Annals of Tropical Medicine and Public Health
Volume 7, Issue 5, 2021
Print ISSN: 1755-6783
Online ISSN: 0974-6005

Energy Deficiency and Protein Intake Related to Stunting and Motor Development in Children Aged Under 5 Years: Cross-Sectional Study In Kaway XVI District, West Aceh District

Suryana[1*], Yulia Fitri[1], Andi Eka Yunianto[2], Silvia Wagustina[1],Nunung Sri Mulyani[1], Sanya Anda Lusiana[3] Fitria Nur[1]

[1]Department of Nutrition, Aceh Health Polytechnic, Aceh, Indonesia
[2]Departement of Nutrition, Siliwangi University, Tasikmalaya, Indonesia
[3]Departemen of Nutrition, Jayapura Health Polytechnic, Jayapura, Indonesia

Corresponding author: Suryana, Department of Nutrition, Jl. Soekarno Hatta. Lampeuneurut, Aceh besar, Indonesia; email: bundanafisgibran@gmail.com

Abstract

Background: Food consumption is an important factor that can affect the nutritional status and development of children. The quality of children can be reflected in their nutritional status and development.

Method: This study used a cross-sectional design, with a total sample of 81 people. Samples were toddlers aged 24-59 months, selected by using the technique of random sampling. The study was conducted in Kaway XVI District, West Aceh Regency. Chi-square test was used to analyze the relationship of energy and protein intake to the incidence of stunting and child development.

Results: Children under five with a prevalence of stunting 49.4%, and More than half (59.3%) of the samples had the suspect on motor development, 44.4% had the suspect on fine motor development, and 17.3% had the suspect on gross motor development. There was a significant relationship between energy intake (p-value = 0.001) and protein (p-value = 0.003) to the incidence of stunting. There was an influence of energy intake (p-value = 0.000), but it did not affect the intake of protein (p-value = 0.922) and growth (heiht/age) or stunting on the motor development of toddlers.

Conclusion: Energy and protein intake influence the incidence of stunting in children under five in Kaway XVI District, West Aceh Regency. Energy intake affects the motor development of children but does not affect protein intake. The government is expected to design appropriate policies to improve the nutritional status and quality of children.

Keywords: *Energy, protein, stunting, motor development, children*

 http://doi.org/10.36295/AOTMPH.2021.7501

Introduction

Food consumption is an essential factor in determining the nutritional intake of children under five, which can affect height growth and child development (1). Nutritional deficiencies have an impact on the low quality of humans (2). The quality child can be reflected in the nutritional status and child development. Stunting is defined as a failure to achieve linear growth, indicating the cumulative effect of long-term lack or insufficient intake of energy, macronutrients, or micronutrients or the result of chronic or recurring infections. (3,4). Stunting and delays in motor development is a form of child growth failure (5). Stunting correlates with long-term impacts (6). Linear growth failure as a marker of various pathological disorders associated with increased morbidity and mortality, loss of physical growth potential, decreased neurological and cognitive development function, and increased risk of chronic disease in adulthood (7).

Stunting indicates a state of malnutrition according to the body length index according to age or height according to age with a z-score <-2 SD (8,9). Around 151 million (22%) children under five in 2017 were stunted, and more than half of children with stunting came from Asia (10). According to the World Health Organization (WHO), Indonesia is a country with a high prevalence of stunting (30-39%) (11). According to UNICEF, Indonesia is ranked fifth among countries with the highest burden of child stunting (12). The trend of decreasing stunting in Indonesia in the last ten years, from 42% to 36% (12).

The results of Health Research in 2018, Indonesia experienced a decrease in the prevalence of stunting from 19.6% to 17.7%. Aceh is one of the provinces with a stunting prevalence above the national rate, which is 37.5%. Aceh Barat Daya District has a stunting prevalence of 28.8% (13). The World Health Organization (WHO) limits stunting in every country, province, and district/city to only 20% of the number of children under five in that area. This means that the problem of stunting due to chronic malnutrition in Indonesia and several regions is still far from the target (11).

Various factors influence the stunting and motor development of children. A history of inadequate breastfeeding and inappropriate complementary feeding affects linear growth or stunting and child development (14). Exclusive breastfeeding, consumption of foods rich in nutrients, regular feeding, lack of infectious diseases, and mental stimulation of children, including good parenting, also affect children's growth and development (15). Energy and protein intake factors play an essential role in the incidence of stunting and motor development in children (16). Several studies have shown that children who are stunted have a lower intake of energy, protein, and several micronutrients such as calcium, zinc, iron, magnesium, selenium, iodine, and phosphorus than non-stunting children (17,18). Inadequate nutrient intake and exacerbated by the frequent frequency of disease can cause linear growth disorders or height does not reach the standard (7). Children with energy intake <70% RDA and protein intake <80% are at risk of experiencing growth and development disorders, including motor development (1). This study aims to analyze the effect of energy and protein intake on the incidence of stunting and children's motor development.

Methods

This research is a descriptive-analytic study using a cross-sectional design. The research was conducted in Kaway XVI Subdistrict, Aceh Barat Daya District, in March 2019. The population in this study were all mothers who had toddlers aged 24-59 months who were in Dikemukiman Peureumeu Settlement, Kaway XVI Subdistrict, West Aceh Regency. The sample in this study was children under five who were in Dikemukiman Peureumeu Settlement, Kaway XVI District, West Aceh Regency. The children must meet the criteria, including being willing to participate by filling out the consent form, the sample was not in a sick state, and being cared for by the mother. Sampling was done using a standardized random sampling technique. The minimum sample size is 81 children under five aged 24-59 months.

Data variables in this study included data on sample characteristics (age, gender), family demographic characteristics data (maternal age, maternal occupation), growth data (height and energy intake), nutrients data (energy intake, protein, calcium. and iron), and motor development data.

http://doi.org/10.36295/AOTMPH.2021.7501

Body length measurements were carried out using a microtoise tool with an accuracy of 0.1 cm. Each of these measurements was carried out twice. The final result was the mean of measurement compared to the cut-off point of stunting if <-2 SD, normal ≥-2 SD. Measurement of energy intake and protein, calcium, and iron nutrients using the 24-Hour Food Recall method for two consecutive days. . The intake of days 1 and 2 was summed and then averaged, then the weight was converted into grams, energy, protein, calcium, and iron content were calculated using the 2007 Nutri-survey software program, whose baseline data obtained from the list of Indonesian Food ingredients. Consumption data collection also used food model tools and food photo books. Energy and protein adequacy figures were used in the equation model for energy estimation for each child's age (Hardinsyah et al. In the Ministry of Health 2014), and compared with the cut-off point for the deficit category <90% RDA, normal ≥90%(19,20).

Measurement of children's motor development was carried out by observation using the Pre-Screening Development Questionnaire. Then, categorized as "Normal or age-appropriate" if the child was able to perform or succeed in tasks on fine motor development items, and gross motor skills in the Pre-Screening Development Questionnaire. Categorized as "Suspect or not according to age" if the child had one or more disabilities in performing tasks on fine and gross motor development items, according to questionnaires (21). Items of developmental functions in children aged 24 months consisted of 4 fine motor development tasks, 3 gross motor development tasks. Age 30 months consisted of 2 fine motor development task items and 2 gross motor development task items. The age of 36 months consisted of 3 fine motor development task items and 2 gross motor development task items. The age of 48 months consisted of 3 fine motor development task items and 2 gross motor development task items. The age of 54 months consisted of 3 fine motor development task items and 2 gross motor development task items. The age of 60 months consisted of 3 fine motor development task items and 2 gross motor development task items.

Data analysis used the Microsoft Office Excel 2010 computerized software system, Statistical Program for Social Science (SPSS) version 17.0 for windows. The Chi-Square test with p- <0.05 was **applied** to identify the impact between variables.

Results

The sample in this study were toddlers aged 24 to 59 months. Sample characteristics included age of under five, sex, linear growth in height/age, motor development (fine and gross motor skills), energy intake, and protein intake. Most of the samples in this study were 60.5% aged 24-42 months, and 58.0% female (**Table.1**). More than half of the samples had nutritional status according to height/age in the normal category, but almost half had nutritional status in the stunting category, which was about 49.4%. Most of the samples had a deficit energy intake of 65.4% and a sufficient protein intake of 76.5%. The average energy intake of the sample was 961.4 kcal, and 29.2 grams of protein. More than half (59.3%) of the samples had the suspect on motor development, 44.4% had the suspect on fine motor development, and 17.3% had the suspect on gross motor development.

Table 1. Characteristics of toddlers in kemukiman peureumeu

Toddler Characteristics	n	%
Age (months)		
24 - 42	48	59.3
43 - 59	33	40.7
Sex		
Male	34	42.0
Female	47	58.0
Growth (Height / Age)		
Stunting	40	49.4
Normal	41	50.6
Motor development		
Suspect	48	59.3
Normal	33	40.7
Fine motor development		
Suspect	45	44.4
Normal	36	55.6
Gross motor development		
suspect	14	17.3
Normal	67	82.7
Energy (Kcal)		
Deficit	53	**65.4**
Normal	28	**34.6**
Mean ± SD (min-max)	**961.4±192.9 (703-1.375)**	
Protein (grams)		
Deficit	19	23.5
Normal	62	76.5
Mean ± SD (min-max)	**29.2±7.8 (17.6-47.6)**	

http://doi.org/10.36295/AOTMPH.2021.7501

Table. 2 shows that deficit of energy and protein intake was mostly owned by stunting samples, about 62.3% in deficit energy intake, and 78.9% in deficit protein intake. Meanwhile, normal energy and protein intake were mostly owned by non-stunting samples. Chi-square test results obtained p-value <0.005 in energy and protein supply. It means there was a significant effect between energy and protein intake on stunting in children aged 24-59 months.

Table 2. Effect of energy and protein intake on stunting

Variable	Nutritional status				p	OR
	Stunting		Normal			
	n	%	n	%		
Energy intake						
Deficit	33	62.3	20	37.7	0.001	6.7 (2.1-20.,6)
Normal	7	25.0	21	75.0		
Protein intake						
Deficit	15	78.9	4	21.1	0.003	5.5 (1.6-18.6)
Normal	25	40.3	37	59.7		

Table. 2 also shows that samples with a deficit energy intake of <90% RDA had a 6.7 times risk of becoming stunted compared to samples with normal energy intake of ≥90% (OR = 6.7; 95% CI; 2.1-20.6). Samples with deficient protein intake had a 5.5 times risk of becoming stunted compared to samples with normal protein intake ≥90% RDA (OR = 5.5; 95% CI; 1-6-18.6).

Table 3. Effect of energy and protein intake on motor development

Variable	Motor development				p	OR
	Suspect		Normal			
	n	%	n	%		
Energy intake						
Deficit	40	75.5	13	24.5	0.000	7.6 (2.7-21.5)
Normal	8	28.6	20	71.4		
Protein intake						
Deficit	11	57.9	8	42.1	0.890	0.9 (0.3-2.6)
Normal	37	59.7	25	40.3		
Growth						
Stunting	26	65.0	14	35.0	0.208	1.6 (0.6-3.92)
Normal	22	53.7	19	46.3		

Table. 3 shows that less energy intake was mostly owned by samples with suspected or doubtful motor development based on age. Conversely, the less protein intake was mostly owned by normal samples. Samples with suspected development belonged mostly to stunting samples, and samples with normal growth mostly owned normal growth samples. Chi-square test results obtained p-value <0.005 on energy intake, and p-value> 0.005 on protein intake and growth with the height/age indicator. These results were significant; energy intake had a significant effect on motor development in toddlers aged 24-59 months; while protein intake and growth with the height/age indicator did not affect motor development. Table 4 also shows that samples with a deficit energy intake of <90% RDA risked 7.6 times to suspect motor development compared to samples with energy intake ≥90%.

http://doi.org/10.36295/AOTMPH.2021.7501

Discussion

The prevalence of stunting in the study sites was found to be quite high, almost half of the children aged 24-59 months (49.4%) had linear growth disorders or height that was not suitable for age or height was below standard. This number was much higher when compared to the prevalence rate of stunting in Aceh Province of 37.6% (13). The high prevalence of stunting was also found at the same age as children, such as in North Pontianak District, namely 41.1% (22). The prevalence of stunting in this study area is far from the number set by the World Health Organization (WHO) in limiting stunting in each country, province, and district/city to only 20% of the number of children under five in that area. (11).

The motor development with a suspicious or doubtful category following the age was also quite high, at 59.3%. Motor development is the ability to control body movements in a coordinated manner between the central nerves, nerves, and muscles. Children's motor skills include gross motor skills, namely the ability to perform movements that involve large parts or muscles of the body, such as walking, sitting, running, or jumping. Meanwhile, fine motor skills are the ability to perform movements that involve small muscles such as holding, grabbing, writing, or throwing. Delay in motor development tasks is a common symptom of mental retardation and is often an early symptom of learning disorders (23).

According to WHO, linear growth disorder or stunting is often called the result of the accumulation of long-lasting stressful episodes of poor food intake and infections. This is then not matched by catch-up growth, which is characterized by a deficit in height or body length of less than -2 SD Z score (9). This research shows a significant effect between energy and protein intake on the incidence of stunting in children under five years of age 24-59 months. A deficit energy intake of <90% RDA had a 6.7 times risk of becoming stunted compared to samples with normal energy intake of ≥90%, and samples with a deficit protein intake had a 5.5 times risk of becoming stunted compared to samples with normal protein intake of ≥90%. In contrast to studies conducted on children aged 0.5-1.9 years, it shows that energy intake <80% RDA, and protein intake <70% RDA are risk factors for growth disorders or stunting and development. Children who are stunted are indicated by a protein intake of <80% RDA with a 2.2 times risk of becoming stunted compared to children with an intake of ≥80% RDA (1). These findings equally show the effect of energy and protein intake on stunting, but the age of the child and the energy and protein intake standards used are different.

In this study, most of the samples had a deficit energy intake, while protein intake was normal. The average energy and protein intake in stunted children were lower than in normal children. Stunted children had an average energy intake of 919.7 kcal, and 27.6 g of protein, while normal children had an average energy intake of 1020.2 kcal and 31.3 g of protein. There was a significant difference that the average energy and protein intake in stunted children was lower than in non-stunting children (24, 25). Protein-energy malnutrition causes global deficits, which can be measured by general developmental testing, and area-specific effects on the hippocampus and cortex (26).

Lack of chronic energy over a long period can cause disrupted linear growth (27). Negative energy imbalance can cause plasma insulin to decrease. So, it can reduce the synthesis of liver insulin Growth factor (IGF-1), affect the action of IGF binding protein-1, thyroid hormone, and other systemic factors involved in fibroblast growth factor (FGF-21), which all of them contribute to linear growth (28). Adequate protein plays a role in linear growth, in addition to the role of the hormone insulin, thyroid hormone, growth hormone, and insulin growth factors (IGF) (Jackson 2007). Inadequate protein intake can damage bone mass by impairing the production of IGF-1, which affects bone growth by stimulating the proliferation and differentiation of chondrocytes in the growth epiphytic plate and will affect osteoblasts (22). So that toddlers who are deficient in protein intake will experience linear growth disorders, which can cause stunting.

Muscle growth is only possible when the appropriate amino acids are available, including maintenance and growth. A good source of protein and rich in high-quality protein is food that comes from animal or animal protein. The quality of animal protein is higher than the quality of vegetable protein (29). However, in this study, the sample protein consumption was not differentiated between vegetable and animal protein.

http://doi.org/10.36295/AOTMPH.2021.7501

Moral development is related to brain development. Brain development reaches its peak a few months before birth. At birth, brain development only reaches 27% of the adult brain size and will continue to develop until the age of 2 years reaches 80% (27). Energy intake, protein, and several other micronutrients such as iron, zinc, copper, iodine, selenium, vitamin A, choline, and folate have a greater effect on children's brain development (30,31). In this study, energy intake had a significant effect on children's motor development, while protein intake and growth with indicators of height/age had no effect.

Children aged 24-59 months with a deficit energy intake of <90% RDA risk 7.6 times to suspect motor development compared to samples with an energy intake of ≥90%. These results indicate that energy intake has an important role in children's motor development. This is different from research (32) that energy and protein intake are related to development (33). Nutritional deficiencies in childhood can affect the function of the central nervous system (CNS) and the development of the neurotransmitter system (26,34).

Conclusions

There was a significant relationship between energy intake and protein to the incidence of stunting in children under five in Kaway XVI District, West Aceh Regency. There was an influence of energy intake, but it did not affect the intake of protein on the motor development of toddlers. Energy intake affects the motor development of children but does not affect protein intake. The government is expected to design appropriate policies to improve the nutritional status and quality of children.

Conflict Of Interest

All authors declare that there is no conflict of interest in this study.

Acknowledgments

The Reseacher thanks to Dikemukiman Peureumeu Settlement, Kaway XVI Subdistrict, West Aceh Regency governments that have given permission. Enumerator team. Mothers who have been willing to become respondents and give their children are part of this research.

Ethical Clearance

The ethical clearance for this study has been approved by the Research Ethics Committee the Polytechnic of Health Ministry Aceh No:LB.02.03/7835/2019 before the survey was executed.Information of the respondent gathered by the questionnaires was confidentially kept. Signed informed consent for the respondent participation was obtained before included in this study.

References

1. Laurus G, Fatimah SN, Gurnida DA. Pattern of Energy and Protein Intake among Stunted Children Aged 3–5 Years in Jatinangor. Althea Med J. 2016;3(3):364–70.

2. Alshammari E, Suneetha E, Adnan M, Khan S, Alazzeh A. Growth profile and its association with nutrient intake and dietary patterns among children and adolescents in Hail Region of Saudi Arabia. Biomed Res Int. 2017;2017.

3. WHO. WHA Global Nutrition Targets 2025: Stunting Policy Brief [Internet]. 2014. Available from: https://www.who.int/nutrition/topics/globaltargets_stunting_policybrief.pdf

4. Branca F, Ferrari M. Impact of Micronutrient Deficiencies on Growth: The Stunting Syndrome. Ann Nutr Metab [Internet]. 2002;46(1):8–17. Available from: https://www.karger.com/Article/FullText/66397

5. Dwi Utami A, Lanti Y, Dewi R. The Effect of Nutrient Intake and Socioeconomic Factor toward Stunting Incidence among Primary School Students in Surakarta. J Epidemiol Publich Heal [Internet]. 2017;2(1):1–10. Available from: https://doi.org/jepublichealth.2017.02.01.01

6. Vonaesch P, Tondeur L, Breurec S, Bata P, Nguyen LBL, Frank T, et al. Factors associated with stunting in healthy children aged 5 years and less living in Bangui (RCA). PLoS One. 2017;12(8).

 http://doi.org/10.36295/AOTMPH.2021.7501

7. de Onis M, Branca F. Childhood stunting: A global perspective. Matern Child Nutr. 2016;12:12–26.

8. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet [Internet]. 2013 Aug;382(9890):427–51. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0140673613609 37X

9. Organization UNCFWH. n. Low Birthweight: Country, Regional and Global Estimates. New York: UNICEF; 2004.

10. WHO. Levels and Trends in Child Malnutrition [Internet]. 2019. Available from: http://www.who.int/nutgrowthdb/2018-jmebrochure.pdf?ua=1

11. World Health Organization. Country Profile Indicators: Interpretation Guide. Geneva: World Health Organization; 2010.

12. UNICEF. Improving Child Nutrition: The Achievable Imperative for Global Progress. New York: UNICEF; 2013.

13. Kesehatan K. Laporan Nasional Riset Kesehatan Dasar 2018. Jakarta: Kementerian Kesehatan Republik Indonesia; 2019.

14. Tasnim S. Effect of breast feeding on child development: At birth and beyond. South East Asia J Public Heal. 2015;4(1):4–8.

15. Huang J, Vaughn MG, Kremer KP. Breastfeeding and child development outcomes: an investigation of the nurturing hypothesis. Matern Child Nutr. 2016;12(4):757–67.

16. Tessema M, Gunaratna NS, Brouwer ID, Donato K, Cohen JL, McConnell M, et al. Associations among high-quality protein and energy intake, serum transthyretin, serum amino acids and linear growth of children in Ethiopia. Nutrients. 2018;10(11):1–17.

17. Penny ME. Micronutrients in the Treatment of Stunting and Moderate Malnutrition. In 2012. p. 11–21. Available from: https://www.karger.com/Article/FullText/337388

18. Nasreddine LM, Kassis AN, Ayoub JJ, Naja FA, Hwalla NC. Nutritional status and dietary intakes of children amid the nutrition transition: the case of the Eastern Mediterranean Region. Nutr Res [Internet]. 2018;57:12–27. Available from: http://dx.doi.org/10.1016/j.nutres.2018.04.016

19. Kemenkes RI. Angka Kecukupan Gizi yang Dianjurkan Bangsa Indonesia. Jakarta: Direktorat Bina Gizi dan Kesehatan Ibu dan Anak; 2014.

20. Kemenkes RI. Angka Kecukupan Gizi Mayarakat Indonesia. Menteri Kesehatan Republik Indonesia Peraturan Menteri Kesehatan Republik Indonesia 2019 p. 2004–6.

21. Dhamayanti M. Kuesioner Praskrining Perkembangan (KPSP) Anak. Sari Pediatr. 2006;8(1):9–15.

22. Sari EM, Juffrie M, Nurani N, Sitaresmi MN. Asupan protein, kalsium dan fosfor pada anak stunting dan tidak stunting usia 24-59 bulan. J Gizi Klin Indones. 2016;12(4):152.

23. Yuniati E. Puzzle mempengaruhi perkembangan motorik halus anak usia prasekolah Di TK At Taqwa Mekarsari Cimahi. J Kesehat Poltekkes Ternate. 2018;11(1):36.

24. Hautvast J, van der Heijden L, Luneta A, van Staveren W, Tolboom J, van Gastel S. Food consumption of young stunted and non-stunted children in rural Zambia. Eur J Clin Nutr [Internet]. 1999 Jan 18;53(1):50–9. Available from: http://www.nature.com/articles/1600676

25. Cahyati WH, Yuniastuti A. Disparity of Risk Factors Stunting on Toddlers in the Coast and the Mountain Areas of Sinjai, South Sulawesi. Public Heal Perspect J. 2019;4(3):196–205.

http://doi.org/10.36295/AOTMPH.2021.7501

26. Georgieff MK. Nutrition and the developing brain: Nutrient priorities and measurement. Am J Clin Nutr. 2007;85(2):614–20.

27. Nurliyana AR, Mohd Shariff Z, Mohd Taib MN, Gan WY, Tan KA. Early nutrition, growth and cognitive development of infants from birth to 2 years in Malaysia: A study protocol. BMC Pediatr [Internet]. 2016;16(1):1–7. Available from: http://dx.doi.org/10.1186/s12887-016-0700-0

28. Gat-Yablonski G, Phillip M. Nutritionally-induced catch-up growth. Nutrients. 2015;7(1):517–51.

29. S A. Prinsip Dasar Ilmu Gizi. Jakarta: PT Gramedia Pustaka Utama; 2006.

30. Sarah E. Cusick MKG. The Role of Nutrition in Brain Development: The Golden Opportunity of the "First 1000 Days." J Pediatr. 2017;175:16–21.

31. Yakoob MY, Lo CW. Nutrition (Micronutrients) in Child Growth and Development. J Dev Behav Pediatr [Internet]. 2017 Oct;38(8):665–79. Available from: http://journals.lww.com/00004703-201710000-00013

32. Adani FY, Nindya TS. Perbedaan Asupan Energi , Protein , Zink , dan Perkembangan pada Balita Stunting dan non Stunting The Differences of Energy , Protein , Zinc Intake and Development to Stunting and non-Stunting Toddler. Amerta Nutr. 2017;46–51.

33. Rosidi A, Bening S, Sulistyowati E, Hunandar C, Wijaningsih W, Sunarto. Inadequate Energy Intake As A Risk Factor To Developmental Delay Of Pre-School Aged Children. Curr Nutr Food Sci. 2018;15:1–5.

34. Nyaradi A, Li J, Hickling S, Foster J, Oddy WH. The role of nutrition in children's neurocognitive development, from pregnancy through childhood. Front Hum Neurosci. 2013;7(MAR):1–16.

 http://doi.org/10.36295/AOTMPH.2021.7501