



Analysis of macronutrient and micronutrient intake with the incidence of stunting and wasting in toddlers 0-59 months of age at public health center in Bojong, Bogor regency, Indonesia

Received 6 December 2023
Accepted 15 January 2024
Published 29 February 2024

Link to DOI:

[10.25220/WNJ.V07.i2.0010](https://doi.org/10.25220/WNJ.V07.i2.0010)

Citation: Widyawardani N, Bustamam N, Aprilia C. A, Hardini N, Prasetyo P.O, Yusuf K. N, Harahap M. F. R, Raihan R.U.. Analysis of macronutrient and micronutrient intake with the incidence of stunting and wasting in toddlers 0-59 months of age at public health center Bojong, Bogor regency, Indonesia. World Nutrition Journal.2024 February 29,7(i2): 78-90.



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Abstract

Background: Stunting is defined as not achieving optimal height for age. One of the factors of stunting is caused by unbalanced nutrition. This is due to long-term nutrient intake inadequacies that potentially lead to insufficient nutrient requirements from food. Wasting often has symptoms of severe weight loss in the short term. It usually occurs when toddlers do not get a good quality and quantity of food and/or they suffer from recurrent or chronic illnesses.

Objective: Assessing the relationship between macro-micronutrient intake with the incidence of stunting and wasting in the Bojong Health Center working area, Bogor Regency July-August 2023 Period.

Methods: This research using cross-sectional study was conducted in the working area of Public Health Centre Bojong, Bogor Regency, Indonesia, from July 2023 to August 2023. The number of subjects is 93 subjects. Subjects were recruited using consecutive sampling, toddlers aged 0-59 months and mothers were the respondents who answered questions during interviews, 2x24-hour food recall, SQFFQ. The data in this study was obtained through direct interviews with respondents.

Results: Subject macronutrient and micronutrient intake tended to be deficient refer to RDA 2019. There was an association ($p=0.000$) between the intake of energy, protein, carbohydrates, fat, Fe, Omega 3, Zn, vitamin D, and Ca with the incidence of stunting and wasting.

Conclusions: Intakes of energy, protein, carbohydrate, fat, iron, omega-3, zinc, vitamin D, and Ca were significantly lower in children with nutritional problems (stunting and wasting) compared to RDA Indonesian Ministry of Health 2019.

Keywords: stunting, wasting, macronutrient, micronutrient, toddlers 0-59 months

Introduction

Every child has the right to receive food and nutrients to improve brain growth and intelligence. Nutrient intake is a necessity that plays an important role in growth, especially brain development. Children's growth and development

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depends on a balanced intake of nutrients. Intake of nutritious food is an important requirement for development, especially the development of children's cognitive. One's ability to development depends on a balanced intake of nutrients.¹

Stunting is defined as not achieving optimal height for age. The causes of stunting are chronic or recurrent undernutrition, commonly associated with poverty, poor maternal health and nutrition, a history of illness and/or inappropriate feeding and care in early life.² One of the factors of stunting in children is caused by unbalanced nutrition. This is due to long-term nutrient intake inadequacies that potentially lead to insufficient nutrient requirements from food. Stunting occurs when the baby is still in the womb but does not appear until the child is 2 years old. Growth retardation can have profound effects on the health status of the child.³

Wasting is defined as low body weight compared to height. Wasting often has symptoms of severe weight loss in the short term. It usually occurs when toddlers do not get a good quality and quantity of food and/or they suffer from recurrent or chronic illnesses.⁴ Several previous studies have also shown a relationship between intake and the incidence of malnutrition, especially stunting and wasting.⁵⁻⁸

Based on Basic Health Research (RISKESDAS) data in 2018, it is known that the prevalence of stunting aged 0-59 months in Indonesia in 2018 was 30.8%, consisting of a prevalence of shortness of 19.3% and very short of 11.5%. The prevalence of undernutrition and malnutrition aged 0-59 months according to the 2018 Riskesdas was 10.2%. This shows that Indonesia is experiencing severe public health challenges in the case of stunting and wasting toddlers. Bogor Regency is one of the regions in West Java Province with a stunting prevalence of 28.6% and a wasting prevalence of 4.2%. This makes it one of the top 7 regions in West Java with the highest prevalence of stunting.⁹ Although the prevalence of wasting in Indonesia and West Java is below the threshold, it needs to be a concern to prevent future spikes.

The intake of these macronutrients is a major contributor to energy, which is the main source of

muscle growth.¹⁰ While micronutrients are used in small amounts, but have a very vital role in the formation of hormones, and enzyme activity, and regulate the function of the reproductive system.¹¹ Determinants that cause macro and micronutrient problems are lack of parental knowledge related to nutrition and economic factors that can affect the selection of food types and food diversity.¹² Therefore, the study aimed to determine the relationship between macro and micronutrient intake and the incidence of stunting and wasting in toddler 0-59 month at the Bojong Health Center working area, Bogor Regency, West Java, Indonesia.

Methods

Study population and design

A cross-sectional study was conducted in the working area of Public Health Centre Bojong, Bogor Regency, Indonesia, from July 2023 to August 2023 without using a pretest. The number of subjects used the Lemeshow formula and obtained 93 subjects. Subjects were recruited using consecutive sampling, with inclusion criteria of toddlers aged 0-59 months, were patients of the nutrition clinic of Bojong Health Centre, resided in the working area of Bojong Health Centre, Bogor Regency, and were willing to become research subjects by signing the informed consent form. The exclusion criteria for this research subject were subjects who were sick during data collection. Subjects were toddlers aged 0-59 months and mothers were the respondents who answered questions during interviews. The main result of this study is the correlation between macronutrient and micronutrient intake with the incidence of stunting and wasting of toddlers aged 0-59 years in the Bojong Health Centre working area.

Data collection

Data collection was carried out using primary data. The data in this study was obtained through direct interviews with respondents including respondent characteristics, 2x24-hour food recall,

SQFFQ and direct subject measurements to determine the nutritional status of subjects by measuring the child's height and weight using a microtoise measuring instrument and a child's weight scale.

Interviews were conducted by clinical nutrition specialists, nutritionists, and several enumerators who had been trained for one month to fill out questionnaires, 2x24-hour food recall forms and SQ FFQ. The 2x24 hour food recall interview was assisted using the Porsimetry Book Kemenkes RI to visualize the food intake and gave aid in the food portion size estimation. Meanwhile, the SQ FFQ form uses the general one. All forms used are forms that have been validated and used in previous research.

Data analysis

Data was input and analyzed using Windows's SPSS version 26. Normal data distribution was assessed if the p-value was >0.05 using the Kolmogorov-Smirnov test. The mean and standard deviation are used to describe normally distributed data, and conversely the median is used with minimum-maximum values. The Pearson or Spearman correlation test was used to analyze the correlation between variables, with a p-value <0.05 considered significant. Linear regression test is used to confirm variables.

Food intake from the 2x24 hour food recall is input into the Nutrisurvey application using the Indonesian Food Composition Table database. The SQFFQ form is used to determine the subject's dietary habits.

Ethical approval

This research has been approved by the Health Research Ethics Committee of UPN Veteran Jakarta (UPNVJ) with Ethics Approval number 352/VIII/2023/KEPK.

Results

Data on subject characteristics was obtained using direct interviews with respondents and direct

measurements of the subject's weight and height carried out by a nutritionist.

Based on **Table 1**, the results of toddlers 0-59 months were 38 people (40.9%) were male and 55 people (59.1%) were female. According to the height for age z-score calculation, 67 people (72%) of respondents experienced severe stunting, 14 people (15.1%) experienced stunting and 12 people (12.9%) were normal. In the calculation of the weight for height z-score, the results of respondents who experienced stunting were 60 people (64.5%), 28 people (30.1%) were normoweight and as many as 5 people (5.4%) were overweight.

Based on **Table 2**, the intake of macronutrients energy (24.7%), protein (15.1%), carbohydrates (24.7%), and fat (19.4%) tended to be deficient.

In addition, the intake of micronutrients Fe (22.6%), Omega 3 (23.7%), Zn (22.6%), Vitamin D (22.6%), and Ca (17.2%) showed that the average intake of respondents tended to be deficient.

Table 3 shows the results of the analysis of the relationship between nutrient intake and the incidence of stunting in toddlers, it was found that less energy intake mostly affected the incidence

Table 1. Subject's characteristics (n=93)

Category	n	%
Sex		
Male	38	40.9
Female	55	59.1
BW/A		
Severe Stunting <-3SD Z Score	67	72
Stunting <-2 SD Z Score	14	15.1
Normal -2 SD ≤ 2SD Z Score	12	12.9
BW/BH		
Wasting <-2 SD Z Score	60	64.5
Normoweight -2 SD ≤ 2SD Z score	28	30.1
Overweight >2SD Z Score	5	5.4

of severe stunting by as much as 82.8%. The statistical test results obtained a p-value of 0.000, meaning that there is a significant relationship between the level of energy intake and the

incidence of stunting, from the results of the analysis there is a relationship between protein intake and the incidence of stunting in toddlers obtained that most of the protein intake is less in severe stunting toddlers by 83.5% and sufficient protein intake in severe stunting toddlers by 7.1%. The statistical test results obtained a p-value of 0.000, meaning there is a significant relationship between the level of protein intake and the incidence of stunting. The relationship between fat intake and the incidence of stunting shows that there is a relationship between fat intake and the incidence of stunting in toddlers, which is obtained that less fat intake in severe stunting

toddlers is 84% and sufficient fat intake in severe stunting toddlers is 22.2%. The statistical test results obtained a p-value of 0.000, meaning there is a significant relationship between the level of fat intake and the incidence of stunting. From the results of the analysis of the relationship between carbohydrate intake and the incidence of stunting in toddlers, it was found that most severe stunting children had less carbohydrate intake by 80% and sufficient carbohydrate intake in severe stunting toddlers by 47.8%. The statistical test result p-value is 0.001, meaning that there is a significant relationship between the level of carbohydrate intake and the incidence of stunting.

Table 2. Overview of nutrient intake

	Incidence of Stunting						Total		p-value
	Severe Stunting		Stunting		Normal		n	%	
	N	%	n	%	n	%			
Energy Intake									
Less	58	82.8	11	15.7	1	1.5	70	100	0.000
Sufficient	9	39.1	3	13.1	11	4.78	23	100	
Protein Intake									
Less	66	83.5	13	16.5	0	0	79	100	0.000
Simply	1	7.1	1	7.1	12	85.8	14	100	
Carbohydrate Intake									
Less	56	80	12	17.1	2	2.9	70	100	0.001
Sufficient	11	47.8	2	8.7	10	43.5	23	100	
Fat Intake									
Less	63	84	12	16	0	0	75	100	0.000
Sufficient	4	22.2	2	11.1	12	66.7	18	100	
Fe intake									
Less	58	80.5	13	18.1	1	1.4	72	100	0.000
Sufficient	9	42.8	1	4.8	11	52.4	21	100	
Omega 3 intake									
Less	56	78.8	13	18.3	2	2.9	71	100	0.000
Sufficient	11	50	1	4.5	10	45.5	22	100	
Zn intake									
Less	60	83.3	11	15.3	1	1.4	72	100	0.000
Sufficient	7	33.4	3	14.2	11	52.4	21	100	
Vitamin D Intake									
Less	58	80.5	13	18.3	1	1.4	72	100	0.000
Sufficient	9	33.4	1	4.5	11	52.4	21	100	
Ca intake									
Less	63	81.8	12	15.6	2	2.6	77	100	0.000
Sufficient	4	25	2	12.5	10	62.5	16	100	

Table 3. Relationship between micro and macro nutrient intake and the incidence of stunting

	Incidence of Stunting						Total		p-value
	Severe Stunting		Stunting		Normal		n	%	
	n	%	n	%	n	%			
Energy Intake									
Less	58	82.8	11	15.7	1	1.5	70	100	0.000
Sufficient	9	39.1	3	13.1	11	4.78	23	100	
Protein Intake									
Less	66	83.5	13	16.5	0	0	79	100	0.000
Simply	1	7.1	1	7.1	12	85.8	14	100	
Carbohydrate Intake									
Less	56	80	12	17.1	2	2.9	70	100	0.001
Sufficient	11	47.8	2	8.7	10	43.5	23	100	
Fat Intake									
Less	63	84	12	16	0	0	75	100	0.000
Sufficient	4	22.2	2	11.1	12	66.7	18	100	
Fe intake									
Less	58	80.5	13	18.1	1	1.4	72	100	0.000
Sufficient	9	42.8	1	4.8	11	52.4	21	100	
Omega 3 intake									
Less	56	78.8	13	18.3	2	2.9	71	100	0.000
Sufficient	11	50	1	4.5	10	45.5	22	100	
Zn intake									
Less	60	83.3	11	15.3	1	1.4	72	100	0.000
Sufficient	7	33.4	3	14.2	11	52.4	21	100	
Vitamin D Intake									
Less	58	80.5	13	18.3	1	1.4	72	100	0.000
Sufficient	9	33.4	1	4.5	11	52.4	21	100	
Ca intake									
Less	63	81.8	12	15.6	2	2.6	77	100	0.000
Sufficient	4	25	2	12.5	10	62.5	16	100	

From the results of the analysis of the relationship between Fe intake and the incidence of stunting in toddlers, it was found that most of the Fe intake was lacking in severe stunting children by 80.5% and sufficient Fe intake in severe stunting toddlers by 42.8%. The statistical test results obtained a p-value of 0.000, meaning there is a significant relationship between the level of Fe intake and the incidence of stunting. From the results of the analysis of the relationship between Omega 3 intake and the incidence of severe stunting in toddlers, it was found that most of the Omega 3 intake was less at 78.8%, and sufficient Omega 3 intake in severe stunting toddlers was 50%. The statistical test results obtained a p-value of 0.000, meaning there is a significant relationship

between the level of Omega 3 intake and the incidence of stunting. From the results of the analysis of the relationship between Zn intake and the incidence of stunting in toddlers, it was found that most of the Zn intake was less at 83.3% and sufficient Zn intake in severe stunting toddlers was 33.4%. The statistical test results obtained a p-value of 0.000, meaning there is a significant relationship between the level of Zn intake and the incidence of stunting. From the results of the analysis of the relationship between vitamin D intake and the incidence of stunting in toddlers, it was found that most of the vitamin D intake was less at 80.5%, and sufficient vitamin D intake in severe stunting toddlers was 42.8%.

Table 4. Relationships between micro and macronutrient intake and wasting incidence

	Incidence of Stunting						Total		p-value
	Wasting		Normoweight		Overweight		n	%	
	n	%	n	%	n	%			
Energy Intake									
Less	57	81.4	13	18.6	0	0	70	100	0.000
Sufficient	3	13	15	65.3	5	21.7	23	100	
Protein Intake									
Less	60	75.9	17	21.6	2	2.5	79	100	0.032
Sufficient	0	0	11	78.6	3	21.4	14	100	
Carbohydrate Intake									
Less	59	84.3	10	14.3	1	1.4	70	100	0.000
Sufficient	1	4.3	18	78.3	4	17.4	23	100	
Fat Intake									
Less	60	80	13	17.3	2	2.7	75	100	0.000
Sufficient	0	0	15	8.3	3	16.7	18	100	
Fe intake									
Less	58	80.5	13	18.1	1	1.4	72	100	0.000
Sufficient	2	9.5	15	71.5	4	19	21	100	
Omega 3 intake									
Less	60	84.5	9	12.7	2	2.8	71	100	0.000
Sufficient	0	0	19	86.4	3	13.6	22	100	
Zn intake									
Less	60	83.3	12	16.7	0	0	72	100	0.000
Sufficient	0	0	16	76.2	5	23.8	21	100	
Vitamin D Intake									
Less	57	79.2	13	18	2	2.8	72	100	0.000
Sufficient	3	14.3	15	71.4	3	14.3	21	100	
Ca intake									
Less	59	76.6	16	20.8	2	2.6	77	100	0.022
Sufficient	1	6.3	12	75	3	18.7	16	100	

The statistical test results obtained a p-value of 0.000, meaning there is a significant relationship between the level of vitamin D intake and the incidence of stunting. From the results of the analysis of the relationship between Ca intake and the incidence of stunting in toddlers, it was found that most of the Ca intake was less at 81.8% and sufficient Ca intake in severe stunting toddlers was 25%. The statistical test result p-value is 0.000, meaning there is a significant relationship between the level of Ca intake and the incidence of stunting.

Table 4 shows the results of the analysis of the relationship between nutrient intake and the incidence of wasting in toddlers obtained that the lack of energy intake mostly affects the incidence of wasting as much as 81.4%. The statistical test results obtained a p-value of 0.000, meaning that

there is a significant relationship between the level of energy intake and the incidence of wasting, from the results of the analysis there is a relationship between protein intake and the incidence of wasting in toddlers obtained that most of the protein intake is less in toddlers wasting by 75.9%. The statistical test results obtained a p-value of 0.032, meaning there is a significant relationship between the level of protein intake and the incidence of wasting. The relationship between fat intake and the incidence of wasting showed that there was a relationship between fat intake and the incidence of wasting in children under five years of age, with 80% of children under five years of age having insufficient fat intake. The statistical test results obtained a p-value of 0.000, meaning that there is a significant relationship between the level of fat

intake and the incidence of wasting. From the results of the analysis of the relationship between carbohydrate intake and the incidence of wasting in toddlers, it was found that most of the carbohydrate intake was less at 84.3%, and sufficient carbohydrate intake in wasting toddlers was 4.3%. The statistical p-value was 0.000, meaning that there was a significant relationship between the level of carbohydrate intake and the incidence of wasting. From the results of the analysis of the relationship between Fe intake and the incidence of wasting in toddlers, it was found that most of the Fe intake was less at 80.5%, and sufficient Fe intake in wasting toddlers was 9.5%.

The statistical p-value was 0.000, meaning that there was a significant relationship between Fe intake and the incidence of wasting. There was a significant association between the level of Fe intake and the incidence of wasting. From the results of the relationship analysis, there was a significant correlation between Omega 3 intake and the incidence of wasting in children under five years old, with the majority of Omega 3 intake being less at 84.5%. The statistical p-value was 0.000, meaning that there was no significant relationship between the level of Omega 3 intake and the incidence of wasting. From the results of the analysis of the relationship between Zn intake and the incidence of wasting in toddlers, it was found that most of the Zn intake was less at 83.3%. The statistical p-value was 0.000, meaning that there was a significant relationship between the level of Zn intake and the incidence of wasting. From the results of the analysis of the relationship between vitamin D intake and the incidence of wasting in toddlers, it was found that most of the vitamin D intake was less at 79.2%, and sufficient vitamin D intake in toddlers with wasting was 14.3%. The statistical p-value was 0.000, meaning that there was a significant relationship between the level of vitamin D intake and the incidence of wasting. From the results of the analysis of the relationship between Ca intake and the incidence of wasting in toddlers, it was found that most of the Ca intake was less at 76.6%, and sufficient Ca intake in wasting toddlers was 6.3%. The statistical p-value was 0.022, meaning that there was a significant

relationship between the level of Ca intake and the incidence of wasting.

Discussion

Relationship between energy intake and incidence of stunting and wasting

The results of this study showed there was a significant relationship between the energy intake of toddlers with the incidence of stunting $p=0.000$ ($p<0.05$) and wasting $p=0.000$ ($p<0.05$).

The results of the study are in line with Husna¹³ research which shows that there is a significant relationship of $p=0.001$ ($p<0.05$) between the level of energy intake and the incidence of stunting in toddlers. In addition, this study is also in line with the research of Syarfaini⁸ which shows that there is a significant relationship of $p=0.000$ ($p<0.05$) between energy intake and the incidence of wasting in toddlers. Stunting and wasting are caused by the accumulation of deficiencies in the level of energy intake over a long period which ultimately causes the growth rate of children under five to be not optimal.^{14,15}

Energy intake that does not meet the needs can cause energy imbalance. Prolonged energy imbalance leads to nutritional problems. Toddlers with low levels of energy intake affect the function and structural development of the brain and can result in stunted growth and cognitive development. Energy from food can be obtained from several macronutrients, namely carbohydrates, protein, and fat. Energy has a function as a support for the growth process, and body metabolism and plays a role in the process of physical activity.^{16,17}

Relationship between protein intake and the incidence of stunting and wasting

The results of this study indicate there is a significant relationship between the protein intake of toddlers with the incidence of stunting $p=0.000$ ($p<0.05$) and wasting $p=0.032$ ($p<0.05$). This study is in line with the research of Husna¹³ and Syarfaini⁸ which showed a significant relationship between protein intake with the

incidence of stunting ($p=0.001$) and wasting ($p=0.000$). Protein has a major role in growth in children under five. Protein intake is associated with effects on plasma levels of insulin growth factor I (IGF-I), bone matrix proteins, and growth factors, as well as calcium and phosphorus which play an important role in bone formation.^{18,19}

Relationship between carbohydrate intake and the incidence of stunting and wasting

Based on statistical tests, shows that there is a significant relationship between carbohydrate intake and the incidence of stunting, where the p-value is obtained = 0.001 ($p < 0.05$). This is in line with Ayuningtyas¹⁶ in 2018, who obtained a value of $p = 0.003$ ($p < 0.05$) so there is a significant relationship between the level of carbohydrate intake and the incidence of stunting. This study also found a significant relationship between carbohydrate intake and the incidence of wasting $p=0.000$ ($p < 0.05$). This is in line with Soedarsono's research in 2021 which showed a value of $p=0.014$ ($p < 0.05$) in the relationship between carbohydrate intake and the incidence of wasting.²⁰

Carbohydrates are the main energy provider and a relatively cheaper food source compared to other nutrients. If you experience a lack of carbohydrates the body will use fat and protein as a source of energy so that it will disrupt the balance of other nutrients that inhibit growth.^{17,21}

Relationship between fat intake and the incidence of stunting and wasting

The results of this study indicate that there is a significant relationship between toddler fat intake and the incidence of stunting $p=0.000$ ($p < 0.05$), this is in line with research by Nur et al (2019) which obtained a value of $p=0.000$ ($p < 0.05$) in analyzing the relationship between the adequacy of fat intake and the incidence of stunting.²²

The analysis of the relationship between fat intake and the incidence of wasting has the same results where the value of $p=0.000$ ($p < 0.05$) means that there is a significant relationship between the level of fat intake and the incidence

of wasting. This study is also in line with research by Diniyyah and Nindiya²³ in 2017 in Desa Suci Gresik, concluding that there is a significant relationship between fat intake and wasting nutritional status in children.

Fat intake from food if it is lacking, will have an impact on the lack of calorie or energy intake for the body's activity and metabolic processes.¹⁷ Low-fat intake followed by reduced energy in the body will cause changes in muscle mass and body tissue and impaired absorption of fat-soluble vitamins.^{19,24}

Relationship between Fe intake and incidence of stunting and wasting

The results of this study indicate there is a significant relationship between Fe intake of toddlers with the incidence of stunting $p=0.000$ ($p < 0.05$) and wasting $p=0.000$ ($p < 0.05$). The results of this study are in line with research conducted by Dewi and Nindya²⁵ and Bingan²⁶ where the results showed a significant relationship $p=0.011$ ($p < 0.05$) between the relationship between the level of Fe consumption adequacy with the incidence of stunting and wasting.

Stunting and wasting can occur due to chronic energy deficiency over a long period of years.²⁷ Iron intake is stored in muscle (myoglobin) and liver (ferritin). If iron sufficiency is inadequate, iron stores in the liver and spinal cord that are used to produce hemoglobin (Hb) decrease. Hb functions as an oxygen carrier from the lungs to the rest of the body. When Hb decreases, erythrocyte-free protoporphyrin will increase which will result in reduced heme synthesis and reduced erythrocyte size (microcytic erythrocytes). This condition will lead to iron anemia. In addition to causing iron anemia, iron deficiency can reduce the body's immune system, making it easier for infectious diseases to enter the body. Iron anemia and prolonged infectious diseases will affect the linear growth of the child.^{17,28}

Relationship between Omega-3 intake and the incidence of stunting and wasting

This study shows that there is a significant relationship between omega-3 intake and the incidence of stunting with a value of $p=0.000$ ($p<0.05$). This is in line with research conducted by Jutomo et al (2020) where the study found that 12 children with Omega-3 supplementation experienced a significant increase in height $p=0.009$ ($p<0.05$) [22]. This study also showed a significant relationship of $p=0.000$ ($p<0.05$) between the adequacy of omega-3 consumption and the incidence of wasting. This is supported by the research of Shahida Khan et al.,³⁰ which in their research mentioned that omega-3 supplementation increased the amount of energy consumed to improve the nutritional status of the respondents of the study.

Omega-3 PUFAs, EPA, and DHA are dietary essentials found mainly in fish and fish oil supplements. Consumption of omega-3 fatty acids can improve heart function and also function as an anti-inflammatory. Indirectly, omega 3 plays an important role in the growth and development of children under five. Long-chain polyunsaturated fatty acids including omega 3 are important for synaptogenesis, membrane function, and myelination. One form of omega 3 is docosahexaenoic acid (DHA), a neurobiological agent that affects neuronal membrane structure, synaptogenesis, and myelination. In lack of omega-3 fatty acids, the nerve cells in the brain will lack energy for nerve processes in the brain for growth and development which can interfere with the work and function of the brain. DHA functions as a nerve-wrapping tissue, this substance can launch commands to the nerves and deliver nerve stimuli to the brain.^{17,19,31}

Relationship between Zn intake and the incidence of stunting and wasting

Based on statistical tests, there is a significant relationship between Zn intake and the incidence of stunting $p=0.000$ ($p<0.05$) and a significant relationship with the incidence of wasting

$p=0.000$ ($p<0.05$). The results in this study are in line with research conducted by Nur et al.,²² in 2019, which in the study found a significant relationship with a value of $p=0.004$ ($p<0.05$) between Zn intake and the incidence of stunting.

Zn deficiency can reduce immunity and increase the risk of infectious diseases, leading to increased energy and zinc requirements which can inhibit bone growth. Zn is also one of the micronutrients related to protein and functions as a brain cell structure and neurotransmitters involved in brain memory so it can affect cognitive development.^{17,32}

Relationship between Vitamin D intake and the incidence of stunting and wasting

The results of this study indicate that there is a significant relationship between the level of vitamin D intake with the incidence of stunting $p=0.000$ ($p<0.05$) and the incidence of wasting $p=0.000$ ($p<0.05$). This is supported by research by Fakhira et al (2023) which shows the effect of vitamin D deficiency on the process of bone growth in stunted toddlers, namely the inhibition of IGF-1 function in increasing osteoblastogenesis to reduce the rate of bone growth to provide the conclusion that vitamin D has an important role in the process of calcium absorption which is useful for bone growth in stunted toddlers.^{17,19,33} Other studies have also concluded that giving high doses of vitamin D as much as 200,000 IU can greatly help improve the results of Z-score body weight for height of children with severe malnutrition (wasting).³⁴ Another study also concluded the same results in severe acute malnutrition children who were given high-dose vitamin D3 supplementation in Pakistan.³⁵

Relationship between Ca intake and the incidence of stunting and wasting

The results of this study indicate there is a significant relationship between the level of Ca intake and the incidence of stunting $p=0.000$ ($p<0.05$) and wasting $p=0.022$ ($p<0.05$). This is in line with Wati's research (2021) where a

significant relationship was found ($p=0.046$) between the adequacy of Ca intake and the incidence of stunting.³⁶ In a more in-depth study, it was mentioned that children with poor nutrition who experience Ca deficiency have a higher risk of death than children who do not experience Ca deficiency.³⁷ Micronutrients such as calcium play an important role in the linear growth of children. Optimal growth, especially bone lengthening, requires the intake of adequate amounts of animal protein and calcium.^{17,38}

The concentration of calcium in the plasma, especially free calcium ions, is carefully maintained for the transmission of nerve impulses and muscle contraction, and as a catalyst for various biological reactions, such as the absorption of vitamin B12, the action of fat-splitting enzymes, pancreatic lipase, the secretion of insulin by the pancreas, and the formation and breakdown of acetylcholine. Calcium homeostasis is regulated primarily through an integrated hormonal system that controls calcium transport in the gut, kidneys, and bones. This process involves two major calcium-regulating hormones and their receptors namely PTH and PTH receptor, and 1,25(OH)₂D and vitamin D receptor, as well as ionized serum calcium and calcium-sensing receptor. Serum calcium homeostasis develops to maintain extracellular levels of calcium ions within a normal range by circulating calcium to and from bone reserves.^{17,19,39}

Limitation of this study

The limitation of this research is that it did not carry out a comprehensive analysis of other factors causing stunting and wasting, especially the history of the disease and the duration of the disease experienced by the subject. So it still cannot be determined with certainty whether it is only insufficient nutritional intake that influences the incidence of stunting and wasting.

Conclusions

The intake of energy, protein, carbohydrates, fat, iron, omega-3, zinc, vitamin D, and Ca is

significantly lower in children with nutritional problems (stunting and wasting) when compared with the RDA from the Indonesian Ministry of Health in 2019. Nutritional Problem such as stunting and wasting can be overcome with early warning through monitoring nutritional status by regularly measuring body weight and height at the posyandu so that it can be detected and provided with interventions including nutritional services and nutritional medical therapy according to the RDA to fulfill balanced nutrition. for toddlers optimally.

Recommended for further research to carry out optimal nutritional intake interventions to see whether there are changes before and after the intervention. It is also necessary to pay attention to other factors that cause stunting and wasting.

Acknowledgment

This research was supported by funding from Lembaga Penelitian dan Pengabdian Masyarakat of UPN Veteran Jakarta in 2022. The contents of this research are the sole responsibility of the researcher.

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