula milk at the ages of 3 months and 6 months. When they reached 6 months of age, the subjects who were fed with infant formula milk had the highest body length, reaching 64.02 cm compared to babies who were fed with breast milk or a combination of breast milk and instant formula milk.

It was found that providing breast milk, infant formula milk, and a combination of both did not affect the body length of late preterm babies. However, according to Hallowell *et al.* (2016), preterm babies who experience mineral deficiency for a long time can cause metabolic bone disease and slow bone growth, so the baby becomes short [5]. Body length is an indicator of nutritional status better than body weight because it is not affected by the amount of fluid and reflects true lean body mass if done correctly. Preterm babies can experience an increase in body length of 0.8-1.0 cm/week. According to research conducted by Brown *et al.* (2016), late preterm babies who are fed breast milk with Human Milk Fortifier, can experience an increase in body length of 0.12 cm/week [39]. According to research by Santos *et al.* (2009), one of the risk factor for failure to thrive and nutritional problems when a child in more than one year old is late preterm birth [38]. Whereas, the first month after birth of late

preterm infants are characterized by rapid postnatal catch-up growth, therefore, at term-corrected age, they reach a weight that is either similar to or greater than that of term infant [40].

Differences in the head circumference of late preterm babies fed with breast milk, infant formula milk, and a combination of both

At 1 month of age, the babies who were fed with a combination of breast milk and instant formula milk had the largest head circumference compared to other nutrients, while babies who were fed with infant formula milk had the smallest head circumference. Kruskal-Wallis statistical analysis test showed that babies who were fed with breast milk, infant formula milk, or a combination of breast milk and instant formula milk had the same head circumference at 1 month of age (Table 6).

At 3 months of age, the subjects who were fed with a combination of breast milk and instant formula milk had the largest head circumference than others, while the subjects who were fed with infant formula milk had the smallest head circumference. The results of the statistical analysis test showed the babies who were fed with breast milk, infant formula milk, or a combination of breast milk and instant formula milk had the same head circumference at 3 months of age.

At 6 months of age, the subjects who were fed with infant formula milk had the largest head circumference than others, while the subjects who were fed with breast milk had the smallest head circumference. Based on the results of Kruskal-Wallis statistical analysis test, the babies who were fed breast milk, infant formula milk, or a combination of breast milk and instant formula milk had the same head circumference at 6 months of age (Table 5).

It is showed that providing breast milk, infant formula milk, and a combination of both did not affect the head circumference of late preterm babies. An increase in head circumference indicates brain development. According to the Indonesian Pediatrician Association, the normal growth of head circumference in preterm babies is 0.5-0.8 cm/week. According to research by Browm *et al.* (2016), late preterm babies who are fed with exclusive breast milk with HMF can experience an increase in head circumference of 0.08cm/week compared to babies who are given exclusive breast milk without HMF [39]. According to research by Santos *et al.* in 2009, late preterm is one of the risk factors for failure to thrive and nutritional problems when the child is more than one year old [38]. Sammallahti in 2017, found that there is a correlation between growth spurt during the critical early period after birth (5-20 months) and better adult neurocognitive functioning. However, the same correlation is not consistently seen with mental health outcomes. This suggests that there may be different factors at play when it comes to the development of cognitive functioning versus mental health [43,44].

TABLE 3 Anthropometric Status late preterm baby in 3 and 6 months of age using 2006 World Health Organization (WHO) growth chart

Variable	3 Months		6 Months	
	n	%	N	%
WAZ				
Severely Underweight	17	24.2	13	18.6
Underweight	11	15.7	14	20
Normal	42	60	43	61.4
LAZ				
Severely Stunted	15	21.4	30	42.8

Variable	3 Months		6 Months	
	n	%	N	%
Stunted	14	20	14	20
Normal	41	58.6	26	37.2
HCAZ				
Macrocephaly	1	1.4	0	0
Normal	61	87.2	64	91.4
Microcephaly	8	11.4	6	8.6

TABLE 4 Body weight difference of late preterm baby in 1, 3, and 6 months of age

Birth Weight	n	Min-Max	Median	Mean	*Std. Deviation*	*P*-value
1 Month[(a)]						
Breastmilk	37	1500-3900	2450	2578.81	580.98	0.795
Infant formula milk	12	1600-3900	2300	2538.46	698.26	
Combination of Both	21	1500-3800	2400	2508.70	617.85	
3 Months[(a)]						
Breastmilk	27	2900-5700	4000	4024.07	821.28	0.365
Infant formula milk	22	2500-5700	3350	3581.82	947.99	
Combination of Both	29	2700-5000	3900	3748.28	651.71	
6 Months[(a)]						
Breastmilk	20	4700-7800	6000	5935	787.58	0.868
Infant formula milk	30	3400-7800	5900	5756.67	1067.29	
Combination of Both	28	4300-7500	5350	5500	875.17	

(a) One-way ANOVA

TABLE 5 Body length difference of late preterm baby in 1, 3, and 6 months of age

Variable	3 Months		6 Months	
	n	%	N	%
WAZ				
Severely Underweight	17	24.2	13	18.6
Underweight	11	15.7	14	20
Normal	42	60	43	61.4
LAZ				
Severely Stunted	15	21.4	30	42.8
Stunted	14	20	14	20
Normal	41	58.6	26	37.2
HCAZ				
Macrocephaly	1	1.4	0	0
Normal	61	87.2	64	91.4
Microcephaly	8	11.4	6	8.6

(k)Kruskal-Wallis

TABLE 6 Head circumference difference of late preterm baby in 1, 3, and 6 months of age

Head Circumference	n	Min-Max	Median	Mean	*Std. Deviation*	*P*
1 Month[(k)]						
Breastmilk	37	29-37	34	34.10	1.92	0.656
Infant formula milk	12	27-36	34	33.85	2.41	
Combination of both	21	32-38	34	34.61	1.62	
3 Months[(k)]						
Breastmilk	23	32-41	37	37.19	2.10	0.656
Infant formula milk	20	28-40	37,5	37.16	2.45	

Head Circumference	n	Min-Max	Median	Mean	*Std. Deviation*	*P*
Combination of both	27	34-41	37	37.31	1.97	
6 Months[k]						
Breastmilk	18	38-44	41	40.85	1.70	0.374
Infant formula milk	27	32-44	42	41.27	2.26	
Combination of both	25	35-46	41,5	40.89	2.42	

Conclusion

This study aimed to analyze the difference in body weight and length. However, the results of this study were mostly not significant. Some of the weaknesses of this work following that the study was conducted in a tertiary hospital, that had a higher proportion of patients with medical problems both before and after birth. Moreover, this study used a retrospective cohort research method using secondary data source. The lack of standardized measuring instruments was observed. Measurements carried out by each health facility or Primary Health Care could be highly subjective during the execution and interpretation of results. In conclusion, there were no significant differences in weight, body length, and head circumference of late preterm babies fed with breast milk, infant formula milk, and combination of both aged 1,3, and 6 months. Other research about this study is needed, with standardized tools and method. Multicenter study may be preferred. It is hoped that the results of this research can be used as a consideration for providing nutrition to late preterm babies.

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Authors' contributions

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Conflict of interest

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