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Comparative analysis of macronutrient, vitamin, and mineral intake between stunted and non-stunted children in cirebon

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ABSTRACT

Background: The food consumed by children greatly affects how they will live in the future. The amount of nutrition that enters a child's body affects their health and intelligence. Macronutrients, vitamins and minerals are vital components in the body for the processes of growth and development, endurance, and other important functions. Low nutritional intake in children will cause them to experience growth failure, resulting in stunting.

Objectives: This study was to compare the intake of macronutrients (protein, fat, and carbohydrate), vitamins (A, E, B1, B2, B6, C, folate), and minerals (sodium, potassium, magnesium, calcium, phosphorus, iron, and zinc) between stunted and non-stunted children

Materials and Methods: This study used a cross-sectional design. The population of the study was toddlers living in the Tegalwangi area, a sample of 100 children, ages 2 to 5, who were willing to sign a consent form as research subjects was split into 50 stunting and 50 non-stunting children. The time for the study began in January-May 2023. Data was collected using the 3x24 hour nutritional recall questionnaire method, followed by converting nutritional intake through the Nutrisurvey software

Results: Nutritional intake for stunted children, shows that there are 12 intake criteria below the nutritional adequacy rate, while 5 intake criteria meet the standard. While for children who are not stunted, 12 criteria meet and 5 criteria do not meet the nutritional adequacy standard.

Conclusion: Analysis of differences in the intake of the two groups found that there were no significant differences in the intake of macronutrients (carbohydrates), vitamins (E, B2) and minerals (sodium, potassium, calcium and phosphorum) with $p>0.05$, and significant differences in the intake of macronutrients (protein, fat). vitamins (A, B1, B6, C, folate), and minerals (magnesium, iron, zinc) with $p<0.05$.

***Keywords** : macronutrients; minerals; vitamins; stunting; non-stunting*

BACKGROUND

Nutrition or nutrients are food substances needed by the body for growth and development. The correct diet is provided by fulfilling balanced nutrition and various kinds of food and meeting the nutritional standards needed by children.[1] Adequate nutritional intake in children can make them more active in activities where physical activity is a body movement produced by muscles that requires energy[2]. Stunting conditions do occur in the first 1.000 days of life, due to lack of intake when the child is still in the mother's womb. However, this condition worsens after the child is born and the intake of nutritious food is not met. Lack of nutritional intake can reduce the child's immunity so that the child is easily infected, and this condition worsens the stunting condition. The prevalence of stunting in children in 2021 was 24.4%. The stunting rate in Cirebon Regency was 30.6%, above the national prevalence.

Child nutrition is still a problem in developing countries, including Indonesia. This tends to get worse with the occurrence of multiple problems because malnutrition has not been resolved.[3] One of the causes of nutritional disorders in children is malnutrition. Several contributing factors include direct or indirect causes. Nutritional problems can come from deficiencies of certain nutrients, inadequate eating patterns, or the composition of the proportions of food consumed is not appropriate. Therefore, children who are malnourished can experience nutritional disorders such as stunting.[4] Macronutrients are essential nutrients needed in relatively large amounts (macro amounts) for the body. Macronutrients consist of carbohydrates, proteins and fats. Each provides a different energy for the body. Carbohydrates and protein provide about 4 calories per gram of energy, while fat provides about 9 calories per gram of energy.[5] Protein is found throughout the body including muscles, bones, skin, hair, and almost every other part or tissue of the body. Proteins also make up enzymes that drive many chemical reactions and hemoglobin which carries oxygen in the blood.[6] Fat is the highest source of calories. The calories produced by fat can be stored in the body.[7] Carbohydrates are a source

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of energy, also play a role in the function of body tissues, help regulate protein metabolism, and affect fat metabolism. Carbohydrate storage in the form of glycogen is an energy reserve that is useful for protecting cells, especially brain cells from stress, injury and metabolic functions.[8]

Vitamins are organic nutrients that are required in small amounts for a variety of biochemical functions and are generally not synthesized by the body and therefore must be supplied from the diet.[9] Vitamin A is an essential nutrient that the body needs for growth and disease resistance. Vitamin A has a provitamin namely carotene. In vegetables, vitamin A is found as a provitamin in the form of the yellow pigment ß-carotene.[10] The need for vitamin E increases with increasing intake of polyunsaturated fats, mineral oil intake, exposure to oxygen or various diseases. Inefficient absorption of fat will cause a deficiency of vitamin E which causes neurological symptoms.[11] Some vitamins are water soluble, a deficiency state of these vitamins can cause beriberi (thiamine deficiency), cheilosis, glossitis, seborrhea, and photophobia (riboflavin deficiency), pellagra (niacin deficiency), peripheral neuritis (pyridoxine deficiency), megaloblastic anemia, aciduria methylmalonate and pernicious anemia (cobalamin deficiency), megaloblastic anemia (folic acid deficiency), and scurvy (vitamin C deficiency).[12]

Apart from vitamins, minerals are also known, which are essential nutrients that the body needs in small amounts. Minerals contained in vegetables and fruits such as magnesium, phosphorus, potassium, and zinc can act as antioxidants and counteract bad compounds in the body.[13] Minerals are classified into 2 main groups based on their needs, namely macro minerals (macro-elements) and micro minerals (trace elements).[14] The body's immunity can be strengthened by consuming balanced nutrition and increasing the consumption of vegetables and fruit, because they contain vitamins and minerals, vegetables and fruits[15]. Seeing the high number of stunting in the Tegalwangi locus, Cirebon Regency, the researcher was interested in looking at the comparison of nutritional intake between stunted and non-stunted children This study is a comprehensive result of the nutritional recall entered in the Nutrisurvey application. Previous research revealed one vitamin and mineral, not the entire nutritional intake. This study was to compare the intake of macronutrient (protein, fat, and carbohydrats), vitamins (A, E, B1, B2, B6, C, folate), and minerals (sodium, potassium, magnesium, calcium, phosphorus, iron, and zinc) between stunted and non-stunted children.

MATERIALS AND METHODS

Study design and Sampling

This study used an analytic observational method with a cross-sectional design.

Location and Time

The research was conducted in the stunting locus area in Cirebon from January to May 2023. Permits were obtained from National Unity and Politics, the Cirebon District Office, Weru District Office, andTegalwangi Office to conduct the research. Research ethics permit was obtained from the Health Ethics Commission with license number 003/KEPK/EC/III/2023

Participants

Subjects were recruited between January and May 2023. Basis for recruitment is a list of names of stunted and non-stunted toddlers who live in Tegalwangi Village, Cirebon. The list of names and addresses of the toddlers was obtained from data from the Karangsari Health Center, where Tegalwangi is included in its working area. The number of samples used was calculated using www.openepi.com. The inclusion criteria were toddlers aged 2-5 years, The requirement for parents is to agree to their child being a research subject. They were interviewed regarding the 3x24 hour food recall questionnaire.

Study Instrument

The instruments used included a 3x24 hour food recall questionnaire, menu display book published by Department of Health and for parents who stated that they agreed to have their son/daughter as a subject they were then asked to sign an informed consent. This book contains pictures of food menus complete with measurements of the cutlery used and the calories they contain. Children who were willing to be subjects were then measured for height and weight, while parents/guardians were interviewed to fill out a 3x24 hour nutrition recall questionnaire. The results of the nutrition recall questionnaire were transformed into Nutrisurvey software, which was used to gather consumption data and compare the intake of vitamins, minerals, and macronutrients by stunted and non-stunted children. The mother also fills in the child's biodata including name, date of birth and gender. Furthermore, stunted and non-stunted children were measured for height and weight. Age, sex, height and weight data are entered into the application and the results of the measurements of height

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and weight are then determined by the z-score of height for age and weight for age. After filling in the biodata, the parents will write down the food and drinks their child consumes for 3 days. The results of the questionnaire will be entered into the Nutrisurvey application to convert them into nutrient intakes.

Data Analysis

Statistical analysis bivariate analysis paired sample t test (95% CI) using Statistics Package for the Social Sciences (SPSS) version 21.0.

RESULTS

The number of stunted children in Tegalwangi with an age range of 2-5 is 67 children. There are 50 parents who allow their children to be research subjects. To standardize the number of samples, 50 children who are not stunted are also taken with the same age range.. The 100 children were measured for height and weight. Mothers from the research sample filled out their mother's biodata, including name, age, and last education.

Table 1. Characteristic and Anthropometry of Children Under Five Years

Characteristic and Anthropometrics	Stunted Children f (%)	Non Stunted Children f (%)
Gender		
Boys	21 (42)	29 (58)
Girls	29 (58)	21 (42)
Age of Children		
2-<3 years	16 (32)	16 (32)
3-<4 years	13 (26)	19 (38)
4-<5 years	21 (42)	15 (30)
Mother Education		
Primary school	13 (26)	1 (2)
Junior high school	17 (34)	0 (0)
Senior high School	18 (36)	22 (44)
College	2 (4)	27 (54)
Weight-for-age z-score (WHO)	-2,45±1,45	-0,63±0,75
Severely underweight	2 (4)	0 (0)
Underweight	18 (36)	0 (0)
Normal	30 (60)	50 (100)
Height-for-age z-score (WHO)	-2,32±1,13	-0,59±0,93
Severely stunted	5 (10)	0 (0)
Stunted	45 (90)	0 (0)
Normal	0	50 (100)

[1] Data are presented as n (%) or Mean ± SD

In Table 1 it can be seen that the greatest frequency of stunting in children is in the age range of 2-5 years (42%), followed by ages 2-<3 years (32%) and finally aged 3-<4 years (26%). For the group of children who are not stunted, the highest frecuency is in the age range of 3-<4 years (38%), followed by ages 2-<3 years (32%) and finally aged 3-<4 years (30%). Based on gender, for the stunting group, the boys (58%) were more numerous than the girls (42%). Meanwhile, for the group of children who are not stunted, the girls (58%) have a higher ratio.

The highest frequency for mothers of stunted children has senior high school education (36%), while for mothers with non-stunted children the highest education level is tertiary education (54%) . Based on the

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height for age in the group of stunted children, most of them are short compared to very short. The mean of height for age for stunted children is obtained -2,45±1.45 and for the group of children who are not stunted is 0,63±0,75. Meanwhile, based on weight for age, 2 stunted children were severely underweight, and 18 were underweight. In the group of children who were not stunted, all had normal nutritional status. The mean of weight for age for stunted children is obtained-2,32±1.13 and for the group of children who are not stunted, it is -0,59±0.93.

Intake of macronutrients (protein, fat, carbohydrates), vitamins (A, E, B1, B2, B6, C, folate), and minerals (sodium, potassium, calcium, magnesium, phosphorus, iron, zinc) will be grouped again based on the standards of the Minister of Health regulations for toddlers 2-5 years. The results of intake of stunted and non-stunted children will be entered into their respective groups.

Table 2. Assess Intake Of Macronutrients, Vitamins And Minerals

Nutritional intake criteria	Nutrition Adequacy Standards	Stunting (n=50) Mean±SD (A/L)	Not-stunting (n=50) Mean±SD (A/L)	p value
Macronutrient				
Protein	20-25 g	34,422 ± 15,374 (E)	46,992 ±24,905 (E)	<0,001
Fat	45-50 g	38,863 ± 24,909 (L)	51,206 ±25,589 (E)	0,029
Carbohydrate	215-220 g	152,222 ± 67,099 (L)	177,604 ±66,654 (L)	0,074
Vitamin				
Vitamin A	400-450 RE	259,350 ± 415,575 (L)	591,000 ±73,498 (E)	0,004
Vitamin E	15-20 mcg	2,751 ± 3,349 (L)	4,300 ±4,375 (L)	0,062
Vitamin B1	0,5-0,6 mg	0,284 ± 0,195 (L)	0,420 ±0,358 (L)	0,024
Vitamin B2	0,5-0,6 mg	0,749 ± 0,478 (E)	2,104 ±0,588 (E)	0,273
Vitamin B6	0,5-0,6 mg	0,478 ± ,2937 (L)	0,710 0,372 (E)	0,002
Vitamin C	40-45 mg	67,468 ± 36,636 (E)	40,718 ± 46,650 (E)	0,003
Folat	160-200 mcg	22,896 ± 45,336 (L)	87,756 ± 74,610 (E)	<0,001
Minerals				
Sodium	800-900 mg	376,567 ± 310,850 (L)	494,704 ± 54,866 (L)	0,199
Potassium	2600-2700 mg	829,000 ± 661,401 (L)	1194,354±109,324 (L)	0,058
Calcium	600-1000 mg	421,182 ± 484,784 (L)	604,490 ±906,658 (E)	0,193
Magnesium	65-95 mg	100,582 ± 52,696 (E)	139,472 ±79,997 (E)	0,011
Phosphorus	460-500	548,493 ± 381,631 (E)	723,498 ±683,416 (E)	0,130
Iron	7-10 mcg	4,422 ± 6,214 (L)	7,665 ± 8,757 (E)	0,047
Zinc	3-5 mg	2,701 ± 2,222 (L)	5,290 ±3,972 (E)	0,021

Data are presented as Mean ± SD (adequacy criteria compared to standards, A= Adequate, E= Enough, L=low). Calculated using the t-test

The average intake results from various intake criteria can be seen in Table 2. Meanwhile, to see the number of intake criteria that meet or do not meet the nutritional adequacy rate can be seen in Figure 1.

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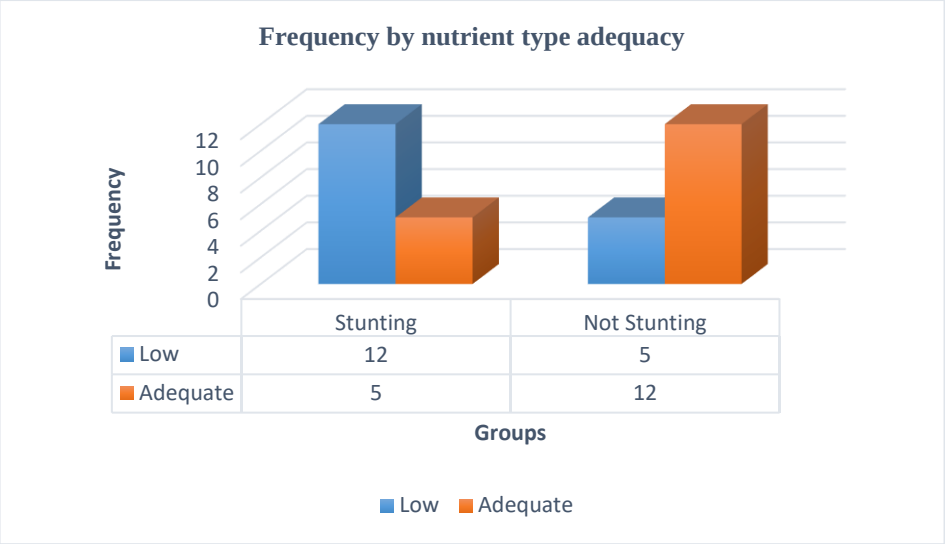

Figure 1. Bar Chart of Nutritional Adequacy of Stunted and Non-Stunted Children

DISCUSSION

Description Relating to The Research Subject

The characteristics of stunted children show that most of the group is aged 4-5 years and the group of children who are not stunted is aged 3-4 years. In this study, the number of stunted children was higher than the number of girls. Boys tend to be more physically active so they spend more energy on activities and not for growth.[16] In addition, boys generally grow faster after going through puberty, while girls generally experience faster growth than boys before. and during puberty.[17]

The education and knowledge characteristics of the mothers of stunted children show that some of the mothers of stunted children with high school education status have a lower level of knowledge than the mothers of non-stunted children. The level of a mother's knowledge is the key in managing the household, this will affect the attitude of the mother in choosing food ingredients that will be consumed by the family.[18] Mothers with good nutritional knowledge will understand the importance of good nutritional status for health and well-being.[19]

Description Related to Nutritional Intake

Protein intake between the two groups met the nutritional adequacy rate of 20-25 g. In contrast to previous research the insufficient level of protein sufficiency in children under two years of age ($p<0.001$) has a risk of 6.495 times experiencing stunting with the least risk being 2.367 times and the highest being 17.820 times compared with children who have a sufficient level sufficient of protein. For the fat intake of the stunted group, it was below standard, while the group of children who were not stunted had met the nutritional adequacy rate. In line with previous research that lack of fat intake in toddlers can lead to the absorption of vitamins A, D, E and K becoming less than optimal. Carbohydrate intake of 2 groups below the nutritional adequacy rate of 215-222 g. Carbohydrates are an important source of energy for growth and development. Research in the Sumatra area shows that a child with low fat intake will have a 1.30 times higher risk of experiencing stunting. This research also inconsistent with the research conducted in Bangkalan district which shows that low levels of carbohydrate intake will be associated with a 1.7 times the higher incidence of stunting.[20]

In this study, the intake of vitamin A in stunted and non-stunted children had different average amounts. The average intake of vitamin A in children with stunting is 285.3 RE. Meanwhile, the average intake of vitamin A in children who are not stunted is 591 RE. The value of vitamin A intake in children aged 2-5 years is 400-450 RE according to Regulation of the Minister of Health Number 28 of 2019. The results of the analysis show that there is a significant difference in vitamin A intake between stunted and non-stunted children. Children who experience vitamin A deficiency will potentially experience 1,002 stunting events. Similar research on stunted children showed that the vitamin A intake of stunted children was lower than that

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of other normal children Vitamin A is an important nutrient that the body really needs for growth and body resistance to disease.[21] It can reduce morbidity and mortality, because vitamin A can increase the body's resistance to infectious diseases such as measles, diarrhea, and ARI (Acute Respiratory Infection).[22]

Intake of vitamin E in 2 groups was below the nutritional adequacy rate of 15-20 mcg.. Similar research by Aritonang et al. found that vitamin E intake in stunted children was low. Given the importance of this intake to maintain the immune system and antioxidants from the outside, its deficiency will reduce the child's immune system Vitamin E deficiency is very rare in humans as it is unlikely to be caused by a diet containing low vitamin E. Instead, it is likely to be caused by irregularities in the absorption or metabolism of dietary fats.[23] Vitamin B1 intake of both groups was below the nutritional adequacy rate. Thiamine (vitamin B1) is an essential water-soluble vitamin that plays an important role in energy metabolism. Its deficiency presents a wide variety of clinical problems, referred to as thiamine deficiency disorders (TDD), which affect the metabolic, gastrointestinal, neurological, respiratory, cardiovascular, and musculoskeletal systems.[24]

The study conducted by Sanin in Bangladesh found that micronutrient adequacy could not be used as a parameter to significantly predict stunting among toddlers normal toddlers due to poor micronutrient adequacy overall it occurs in stunted toddlers and toddlers normal toddlers at the age of 12-24 months.[20] The average calcium intake for stunted children was 421,182 mg, lower than the calcium intake for stunted children of 604.490 mg. These results are the same as previous studies where there was a very significant difference in calcium intake between stunted and for non-stunted children aged 24-49 months in Pontianak. An intake of micronutrients, in this case calcium, greatly affects the growth of children's bones.[26] Low calcium intake will affect the formation of mineral constituents of the matrix of new bone deposits that affect osteoblasts, if a child has a severe deficiency it can cause stunting.[27] Low calcium intake can cause stunting events by 0.996 times when compared to the group with sufficient calcium intake.[28] However, it is very necessary to provide nutrition education to mothers who provide family meals so they can select food ingredients that contain high calcium, not necessarily from milk but can be obtained from fish and green vegetables, so that children's calcium intake can meet the recommended nutritional adequacy rate.[27] Low iron intake in children can cause problems, where iron is needed in the formation of hemoglobin. Previous research also said that a lack of iron intake is a factor in the occurrence of stunting[4]. Zinc intake in stunted children obtained an average of 2.95 mg with a standard value lower than the RDA set by the government.[30] The results of the study on stunted children concluded that the zinc intake of stunted children was lower than that of non-stunted children. More sufficiency level zinc is indeed not in accordance with the theory which states that stunted children experience zinc deficiency.[31] Low intake of zinc can cause zinc levels in the body to be low and experience stunting 2,520 times because zinc plays a role in children's linear growth.[32] Zinc is also associated with important hormones involved in bone growth such as samatomedin-C, osteocalcin, testosterone, thyroid hormone and insulin[27]. Zinc plays an important role in growth and the immune system. Zinc is known to play a role in more than 300 enzymes, both as part of their structure and their catalytic and regulatory actions.[33] Children with zinc deficiency may experience suboptimal growth, diarrhoea, and decreased immune function. Therefore children with zinc deficiency can be given supplementation in order to have better growth because consumption of zinc can stimulate appetite, increase energy intake and increase fat-free mass in the body.[34]

Cases of stunting in children can be used as a predictor of the low quality of a country's human resources. Efforts have been made by the government to provide information related to health and nutrition.[35] Health and nutrition are among the essential needs of early childhood that must be met, with this it is hoped that children can grow and develop optimally according to their age group.[36] The nutritional status of children greatly influences the quality of human resources. Child intelligence is related to nutrition. The intake of nutrients that children receive greatly influences the development of their intelligence[37]. Nutritional status and children's health are negatively correlated with decreased intake of nutrients received. Infants and children who are malnourished, especially those who are less than five years old, may experience decreased physical growth and intelligence. The growth of brain cells is very fast, and at the age of four to five years, it will stop or reach the perfect stage[4].

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CONCLUSIONS

Analysis of differences in the intake of the two groups found that there were no significant differences in the intake of macronutrients carbohydrates, vitamins (E, B2) and minerals (sodium, potassium, calcium and phosphorus) with $p>0.05$, and significant differences in the intake of macronutrients (protein, fat). vitamins (A, B1, B6, C, folate), and minerals (magnesium, iron, zinc) with $p<0.05$.

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