Zinc, folic acid, and calcium as determining factors for failure to thrive in the first 1,000 days of life in the Coastal Region

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Abstract

Background Failure to thrive in the first 1,000 days of life has an impact on the quality of human resources. Aims: The purpose of this study is to analyze the determinants of failure to thrive within the first 1,000 days of life. Settings and Design: This study was an observational study with cohort design. Methods and Material: Thirty cases of children whose weight gain for 2 months were <5 percentile of WHO's weight increments. The remaining 47 who were designated as control group. The determinant factor’s such as age, sex, infection (URI, diarrhea), breastfeeding patterns were collected by structured questionnaires. Consumption of nutrients were measured by recall form 1x24 hours every month. Body weight was measured using a digital baby scale. Statistical analysis used: Data were analyzed using Chi-Square test. Results: Failure was found in this study to thrive mostly occurs at the age of 6-12 months. A smaller percentage of diarrhea compared to URI. Most of the subjects were not exclusively breastfed. Adequacy levels of calcium, Zn, and folic acid according to RDA in the case group were smaller than the control group. Age, adequacy levels of Zn, calcium, folic acid were the determining factors for the failure to thrive (p<0.05). Children with sufficient levels of folic acid, Zn, and calcium had less than 1 - 3 times the chance of experiencing failure to thrive. Conclusions: Factors that determine of growth failure in children aged 6-23 months are the lack of Zn, calcium and folic acid.
Keywords: Failure to thrive, Characteristics, Infection, Breastfeeding patterns, adequacy level of nutrition, The 1000 days of life.

Key Messages:
Micronutrients are very important for the growth and development of the first 1000 days of life, therefore they must be fulfilled in every meal

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Introduction

Failure to thrive is an occurrence of insufficient weight gain that is not appropriate compared to other children of the same age and gender, the failure to gain weight in more than one weighing or even an instance of weight loss compared to previous weighing. ¹ According to WHO, failure to thrive is a condition in which the weight increment of children is < the 5th percentile. ² Several studies argued that about 27% of children experienced failure to thrive at the minimum once in their first year of life. ³ Other data showed that failure to thrive was mostly found in children aged 18 months. ³,⁴ If not detected earlier, failure to thrive will be manifested in the form of malnutrition or poor nutrition (stunting, wasting). FAO estimated that 1 of eight children around the world had malnutrition. 70% of such cases occurred in Asia, 26% in Africa and 4% in Latin America and Caribbean. ⁴

Failure to thrive is caused by organic factor (medical condition) and non-organic factors (environment, social). ² However, in reality, the causes of failure to thrive are the quantity and quality of calorie intake that are not sufficient, incomplete calorie absorption as the effect of infection and the increase of calorie needs in certain medical conditions. ² Exclusive breastfeeding gives a positive impact on the growth of children, as it not only has complete nutritional content, but it also contains elements that can boost immunity. Children who do not get exclusive breastfeeding are 2.8 times more likely to experience failure to thrive compared to children who get exclusive breastfeeding. ⁵,⁶ According to WHO, the cause of failure to thrive for children around the world is inadequate feeding in terms of age, quantity, quality and safety of the food.⁷ A research by Sulendri in Lombok found that there was an impact of complementary feeding towards weight increment, but there was no change in the nutritional status.⁸ The role of mother as a “Gate Keeper” is very important in providing a healthy and nutritious food as children are passive consumers, meaning that what the children eat depends
entirely on the mother. Another direct cause of failure to thrive is infection, particularly diarrhea and URI (Upper Respiratory Tract Infection) that are mostly suffered by children, which interferes with the absorption of nutrients and increases the needs as the effect of body catabolism process, as stated in the finding of a study in Ethiopia and Sri Lanka which discovered that diarrhea and URI affected the occurrence failure to thrive.\textsuperscript{10,11}

The period of under two years old is the “Window of opportunity", which is a period when a child’s physique and brain grow and develop optimally; therefore, he/she requires a balanced intake of nutrients both in terms of quantity and proportion to achieve optimal weight and height. Deficiency of both macronutrient and micronutrient in this period is irreversible, which greatly affects the quality of human resources. A research in South-east Asia found that children with weight-for-age index of <80% were 3 – 5 times more likely to have a non-verbal IQ of < 89.\textsuperscript{12} A research in China also showed that the failure to thrive of intrauterine and extrauterine was related to the level of intelligence of children at the beginning of school age, language skills, gross motoric movements and interpersonal relationship.\textsuperscript{13}

According to the data from Basic Health Research (RISKESDAS), Central Java Province is in the 10th place out of 33 provinces in Indonesia, with the occurrences of malnutrition and poor nutrition at 18% which means that it has not reached the 2015 MDG’s target (15%). Ice Berg theory states that if 1 child is found to have suffered from malnutrition in an area, then 10% of children who experience failure to thrive will be discovered.\textsuperscript{14} According to the mapping of malnutrition in Semarang City, Bandarharjo Urban Village is the 2nd region after TlogosariWetan Urban Village that has more cases of malnutrition in children under five years of age compared to other villages in Semarang City. Bandarharjo Urban Village is one of the villages that are located on the north coast of the city of Semarang. Most people have easy access to fish but have a lower-middle socioeconomic status.

\textbf{Subjects and Methods}

This study is an observational analytic study with cohort design. The total population was 77 children aged 6-23 months in the north coast area of Semarang city. Determination of the case was based on observations of weight gain for 2 months. Thirty cases of children who’s weight gain <5 percentile of WHO’s weight increment standard were found, while the remaining 47 children designated as control group. The subjects were taken with consecutive sampling. Each subject must have an MCH handbook, no organic disorders and no infections for 1 (one) week before the study.
The subject characteristics were collected by a structured questionnaire. The subjects' nutritional consumption was measured by a food recall form. The subject's weight was measured by a baby digital scale.

The nutrition adequacy levels were calculated by comparing the intake of nutrients with the Recommended Dietary Allowances (RDA) according to the age group. The adequacy level of macronutrients as energy and protein were categorized into 2 categories, namely < Adequacy by comparing the Levels (< 90 %), ≥ Adequacy Levels (≥ 90 %). The adequacy levels of micronutrients (Zn, iron, calcium, vitamin B12, folic acid) were categorized as < Adequacy Levels (< 77 %), ≥ Adequacy Levels (≥ 77 %).

Data were analyzed using univariate and bivariate analysis with chi square test. This study was approved by the "Health Research Ethics Committee" of the Faculty of Public Health, the University of Diponegoro with letter no: 249/EK/KEP-FKM/2018.

Results

Indirect factors affecting growth failure

Indirect factors that affect failure to thrive including age, sex, and breastfeeding pattern. The majority of failure to thrive cases occurred to male children aged 6-12 months old. Meanwhile, the control group consisted of mostly male children aged 13-23 months old. Almost all subjects were exclusively breastfed (figure 1). Chi square test showed that age is the determinant of failure to thrive. The age group of 6-12 months old had a 1.9 time of failure to thrive compared to the 13-23 months age group (table 1).

Figure 1: Characteristics of subject

<table>
<thead>
<tr>
<th>Subject characteristics</th>
<th>Case</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 12 month</td>
<td>[VALUE] %</td>
<td>[VALUE] %</td>
</tr>
<tr>
<td>13 - 23 month</td>
<td>[VALUE] %</td>
<td>[VALUE] %</td>
</tr>
<tr>
<td>Boys</td>
<td>[VALUE] %</td>
<td>[VALUE] %</td>
</tr>
<tr>
<td>Girls</td>
<td>[VALUE] %</td>
<td>[VALUE] %</td>
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<tr>
<td>Exclusive</td>
<td>[VALUE] %</td>
<td>[VALUE] %</td>
</tr>
<tr>
<td>Not exclusive</td>
<td>[VALUE] %</td>
<td>[VALUE] %</td>
</tr>
</tbody>
</table>

Direct factors affecting growth failure

Direct factors that affect growth failure are infection, consumption of macronutrients (energy, protein), consumption of micronutrients (vitamin B12, folic acid, zinc, iron, calcium). The results showed that the incidence of URI in both groups was more than diarrhea (figure 2). Chi square test showed diarrhea, URI, and breastfeeding pattern are not determinant of failure to thrive (p<0.05).

![Figure 2: Description of infection of subject](image)

The adequate level of nutrient as determinants of failure to thrive

The adequacy level of macronutrients as energy and protein was categorized into 2 categories, namely < Adequacy by comparing the Levels (< 90 %), ≥ Adequacy Levels (≥ 90 %). The adequacy levels of micronutrients (Zn, iron, calcium, vitamin B12, folic acid) was categorized as < Adequacy Levels (< 77 %), ≥ Adequacy Levels (≥ 77 %).

Figure 2 shows that the level of nutritional adequacy according to the RDA of folic acid, zinc, and calcium in the case group was lower than the control group. Chi square analysis showed that the adequacy of energy, protein, iron and vitamin B12 are not a determinant of growth failure in children aged 6-23 months (p>0.05). Whereas the adequacy levels of Zn were the determining factors for the incidence of failure to thrive of children aged 6-23 months (p<0.05).
Results of recall form showed that in the complementary feeding process, children aged 6-23 months old were not given enough varied food and they lacked adequate animal source food. The
most consumed snacks were sweets and junk foods which are poor in micronutrients (kerupuk, wafers).

Discussion

Infants 6 to 24 months, due to the rapid transition from breastfeeding to complementary feeding, are more likely to be at risk of FTT. Diarrhea and URI infections were not the risk factors for failure to thrive. This can be seen due to the fact that the majority of the samples, both in the case group and the control group (> 40%) suffered from URI and diarrhea (<40%). During infancy, children will suffer from infection for about > 100 times, due to their imperfect immunological system, meaning that their bodies’ resistance to infection is low. A research in Bolaang Mongondow Regency also concluded that infection (URI, Diarrhea, Pneumonia) is not a factor that causes the growth problems of children under two years of age.

The exclusive breastfeeding pattern was not a risk factor of failure to thrive as well. The results showed that in both groups, the majority of children (> 65 %) were not given exclusive breastfeeding, as many of the mothers worked in the private sector to assist family economy. The working mothers had limitations in providing exclusive breastfeeding due to regulations in related institutions. The results of this study contradict the research on infants under 2 years of age in Malawi which stated that breastfeeding was exclusively related to weight gain and height increase.

Adequacy of energy and proteins was not a determining factor of the incidence of failure to thrive in children under the age of 2 years, as the majority of children in both groups had less than adequate energy, protein, iron and Vitamin B12 levels. But the level of sufficiency of Zn, calcium, and folic acid was the determining factor of failure to thrive. The percentage of the sufficiency rate of Zn, calcium, and folic acid were higher in the case group than the control group. Mothers who worked in the private sector did not have enough time to prepare food, hence they mostly bought food from stalls to meet their daily needs. Sufficiency in both quantity and quality as well as food variation are the main factors that directly affect nutritional status, especially for the nutritionally vulnerable group.

Chi-square statistical tests found that by consuming Zn, iron and folic acid, growth failure in children will less likely to occur. Children with sufficient levels of folic acid have less than 3 times the chance of experiencing failure to thrive, while those with sufficient levels of Zn (RR = 2.089) and calcium (RR = 1.994) have 1-2 times less chance of suffering failure. A research in the Egyptian Nile discovered adolescents who experienced growth failure due to Zn deficiency. Developing countries
found many infants and children who had Zn deficiency, which affected growth retardation and high occurrence of infections (diarrhea, pneumonia, malaria).  

The role of Zn in a child's growth process is related to the formation of growth hormone, which activates and starts the synthesis of growth hormone. Calcium is one of the main components of bone mineral tissue. It is important for proper bone formation. Inadequate diet of this nutrient can influence skeletal formation and bone formation processes. All B vitamins assist the body in converting food (carbohydrates) into fuel (glucose), which is used to produce energy. Folic acid plays an important role in brain development and it is especially important in the stages of rapid growth, such as pregnancy, infancy and adolescence. The adequacy levels of Zn, calcium and folic acid that are less than recommended requirement are the determining factors for the incidence of failure to thrive in children aged 6-23 months.

**Conclusion**

The process of child development requires adequate nutrition. In addition to energy and protein, vitamins and minerals are also needed to help optimal growth and development, especially in the first 1000 days of life. Lack of a micronutrient can cause growth failure, which causes the quality of human resources, such as decreased academic potential, work productivity, and susceptibility to infection.

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