

Risk factor of growth faltering in infants aged 2-12 months

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ABSTRACT

Background: Growth faltering is a condition of growth disturbance that marked by slower growth velocity compared with previous growth chart. Growth faltering can cause effects in immune response, cognitive, & physical and psychomotor disturbance, behavioral disorder, learning problems, higher risk of infection and mortality.

Objectives: To analyze risk factor of growth faltering in infant aged 2-12 months.

Materials and Methods: A case control study was conducted in Public Health Center in Semarang city. Subject were infants aged 2 until 12 months with growth faltering. Variables were divided to exclusive breastfeeding, mother's education, mother's employment, social economic status, infection, mother's nutrition and gestational age. Anthropometric and questionnaire data were obtained and analyzed among 116 infants. Statistic test used Chi square and multivariate analysis.

Results: Chi-square analysis showed that breastfeeding ($p=0.016$) and gender ($p=0.04$) had a significant relationship with growth faltering in infant 2-12 months. Under standard parent's income ($p=0.809$), Acute Respiratory Tract Infection (ARTI) ($p=0.377$), diarrhea ($p=0.243$), mother's nutrition ($p=1.00$), gestational age ($p=0.77$), low mother's education ($p=0.83$) and working mother ($p=0.26$) didn't have a significant relationship with growth faltering in infant aged 2-12 months. Multivariate analysis showed that gender ($p=0.035$) and breastfeeding ($p=0.019$) were the most influencing variable to growth faltering. In 2-6 group, breastfeeding pattern had significant relationship with growth faltering ($p=0.77$)

Conclusions: Breastfeeding and gender were risk factors of growth faltering in infant aged 2-12 months. Further research needed on how to prevent growth faltering in first 1000 days of life so it may avoid stunting in later life.

Keywords: Risk; growth faltering; infants

BACKGROUND

Growth faltering is a growth disorder characterized by a slower growth rate compared to the previous growth curve.¹ One way to identify growth faltering is to compare the weight growth curve (weight for age curve). Usually growth faltering occurs in infants aged 3-12 months.² According to Smith in Clinical Pediatric Dietetics, 5-10% of children less than 5 years of age in America experience growth faltering.³ Based on the results of National Health Survey 2013 regarding the nutritional status of toddlers according to weight-age and height-age, 19.6% of children under five in Indonesia are thin and very thin. Meanwhile in Central Java, 11.1% toddlers were very thin and thin.⁴ According to the Semarang City Health Profile in 2013, the number of children under the red line according to growth chart were 1,502 children (1.7%) of the 86,515 children who came and were weighed (D) at the community based preventative and

promotive care (*Posyandu*) and from 801 cases of malnutrition, 32 cases of malnutrition among children under five found in 2013.⁵

Growth faltering causes short-term effects, namely disruption of the immune response; stunted cognitive, physical, and psychomotor growth; behavioral problems, learning difficulties, increased risk of infection; and infant mortality.^{6,7,8} Meanwhile, the long-term effects of growth faltering are emotional and intellectual disorders, risk of chronic disease, metabolic syndrome, macrovascular disease in middle age, and the incidence of low birth weight (LBW).

Growth faltering is caused by an imbalance between energy intake and biological needs for growth.³ Lack of energy intake can be related to feeding difficulty, inadequate food and / or social emotional problems between parents and children⁹, other diseases or eating patterns. The diet includes breastfeeding, age at first complementary feeding, appetite, oral dental

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health, parental knowledge of energy needs for growth, and difficulty eating. The biological need for growth can be increased by the presence of other illnesses such as gastrointestinal disease, neurological disorders, or congenital heart disease³.

Growth faltering considered as the beginning of stunting that still a major concern in Indonesia. Early detection and intervention on growth disturbance can prevent stunting in later life. Growth faltering most common found in age 3 until 6 months. Finding the risk factor of growth faltering in early life will have a lot of advantages in managing undernutrition. Based on this, it is necessary to further investigate the risk factors for growth faltering, especially in children aged 2-12 months, which is the golden age of the first 1000 days of life.

MATERIALS AND METHODS

This study is a case-control study which was conducted at Halmahera Public Health Center Semarang. The case is infant aged 2-12 months with growth faltering. Inclusion criteria include infants aged 2-12 months, experiencing growth faltering, parents willing to take part in the study. Exclusion criteria were chronic disease or congenital abnormalities. Subject needed was 40 subject in each group. Subjects were collected by consecutive sampling in Public Health Center. Hundred and sixteen subjects were participated in this study, and all of the subjects completed the protocol. Data analysis includes descriptive analysis and hypothesis testing. Data were taken by anthropometric measurements on infants.

Anthropometric measurements taken are measurements of body weight, body length and head circumference. Body weight measurements using Laica ® with 10 gram accuracy, body length measured using infantometer in the Public Health Center with 0.1 cm accuracy. The measurement was done by health workers and researcher. Interviews was done by researcher to fill out questionnaires. The results of anthropometric measurements are then plotted on the WHO 2006 curve, on the weight-for-age curve, if there is an increase in body weight that does not match the curve, it is said that the child is experiencing growth faltering. The data obtained from the questionnaire including date of birth, birth weight and birth length, and food recall. Hypothesis testing used the Chi-square test, Fisher exact and multivariate analysis. The p value is considered significant if $p < 0.05$ with a confidence interval of 95%. This research was approved by the Health Research Ethics Commission (KEPK), Faculty of Medicine, Diponegoro University / Dr. Kariadi Semarang (No. 055 / EC / FK-RSDK / 2016).

RESULT

During the study, there were 116 subjects who met the research criteria. Subjects consisted of 41 infants aged 2-6 months and 17 infants aged 7-12 months who experienced growth faltering as a case group and 58 infants with growth line directions N1 or N2 as a control group. Some of the subjects were obtained from *Puskesmas* Halmahera and some from *Posyandu* in the working area of *Puskesmas* Halmahera.

Table 1. Characteristics of Research Subjects

Characteristics	Growth Faltering	
	Yes	No
Gender		
Female (n,%)	31 (53.4)	20 (34.5)
Male (n,%)	27 (46.6)	38 (65.5)
Age (mean, SD) months	5.52±2.98	5.4±2.76
Birth Length (mean±SD) cm	48.17±2.72	48.69±3.19
Birth Weight (mean±SD) kg	3039.3±361.7	3119.4±425.1
Weight (mean±SD) gram	6.54±1.42	6.98±1.57
Length (mean±SD) cm	63.83±6.15	63.86±6.06
Head circumference (mean±SD) cm	42.0±2.19	41.8±2.84
WLZ (mean±SD)	-0.5±1.64	-0.2±2.12
HAZ (mean±SD)	-0.59±1.74	-0.64±1.77

In table 1, there are 58 infants who experienced growth faltering, with 31 infants

were girls and 27 infants were boys. The mean age when experiencing growth faltering was 5.52 ± 2.98 months, with the status of nutrition

was good nutrition based on weight for length z score (WLZ) more or equal than -2 SD .

Table 2. Parent's Characteristics

Characteristics	Growth Faltering		p
	yes	No	
Father's age (mean±SD) years	32.47±6.52	32.86±6.27	0.590 ^a
Mother's age (mean±SD) years	28.66±6.12	29.84±5.41	0.334 ^a
Mother's education			
Low	15	14	0.83 ^b
High	43	44	
Mother's employment			
Employed	21	27	0.26 ^b
Unemployed	37	31	
Father's education			
Low	20	12	0.097 ^b
High	38	46	

^aChi-square test ^bIndependent t-test

From Table 2, it is shown that mothers with high education can still have children with growth faltering, but it was less when the father has a higher education eventhough it is not significant.

Table 3. Risk factors for growth faltering infants aged 2-6 months

Risk factor	Growth Faltering		P	OR (95% CI)
	Yes	No		
Breastfeeding patterns				
Schedule	9	1	0.014 ^a	10.97(1.32-91.22)
On demand	32	39		
Breastfeeding administration				
Bottle	13	7	0.138 ^b	2.19(0.77-6.24)
Direct	28	33		

^aFisher's exact test ^bChi-square test

In table 3, scheduled breastfeeding is a risk factor for growth faltering with p 0.014. It is shown that most mothers give breastmilk to infants based on their hungry cues.

Table 4. Risk factors for growth faltering infants aged 7-12 months

Risk factor	Growth Faltering		P	OR (95% CI)
	Yes	No		
Complementary foods of breastmilk type				
Home made	16	18	0.486 ^a	0.47(0.33-0.67)
Manufacturer	1	0		
Complementary foods of breastmilk frequency				
Less	11	6	0.063 ^b	3.67(0.91-14.82)
Adequate	6	12		
Complementary foods of breastmilk age				
Incorrect	8	4	0.122 ^b	3.1(0.72-13.44)
Correct	9	14		

^aFisher's exact test ^bChi-square test

At the age of 7-12 months, both types of complementary feeding are not risk factors for complementary foods, the frequency of growth faltering. complementary foods and the age of

Table 5. Risk factors for growth faltering infants aged 2-12 months

Risk factor	Growth Faltering		P	OR (95% CI)
	Yes	No		
Age				
≤6 months	41	40	0.84 ^a	1.09 (0.49-2.34)
> 6 months	17	18		
Gender				
Female	31	20	0.04 ^a	0.46 (0.22-0.97)
Male	27	38		
Exclusive breastfeeding				
No	46	34	0.016 ^a	2.71 (1.19-6.16)
Yes	12	24		
Parents' income				
Below Regional Minimum Wage	11	10	0.809 ^a	1.12(0.44-2.89)
Above Minimum Regional Wage	47	48		
ARTI (Acute Respiratory Tract Infection)				
Common	8	5	0.377 ^a	1.69(0.52-5.53)
Less	50	53		
Diarrhea				
Common	3	0	0.243 ^b	2.06(1.7-2.48)
Less	55	58		
Mother's arm circumference				
Less	2	3	1.00 ^b	0.66(0.11-4.07)
Adequate	56	55		
Gestational age				
Preterm	6	7	0.77 ^a	0.84(0.26-2.67)
Aterm	52	51		
Mother's education				
Low	15	14	0.83 ^b	1.09(0.47-2.54)
High	43	44		
Mother's employment				
Employed	21	27	0.26 ^b	0.65(0.31-1.37)
Unemployed	37	31		

^a Chi-square test ^bFisher's exact test

Table 6. Multivariate analysis

Variable	Coefficient	p	OR(95% CI)
Step 1			
Gender	-0.845	0.035	0.43 (0,19-0,94)
Breastfeeding	1.018	0.019	2,71 (1,19-6,16)
Diarrhea	20.795	0.999	2,06 (1,7-2,48)
Constant	-0.277	0.494	

DISCUSSION

The direction of the growth line is viewed through the WHO curve for body weight by age to detect any irregular bending of the growth line. Growth faltering can occur at any age during the growing period. Growth faltering has a multifactorial cause, both external and internal to the individual. Growth faltering, especially that which occurs in the first 1000 days of life has a negative impact on children's growth and development later in life.^{10,11} Disturbance in early life is related to the ability to attend school too late, which has a high predictive value of income in adulthood. Nutritional intake is very important at this age to meet the growing needs of growth. In this study, it was found that the average age of growth faltering was between 3 until 7 months. Research conducted with data collection in 54 countries, found that the average age of growth faltering was at the age of 3 months and decreased rapidly until the age of 12 months, slower until the age of 18-19 months and grew rapidly after that.¹² From this study, we found that growth faltering is more often in female infants than boys. This can be caused by patriarchy culture in this area, so male infants will get more attention including nutrition intake. The other cause could be that male infants get hungry easier so feeding intensity will be more often than female infants. This study found that the absence of exclusive breastfeeding has a significant relationship with the incidence of growth faltering in infants aged 2-12 months with a p value of 0.016. Infants that didn't received exclusive breastfeeding are more prone to infection. Infection can deteriorate nutrition intake and causing growth faltering, especially in infants aged less than six months. Growth faltering most common in infants aged 3 until 5 months, this can be caused when in that ages, mothers has to return to work and education about how to breastfeed during work still scarcely given by the health workers, and this can cause infants could not have the nutrition needed to maintain appropriate growth. Infants who are not exclusively breastfed have a higher risk of experiencing growth faltering than infants who are exclusively breastfed.¹³ This is consistent with a study in Mexico which states that the incidence of growth faltering can be prevented by exclusive breastfeeding. Breastfeeding can improve growth by preventing infection and improving nutritional

intake at the time of infection.^{14, 15, 16} In addition, breastfeeding alone is sufficient to meet the needs of infants up to 6 months old because of the composition of the milk that adjusts with the infant's needs.

The results of this study also indicate that the time pattern of breastfeeding has a significant relationship with growth faltering in infants aged 2-6 months. Infants who are breastfed on a regular basis have a higher risk of experiencing growth faltering when compared to babies who are breastfed on-demand. Research by Ksenia Bystrova shows that infants who are treated in combination, and who are breastfed on-demand, have better growth than infants who are treated separately.¹⁷ On-demand breastfeeding, which means that it is tailored to the wishes of the baby, has been shown to affect the duration of breastfeeding becomes longer. Infants can adjust their needs, if they are hungry, they will breastfeed more often and for longer, thus stimulating the prolactin reflex to produce more milk. The more often the mother breastfeeds, the more milk production will be. Sufficient milk production to meet the needs of the baby is what can lead to better baby growth. On the other hand, on scheduled breastfeeding, mothers tend to limit the frequency of breastfeeding, which can lead to decreased milk production. From other studies, it was found that the provision of a scheduled diet was associated with the well-being of the worse mother, but worse cognitive and academic output in children¹⁸.

Other factors such as nutritional status, maternal occupational education level, socioeconomic, incidence of Acute Respiratory Tract Infection (ARTI) did not show a significant relationship with the incidence of growth faltering in infants aged 2-12 months. The nutritional status of breastfeeding mothers can affect milk production.¹⁹ However, other studies have shown that the composition of breast milk is not sensitive to maternal factors, including nutritional status, in the early months of breastfeeding.²⁰ Previous studies have revealed that even though mothers know the importance of breastfeeding exclusive breastfeeding, but the rate of exclusive breastfeeding is still suboptimal, due to many other factors that can affect the good achievement of exclusive breastfeeding.^{21, 22} Lack of knowledge of mothers on proper

nutrition will reduce nutritional intake in children. The level of education does not guarantee the mother's knowledge of breastfeeding or the infant's growth. Based on the results of the interviews, it appears that mothers with high or low education mostly feel that breastfeeding alone is not enough for their baby's growth. Research in China states that education on correct infant feeding practices can increase growth, reduce the incidence of anemia in infants aged 6-12 months, and improve nutritional status in children under 5 years of age in developing countries.^{23, 24}

Research in Isfahan compared growth in children with working and non-working mothers. There was a significant difference between the two groups in the growth of children aged 12-30 months, but no significant difference was found at the age of 0-12 months.²⁵ This is in accordance with the results of the study that there was no significant relationship between maternal occupation and the incidence of growth faltering in infants aged 2-12 months.

There is no significant relationship between socioeconomic and growth faltering in infants aged 2-12 months in the results of this study. Similar results were obtained in England, which states that social characteristics have only a slight effect on infant weight gain.²⁶ Research in Japan states that infants who come from low-income families have a higher risk of growth faltering.²⁷ On the other hand another, in the middle economic status group there was also growth faltering with an amount that was not much different. Meanwhile, in the highest economic status group, the risk of growth faltering is lower, but still has the same basic pattern of causes of growth faltering as the lower economic status. Therefore, growth faltering can occur in all economic status. Research in 50 low-income countries states that growth faltering is influenced by the overlapping effect of poverty, less varied diets, infectious environments, poor hand washing habits and poor knowledge. low regarding the principles of nutrition and hygiene.²⁸

In this study, we found that there was no significant relationship between diarrhea and the incidence of growth faltering in infants aged 2-12 months. In this area, access to health facility such as Public Health center is reachable and there was routine community based preventative and promotive care every month, so that infants can be routinely checked for their health concern. It is well known that acute infections

such as acute respiratory infections and diarrhea are the leading causes of mortality, especially in developing countries. The results of previous studies found that diarrhea is a major determinant of poor growth in children.²⁹ Acute infection itself can affect growth due to the possibility of decreased appetite, restrictions on food given due to local culture and the presence of malabsorption of the nutrients provided.

In this study, the first age of complementary foods was not associated with the incidence of growth faltering. The first age of giving complementary foods in this study, especially at the age of 2-4 months, was given mashed bananas. According to WHO, complementary foods given at less than 6 months of age do not affect the increase in infant growth and complementary foods before 6 months of age tend to replace breastmilk given.³⁰ A systematic review states that complementary feeding at 4 months of age can reduce the incidence of anemia in infants.³¹ Research in Germany states that late complementary foods increase the risk of allergies and the risk of inadequate energy intake because breast milk cannot meet the needs of babies over 6 months.³² Apart from the first time introducing complementary foods, of course, the quality of complementary foods that contain enough macro and micronutrients also play an important role in meeting the nutritional needs of infants.

Based on consistency, complementary foods are divided into sufficient or insufficient consistency. The consistency is sufficient if it matches the consistency that should be at the age, namely at the age of 6 months of milk porridge, 7-9 months of rice and milk, 9-12 months of crushed and chopped food, 12-24 months of family food.³⁰ The statistical results of this study indicate that the consistency of complementary foods is not associated with growth faltering at 7-12 months of age. The consistency of age-appropriate complementary foods can help babies to adapt to family food later at the age of 1 year. The introduction of foods with an age-inappropriate consistency will result in difficulty eating at a later date.

Periodic measurements of weight and height are more relevant than measuring body weight alone to detect growth disorders. The ability of both health workers and cadres in conducting growth screening is needed so that there is no delay in intervention.

CONCLUSION

From this study, it can be concluded that non-exclusive breastfeeding and female sex are risk factors for growth faltering in infants aged 2-12 months, and the timing of breastfeeding is a risk factor for growth faltering in infants aged 2-6 months. The importance of exclusive breastfeeding and on-demand breastfeeding can reduce the rate of growth faltering in infants. Further research is needed on how to prevent growth faltering in the first 1000 days of life so it may avoid stunting in later life.

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