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Original Article

Infant feeding practice on growth velocity in 4 to 6-month-olds

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Abstract

Background In developing countries, 5-10% of infants suffer from failure to thrive. Adequate feeding is the most crucial factor for optimal growth in early life.

Objective To assess the differences in growth velocity at 4 to 6 months of age, based on the infant feeding practices.

Methods This cross-sectional study involving 4 to 6 month-old babies from 6 public health centres in Yogyakarta was performed from August to November 2016. Data on body weight, and growth velocity as they related to weight at birth were collected. Subjects were divided into groups according to their feeding practices.

Results Of 173 subjects, 130 (75%) infants were exclusively breastfed, 19 infants (11%) were given breast milk and formula, 14 (8%) infants were given breast milk and complementary food (8%), and 10 (6%) infants were given formula and complementary food. The mean growth velocity z-scores by group were as follows: exclusively breastfed 0.04 (SD 1.15) (95%CI -0.16 to 0.24), breast milk and formula -0.61 (SD 0.84) (95%CI -1.01 to -0.21), breast milk and complementary food -0.69 (SD 1.14) (95%CI -1.35 to -0.04), formula and complementary food 0.23 (SD 1.50) (95%CI: -0.84 to 1.31). The mean difference in growth velocity between the exclusively breastfed vs. breast milk and formula groups was 0.65 (SD 0.28) (95%CI: 0.10 to 1.20; P=0.02); vs. breast milk and complementary food was 0.73 (SD 0.32) (95%CI: 0.10 to 1.37; P=0.02); and vs. formula and complementary food was -0.19 (SD 0.37) (95%CI: -0.93 to 0.55; P=0.61).

Conclusion Exclusively breastfed have the most optimal growth velocity compared to infants who experience other feeding practices. **[Paediatr Indones. 2018;58:36-41 ; doi: http://dx.doi.org/10.14238/pi58.1.2018.36-41]**.

Keywords: *growth velocity; feeding practice; infants*

Failure to thrive in infants is found in approximately 5-10 % children in the developing countries.[1] Early detection of failure to thrive in the first year of life is important to prevent negative impacts on children's development. One of the most important factors in growth is sufficient nutrient intake to optimize the growth process.[2] In children aged 0-1 years, especially in the first 6 months, breast milk plays an important role in infant feeding. Kramer *et al.* concluded that exclusive breastfeeding could prevent the incidence of failure to thrive in the first year of life.[3] However, another study showed a slower growth velocity in breastfed babies.[4]

In Indonesia, exclusive breastfeeding is recommended for infants aged 0-6 months. Several

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previous studies on breastfeeding and growth had varying results.[3-5] The aim of this study was to assess infant growth velocity associated with pattern of feeding, i.e. either exclusive breastfeeding, a combination of breastfeeding and formula feeding, a combination of breastfeeding and complementary food, or formula feeding only.

Methods

A cross sectional study was performed from August to November 2016 in six public health centers (Pusat kesehatan masyarakat, Puskesmas). The six health centers were randomly selected from 18 health centers in Yogyakarta: Puskesmas Jetis, Gedongtengen, Danurejan I, Gondokusuman I, Mergangsan, and Umbulharjo I. The study was approved by the Medical and Health Research Ethics Committee, Universitas Gadjah Mada Medical School. Written informed consent was obtained from subjects' parents or legal guardians. There was no commercial support for the trial.

A total of 173 infants were consecutively selected to participate. Every Puskesmas contributed in proportion to the number of infants aged 0-6 months from that Puskesmas in 2014: 27 infants from Jetis, 20 from Gedongtengen, 11 from Danurejan I, 21 from Gondokusuman I, 46 from Mergangsan, and 48 from Umbulharjo I. The inclusion criteria were infants aged 4-6 months who were born in Yogyakarta, born full term with normal weight, had no history of serious illness or chronic disease (based on previous hospital care history), and lived in Yogyakarta. Patients were excluded if they had signs of major congenital anomalies.

Data on birth weights and feeding practices were obtained using questionnaires. Birth weight data were confirmed by the child's growth chart (*Kartu Menuju Sehat, KMS*). Data on food consumption were recalled by parents in the last 24 hours prior to visiting the Puskesmas. Body weight measurements were performed by trained health workers. The children were weighed on calibrated scale (with accuracy of 0.01 kg) in a supine position without clothes. Growth velocity was defined as the difference between the current body weight and the birth weight. The results were converted to *z*-scores using the *World Health Organization* (WHO) growth rate for age table.[1,6] Children whose rate of growth was between -2 and +2 standard deviation (SD) has normal weight gain. Failure to thrive was diagnosed in children whose rate of growth was less than -2 SD or the changes were less than 5th percentile. Growth was considered rapid when the growth rate was more than +2 SD. The growth velocities *z*-scores between feeding practice groups were compared using ANOVA, Fischer's least significant difference (LSD), and post hoc ANOVA tests.

Results

Of 173 infants from 6 Puskesmas who fulfilled the inclusion criteria, 101 (58.4%) were boys and 72 (41.6%) were girls. Most of the babies were delivered vaginally [133 (76.9%) vs. 40 (23.1%) caesarean section deliveries]. There were 99 (57.2%) infants aged 4 months, 54 (31.2%) infants aged 5 months, and 20 (11.6%) infants aged 6 months. Characteristics of the study subjects, stratified by age, are presented in **Table 1**.

Mean *z*-scores of body weight increment by feeding practice group are presented in **Table 2**. **Table 3** shows the weight increment in each type of feeding practice. Most babies had normal weight gain. One-way ANOVA revealed significant differences among the four groups (P=0.02). Post hoc test showed that the mean growth velocity *z*-score of the exclusively breastfed group [0.65 (SD 0.28)] was significantly higher than that of the breast milk and formula group (P=0.02), as well as that of the breast milk and complementary food (P=0.02). However, weight increment *z*-scores were not significantly different between the exclusively breastfed and the formula and complementary food groups (P=0.61) (**Table 4**).

Table 1. Characteristics of the study subjects stratified by age

Infants age stratification	Feeding practice			
	Exclusively breastfed (n=130)	Breast milk and formula (n=19)	Breast milk and complementary food (n=14)	Formula and complementary food (n=10)
Mode of delivery, n(%)				
Vaginal				
4 months	56 (82.4)	9 (13.2)	3 (4.4)	0
5 months	41 (89.1)	2 (4.3)	2 (4.3)	1 (2.2)
6 months	9 (47.4)	2 (10.5)	7 (36.8)	1 (5.3)
Total	106 (79.7)	13 (9.8)	12 (9.0)	2 (1.5)
Caesarean section				
4 months	20 (64.5)	3 (9.7)	1 (3.2)	7 (22.6)
5 months	4 (50.0)	3 (37.5)	0	1 (12.5)
6 months	0	0	1 (100.0)	0
Total	24 (60.0)	6 (15.0)	2 (5.0)	8 (20.0)
Level of maternal education, n(%)				
Senior high school or lower				
4 months	56 (77.8)	8 (11.1)	4 (5.6)	4 (5.6)
5 months	34 (82.9)	4 (9.8)	2 (4.9)	1 (2.4)
6 months	3 (27.3)	1 (9.1)	7 (63.6)	0
Total	93 (75.0)	13 (10.5)	13 (10.5)	5 (4.0)
College, graduate, or higher				
4 months	20 (74.1)	4 (14.8)	0	3 (11.1)
5 months	11 (84.6)	1 (7.7)	0	1 (7.7)
6 months	6 (66.7)	1 (11.1)	1 (11.1)	1 (11.1)
Total	37 (75.5)	6 (12.2)	1 (2.0)	5 (10.2)
Maternal occupation, n(%)				
Senior high school or lower				
4 months	51 (81.0)	7 (11.1)	2 (3.2)	3 (4.8)
5 months	33 (86.8)	3 (7.9)	1 (2.6)	1 (2.6)
6 months	4 (50.0)	0	4 (50.0)	0
Total	88 (80.7)	10 (9.2)	7 (6.4)	4 (3.7)
College, graduate, or higher				
4 months	25 (69.4)	5 (13.9)	2 (5.6)	4 (11.1)
5 months	12 (75.0)	2 (12.5)	1 (6.3)	1 (6.3)
6 months	5 (41.7)	2 (16.7)	4 (33.3)	1 (8.3)
Total	42 (65.6)	9 (14.1)	7 (10.9)	6 (9.4)

Table 2. Comparison of weight increments z-scores based on feeding practices

Group	Weight increment Z-scores		P value
	Mean (SD)	95%CI	
Exclusively breastfed	0.04 (1.15)	-0.16 to 0.24	0.02
Breast milk and formula	-0.61 (0.84)	-1.01 to -0.21	
Breast milk and complementary food (MPASI)	-0.69 (1.14)	-1.35 to -0.04	
Formula and complementary food	0.23 (1.50)	-0.84 to 1.31	

MPASI= makanan pendamping ASI = complementary food

Table 3. Weight gain comparison based on feeding practies

Feeding practices	Weight gain		
	Rapid, n(%)	Normal, n(%)	Failure to thrive, n(%)
Exclusively breastfed (n=130)	5 (3.8)	124 (95.4)	1 (0.8)
Breast milk and formula (n=19)	0	18 (94.7)	1 (5.3)
Breast milk and complementary food (MPASI) (n=14)	0	13 (92.9)	1 (7.1)
Formula and complementary food (n=10)	0	9 (90)	1 (10)

MPASI= makanan pendamping ASI = complementary food

Table 4. Post hoc comparison of weight increment z-score between feeding practice groups

Comparison between feeding practices		Mean of differences (SD)	95%CI	P value
Exclusive breastfed	Breast milk and formula	0.65 (0.28)	0.10 to 1.20	0.02
	Breast milk and complementary food (*MPASI*)	0.73 (0.32)	0.10 to 1.37	0.02
	Formula and complementary food	-0.19 (0.37)	-0.93 to 0.55	0.61
Breast milk and formula	Breast milk and complementary food (*MPASI*)	0.09 (0.40)	-0.71 to 0.88	0.83
	Formula and complementary food	-0.84 (0.45)	-1.72 to 0.04	0.06
Breast milk and complementary food (*MPASI*)	Formula and complementary food	-0.93 (0.47)	-1.86 to 0.01	0.05

MPASI= makanan pendamping ASI = complementary food

Discussion

This study showed that exclusive breastfeeding provided the most optimal growth velocity for infants aged 4-6 months compared to other feeding practices. This result was also supported by the post hoc analysis of the mean (SD) difference of the growth velocity Z-scores, despite the fact that all feeding groups had infants who failed to thrive. We suggest that optimal growth velocity is related to breast milk composition, as it contains the ideal nutrient for infants, especially in the first 4 months of life compared to other foods.

Not only important for growth, breast milk also increases infant immunity and intelligence, and may improve the emotional connection between mother and baby.[7,8] Breast milk contains several protective factors that increase infant immunity in the first 6 months. Lactoferin in breast milk binds iron which may inhibit bacterial growth, as bacteria require iron. Lysozyme is another protective factor that destroys bacterial cell walls. Breast milk also has lipoprotein lipase involved in the lypolysis of triglycerides in breast milk to produce monoglycerides and free fatty acids, linoleic acid as a precursor of prostaglandin and leucotrien.[7] Immunoglobulin in breast milk provide local protection of the gastrointestinal mucosa from pathogens.

The incidence of failure to thrive was found in every feeding practice group, including the exclusively breastfed group (**Table 3**). The number and frequency of feedings were not calculated in this study, so we could not assess infants' caloric intake.[9,10] Similar with the result of this study, previous studies found that breast milk can prevent the incidence of failure to thrive compared to other foods.[3, 11] The incidence of failure to thrive in children is influenced by many factors, such as: parental opinions regarding feeding practices,[12] prematurity,[13] the amount of energy and protein intake from breast milk and other foods,[5] feeding of variety of foods after 6 months of age,[14] maternal factor in food introduction in children under 1 year of age,[15] and socioeconomic status of the family.[16]

Growth velocity is the change in body weight by time (month) or gram/month compared to population according to age. The growth velocity can be measured from body weight, head circumference, and body length. Body weight is the main indicator, as it is useful in the short term. Head circumference has been used as the second indicator, while the body length is

useful for detection of stunting, because its usefulness over a longer period of time.[17] Changes of less than 5th percentile or less than -2 SD are interpreted as a failure to thrive. Changes in body weight can be seen in growth velocity or growth increment tables with intervals of 1-6 months.[11]

We noted that the highest growth velocity was not found in exclusively breastfed group, but in the formula fed group. This finding was consistent with previous studies which reported that formula feeding increased the risk of obesity in children.[17,18] Another study also noted that growth velocity in the exclusively breastfed group was slower than in other feeding practice groups.[4] An optimal growth velocity is expected to support the optimal growth and development in children.[2,19]

In conclusion, there is a significant difference in the mean growth velocity Z-scores of infants aged 4-6 months according to feeding practices. Exclusive breastfeeding provides the most optimal growth velocity (mean Z-score tend to 0) compared to other feeding practice groups.

The limitation of this study was that causal relationships between the variables could not be explained. Exclusive breastfeeding for 6 months remains the main recommendation according to the existing results.

Conflict of interest

None declared.

References

1. Bauchner H. Failure to thrive. In: Kliegman MR, Stanton BF, Schor NF, III JWSG, Behrman RE, editors. Nelson Textbook of Pediatrics. 18th edition. Philadelphia: Elsevier Saunders; 2007. p. 184-187.
2. Tanuwidjaya S. Kebutuhan dasar tumbuh kembang anak. In: Narendra MB, Sularyo TS, Soetjiningsih, Suyitno H, IG NGR, Wiradisuria S, editors. Buku ajar tumbuh kembang anak dan remaja. 1st edition. Jakarta: Sagung Seto; 2002. p. 13-21.
3. Kramer MS, Guo T, Platt RW, Shapiro S, Collet J-P, Chalmers B, *et al.* Breastfeeding and infant growth: Biology or bias? Pediatrics. 2002;110.
4. Johnson L, Jaarsveld V, Llewellyn C, Cole T, Wardle J. Associations between infant feeding and the size, tempo and velocity of infant weight gain: SITAR analysis of Gemini twin birth cohort. Int J Obes. 2014;38:980-987.
5. Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B, Dewey KG. Energy and protein intakes of breast-fed and formula-fed infants during the first year of life and their association with growth velocity: The DARLING study. Am J Clin Nutr. 1993;58:152-161.
6. Syarif DR, Nasar SS. Failure to thrive. Pedoman pelayanan medis. Jakarta: Ikatan Dokter Anak Indonesia; 2010.
7. Sjarif DR, Yuliarti K, Lestari ED, Sidiartha IGL, Nasar SS, Mexitalia M. Rekomendasi praktik pemberian makan berbasis bukti pada bayi dan balita di Indonesia untuk mencegah malnutrisi. Jakarta: Ikatan Dokter Anak Indonesia; 2015.
8. Suradi R. Spesifisitas biologis air susu ibu. Sari Pediatri. 2001;3:125-129.
9. Carling SJ, Demment MM, Kjolhede CL, Olson CM. Breastfeeding duration and weight gain trajectory in infancy. Pediatrics. 2015;135.
10. Stein MT, Kessler DB, Hubbard E. Failure to thrive in a 4-month-old nursing infant. J Dev Behav Pediatr. 2004;25:S69-73.
11. Yamakawa M, Yorifuji T, Kato T, Inoue S, Tokinobu A, Tsuda T, *et al.* Long-term effects of breastfeeding on children's hospitalization for respiratory tract infections and diarrhea in early childhood in Japan. Matern Child Health J. 2015;19:1956-65.
12. Pugliese MT, Weyman-Daum M, Moses N, Lifshitz F. Parental health beliefs as a cause of nonorganic failure to thrive. Pediatrics. 1987;80:175-82.
13. Kelleher KJ, Casey PH, Bradley RH, Pope SK, Whitsade L, *et al.* Risk factors and outcomes for failure to thrive in low birth weight preterm infants. Pediatrics. 1993;91:941-8.
14. Wright C, Loughridge J, Moore G. Failure to thrive in a population context: two contrasting studies of feeding and nutritional status. Proc Nutr Society. 2000;59:37-45.
15. Wright CM, Parkinson KN, Drewett RF. How does maternal and child feeding behavior relate to weight gain and failure to thrive? data from a prospective birth cohort. Pediatrics. 2006;117:1262-9.
16. Patel R, Tilling K, Lawlor DA, Howe LD, Bogdanovich N, Matush L, *et al.* Socioeconomic differences in childhood length/height trajectories in a middle-income country: a cohort study. BMC Public Health. 2014;14:932.
17. Imai CM, Gunnarsdottir I, Thorisdottir B, Halldorsson TI, Thorsdottir I. Associations between infant feeding practice prior to six months and body mass index at six years of age.

Nutrients. 2014;6:1608-17.
18. Li R, Fein SB, Grummer-Strawn LM. Association of breastfeeding intensity and bottle-emptying behaviors at early infancy with infants'risk for excess weight at late infancy. Pediatrics. 2008;122:S77-S84.
19. Batubara JR, AAP BT, Pulungan AB. Pertumbuhan dan gangguan pertumbuhan. Buku Ajar Endokrinologi Anak. I: UKK Endokrinologi Anak dan Remaja IDAI; 2010.