Modern Clinical Medicine Research, Vol. 3, No. 1, April 2019
https://dx.doi.org/10.22606/mcmr.2019.31001

Relation of Food Consumption and Nutritional Adequacy to Nutritional Status of Children with Cerebral Palsy

Marina Indriasari[1], Hardinsyah[1], Lilik Kustiyah[1], Ferial Hadipoetro[2]

[1] Department of Community Nutrition, Faculty of Human Ecology, Bogor Agricultural University, Bogor 16680, Indonesia

[2] Faculty of Medicine and Health University of Muhammadiyah, Jakarta, 15419, Indonesia
Email: indriasarimarina@gmail.com

Abstract. Nutritional problems in children with cerebral palsy (CP) may occur due to inadequate dietary intake. This study aimed to identify food consumption and nutritional adequacy in relation to the nutritional status. This study used a cross-sectional design which was conducted in Special Schools at Jakarta, Depok and Bogor.The subjects were selected by purposive sampling, i.e., CP children aged 5-18 years. The data collected included the subjects' characteristics through questionnaires, food consumption by 1x24-hour food record method, and nutritional status assessed from body mass index (BMI)-for-age. The results of this study showed that about 45% of CP children were 6-12 years old and there were more boys than girls. Approximately 65% of CP children had eating frequency of three times a day with a protein adequacy level of 81,1%. There were 64,4% of CP children with thin nutritional status. Zinc and vitamin C adequacy levels had significant associations with nutritional status.

Keywords: Cerebral palsy, food consumption, nutritional adequacy levels, nutritional status.

1 Introduction

Food consumption is the amount or quantity of food -- either single or diverse -- consumed by individuals or a group of individuals that aim to meet the physiological, psychological, and sociological needs. The physiological goals are to fulfill the desire to eat (hunger) and to meet the nutrients required by the body. The psychological goal is to fulfill emotional satisfaction or taste while the sociological goal is to maintain an interpersonal relationship within family and society. Food consumption is a major factor in fulfilling the nutritional requirements that provide energy for the body, regulate the metabolic process, and repair body tissues as well as useful for growth. Consumption, quantity, and type of food are influenced by many factors. [1]

In terms of quantity, the improper food consumption will affect the nutritional adequacy of individuals which can be measured quantitatively through the nutritional adequacy level (NAL) ratio. NAL is the percentage obtained from the ratio of the total intake of each nutrient to the recommended dietary allowance (RDA) according to age and sex.[2]

Nutritional status is an expression of the state of individual nutritional balance to the fulfillment or non-fulfillment of individual nutritional intake requirement associated with the function of the nutrients themselves such as for growth, maintaining body composition, and maintaining the body function in a normal state. The balance of nutritional status can be achieved through three processes, namely reduced intake, increased requirement, and changes in the utilization of nutrient intake. Anthropometry is one of the indicators used to measure the state of nutritional balance.[3]

Cerebral palsy (CP) is one of the developmental disorders in children that results in eating difficulty other than the motor, cognitive, motion control, and neurological disorders. The motor disorders experienced by CP children lead to feeding disorder, chewing disorder, swallowing disorder, and hyperactive reflexes that cause difficulties in controlling body posture or motor skills (fine and gross) on food consumption patterns.[4]

These problems cause an effect on the growth, development, and nutritional status of CP children. These factors cause the CP children to become undernourished, even suffering from severe malnutrition. Severe malnutrition in CP children makes them vulnerable to infection which results in growth failure

state. Thus, eating difficulties in CP children may influence their growth, development, and nutritional status.[5]

According to Paneth [6], the incidence of CP worldwide ranges from 1,5 to 2,5 children per 1.000 births. Nutritional status will affect the condition of CP children. Their nutritional status can be assessed from body weight, body height, body mass index (BMI), and mid-upper arm circumference.[7] According to World Health Organization (WHO)[8], the age of children is categorized in the range of 1 to 18 years old with different nutrient requirements. The Basic Health Research (BHR) reported that the data regarding the nutritional intake adequacy of children with disabilities were only in the age range of 24 to 59 months with the incidence rate for CP children of 0,09%.[9]

The CP incidence in Indonesia has not been clearly reported. However, there are reports from several health agencies in Indonesia such as Institute for Physically and Mentally Handicapped Children (IPMHC), Surakarta Branch that reported 198 CP children in 2007 and IPMHC Semarang Branch which reported 232 CP children in 2006. In 2003, there were 20% severely malnourished CP children. IPHMC Surakarta recorded the number of CP children that continued to increase year after year.[10] This study aimed to identify the food consumption and nutritional adequacy in relation to the nutritional status of CP children in Jakarta, Depok, and Bogor.

2 Methods

2.1 Design, Location, and Time of Study

This study used a cross-sectional design, and it was conducted in 10 Special Schools (SS) and IPMHC in Jakarta, Depok, and Bogor cities. The study was conducted for three months, from November 2016 to February 2017.

2.2 Number of Subjects and Sampling

The population in this study was CP children in SS and IPHMC in the city of Jakarta, Depok, and Bogor selected by purposive sampling. The inclusion criteria in this study were CP children aged 5-18 years, did not have an infectious disease, and could communicate well. A total of 45 subjects were selected for this study.

2.3 Data Types and Collection Methods

The data collected in this study were subjects' characteristics (age and sex), food consumption (food type, daily eating frequency, amount of food consumption, and supplementation), and BMI (body weight and height). The data collection was conducted by filling out the questionnaires and interviewing the subjects' parents or caregivers. The subjects' food consumption was assessed by 1x24-hour food record method. BMI was measured by an anthropometric method with a BMI-for-age indicator according to WHO criteria. The body height of the CP children was calculated by using knee-height estimation formula.

2.4 Data Processing and Analysis

The data were processed and analyzed using Microsoft Excel and SPSS for Windows. The subjects' characteristics data were presented descriptively. The subjects' food consumption data in household size units were converted into grams and then converted into energy, protein, fat, carbohydrates, and micronutrients intakes by using Nutrisurvey 2016 program. Nutritional adequacy level was calculated by using the ratio of subjects' nutritional intakes to RDA based on age and sex. The data were then processed using Microsoft Excel and SPSS programs. The statistical analyses used were Spearman correlation and chi-square tests. The tests were performed to analyze the association between nutritional adequacy level and subjects' nutritional status with a significant level of 0,05.

3 Results and Discussion

3.1 Subjects' Characteristics

The subjects' characteristics in this study which included age and sex were presented in Table 1.

Table 1. Distribution of subjects' characteristics sizes of headings.

Characteristics	N	%
Age (years)		
< 6	11	24,4
6 - 12	20	44,4
> 12	14	31,2
Sex		
Boys	27	60
Girls	18	40

The study results showed that CP incidence (44,4%) mostly occurred at the age of 6-12 years. The subjects consisted of 27 boys (60%) and 18 girls (40%). The results of this study were in line with the study conducted by Mardiani who reported that CP incidence in boys was more common than girls.[11] The study conducted by Oskoui et al.[12] also reported that the CP incidence occurring in Europe was 1.3 times more common in boys.[12]

3.2 Food Consumption

Food consumption describes the way the individual or a group of individuals consume food based on the amount or type of food consumed. Food consumption patterns include the eating frequency, type of food, and amount of food. The eating frequency of the CP children in this study was presented in Table 2. The study results showed that the main meal frequency of the subjects ranged from two to four times a day. Most of the subjects had the habit of eating the main meal three times a day (64,4%) and the habit of eating snacks once a day (66,7%).

Table 2. Daily eating frequency of CP children.

Frequency (times/day)	Main meal		Snacks	
	n	%	n	%
0	0	0	9	20
1	0	0	30	66,7
2	12	26,7	6	13,3
3	29	64,4	0	0
4	4	8,9	0	0
Total	45	100	45	100

Khomsan has stated that the good main meal frequency is three times a day to avoid gastric emptiness. It is recommended so that the individual can meet his nutritional requirements properly. Not only enough amount of food, but the regular meal time is also important so that the nutrients of the food consumed can be well-absorbed.[13]

The types of food consumed by CP children daily presented in Figure 1 indicate that the types of food consumed mostly by them as the highest source of carbohydrates are rice (100%) and followed by bread (17,7%) and biscuits (17,7%). The most consumed food sources of animal protein are milk (60%), followed by eggs (57,7%), fish (44,4%), and chicken (42,2%). Food sources of vegetable protein consumed by most subjects are tempeh (31,1%) and followed by tofu (11,1%). The most commonly consumed fruits are papaya (17,8%) followed by oranges (13,3%) and avocado (11,1%). Meanwhile, the most commonly consumed vegetables are soup (51,1%) and followed by spinach (20%).

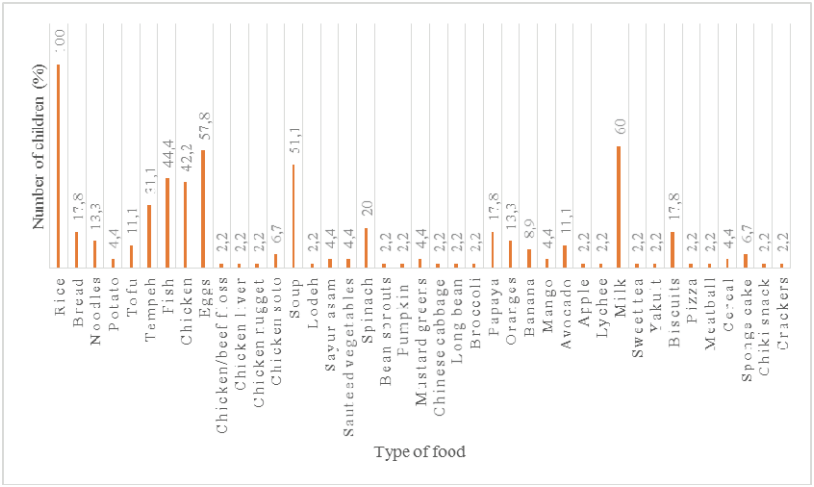

Figure 1. Type of food consumed daily by CP children.

In general, the food consumed by CP children is soft-textured to facilitate the chewing and swallowing processes. The CP children tend to have difficulty digesting solid foods; thereby the recommended foods are in the puree form.[14] Based on the snacks of the CP children, most of them preferred sweet taste (68,9%) than salty taste (31,1%). The commonly consumed snacks were biscuits (17,7%), sponge cake (6,7%), and sweetened drinks such as sweet tea (2,2%).

Children generally love sweet taste. De Camargo and Antunes have stated that the CP children with excessive consumption of sweet foods, especially those with low socioeconomic status, have untreated dental caries. Dental caries may affect the function of oral movements in CP children, thereby affecting the intake of the food consumed.[15]

3.3 Nutritional Status

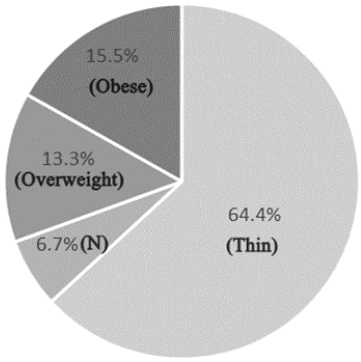

Figure 2. Percentage of CP children with their nutritional status.

One of the nutritional status measurements is conducted by the anthropometric method through BMI calculation. Regarding the anthropometric standards for nutritional status assessment of children, Ministry of Health explains that BMI-for-age can be used for children aged 5-19 years by using Z-score.[16] In this study, it was found that the nutritional status of CP children based on BMI-for-age category were as follows: 64,4% of children were classified as thin, 6,7% of them were normal, 13,3% of them were overweight, and 15,5% of them were obese. The results were in line with the study conducted by Mansur and Sulistyawati who identified 61,1% of CP children who were severely thin.[17] The study was reinforced by Sugiarto who found that almost all the CP children received lower calorie intake than higher protein intake, causing most of them to be undernourished.[10] There were more thin CP children

than obese CP children. It was in line with a study by Tuzun (2013) who found that the prevalence of undernourished CP children was higher than overweight CP children, either among boys or girls.[18]

3.4 Nutritional Adequacy Level

Mean adequacy levels of energy, protein, carbohydrates, and fat were 62,3%, 81,1%, 66%, and 53,4%, respectively. Nutritional adequacy levels of the subjects were still below 100% RDA. According to Ministry of Health (2013), the mean energy, carbohydrates, and fat adequacy levels were classified as a severe deficiency (<70% RDA) while protein adequacy level was classified as a mild deficiency (80-89% RDA).[19] These results were in line with a study by Sullivan et al.[20] who studied the nutritional intakes of 100 children with neurological disorders. The study stated that energy was the main nutrient that tended to be deficient while the protein intake was classified as normal. Energy intake was related to mobility and activity level in which the calculation of energy adequacy on subjects in this study was compared to RDA values. Therefore, it is possible that the energy requirement of children with disorders (especially neurological disorders) is lower than normal children in general. However, the accurate nutritional requirement for children with disabilities which has not been found makes the use of RDA value as a standard reference to be less precise to describe the nutritional adequacy of children with neurological disorders.

CP children are at risk of undernutrition due to posture and oral motor disorders which may cause difficulty in chewing and swallowing.[21] The nutritional requirement of CP children must be met orally either quantitatively or qualitatively so that no aspiration complications occur. Adequate protein intake is important for the growth and the repair of adipose and muscle tissues. The recommended protein intake of 20 g/kg/day can increase energy by 20%. It is needed to increase body weight and improve the nutritional status of CP children.[22]

Table 3. Energy and nutrients adequacy levels of CP children.

Energy and nutrients	Adequacy levels (%)
Energy	62,3
Protein	81,1
Fat	53,4
Carbohydrates	66,0
Vitamin A	136,2
Vitamin D	35,7
Vitamin E	40,1
Vitamin B1	43,6
Vitamin B2	63,7
Folic acid	31,1
Vitamin C	69,5
Calcium	30,4
Iron	40,8
Zinc	41,3
Copper	0,10
Phosphorus	77,0

Mean adequacy of vitamin A, D, E, B1, B2, C, folic acid, calcium, iron, and zinc were 136,2%, 35,7%, 40,1%, 43,6%, 63,7%, 31,1%, 69,5%, 30,4%, 40,8%, and 41,3%, respectively. The micronutrient with the highest adequacy level in the adequate category ($\geqslant$77%) was vitamin A while the rest were classified as inadequate.[23] Phosphorus adequacy level reached the adequate category although the adequacy of calcium and vitamin D contained in milk as the highest intake of CP children after rice belonged to inadequate category (<77%).[24] Oxalate content in spinach that was widely consumed by CP children after vegetable soup might affect the biological availability of calcium from food.[25]

The presence of micronutrient deficiency was in line with the study of Sullivan et al.[20] and Hillesund et al.[26] who reported the calcium, iron, zinc, vitamin C, vitamin A, riboflavin, and thiamine deficiencies

in CP children. The low mean micronutrient adequacy of the subjects could be caused by the food selection. In this study, red meat was not one of the major sources of animal protein consumed by the subjects. Red meat is a food source of iron and zinc that can certainly improve the deficiency state of these two micronutrients. It can be due to the dense texture of the red meat. Thus, it is avoided by the CP children who have problems in chewing and swallowing.[14]

3.5 Association between Nutritional Status and Nutritional Adequacy Levels

Association between variables (i.e., BMI-for-age and nutritional adequacy levels) was presented in Table 4.

Table 4. Association between nutritional status and nutritional adequacy levels.

Energy and nutrients	p-value[1]	p-value[2]
Energy	0,752	0,429
Protein	0,417	0,157
Fat	0,451	0,593
Carbohydrates	0,914	0,311
Vitamin A	0,976	0,460
Vitamin D	0,535	0,169
Vitamin E	0,326	0,746
Vitamin B1	0,528	0.746
Vitamin B2	0,285	0,460
Folic acid	0,857	0,667
Vitamin C	0,008*	0,167
Calcium	0,077	0,561
Iron	0,243	0,184
Zinc	0,037*	0,268
Copper	0,846	-
Phosphorus	0,384	0,461

[1] Association between BMI and nutritional adequacy levels (Spearman),

[2] Association between BMI and nutritional adequacy levels (chi-square)

The results of Spearman correlation test between BMI and nutritional adequacy levels showed that BMI had a significant correlation with zinc (sig. p=0,037) and vitamin C (sig. p=0,008) adequacy levels. This result was not in line with the results of correlation analysis using chi-square test. The results of correlation test using chi-square indicated that none of the variables were related. The chi-square test was not even able to analyze the copper adequacy level because all the subjects fell in the copper deficiency category when the copper adequacy level was categorized. Therefore, all the categories of copper adequacy levels for all subjects were in a consistent state.

The significant correlation between BMI and zinc adequacy level was in line with a study by Dewi and Nindya who found a significant relationship between zinc adequacy level and stunting.[27] Zinc is nutrient that functions in tissue formation. It can affect linear growth. Thus, if the zinc adequacy level is inadequate, it will affect the linear growth inhibition. In the study conducted by Muchlisa et al.[28], there was a significant association between zinc intake and BMI-based nutritional status. Zinc influences the child's cognitive, motor, and behavioral development. Zinc deficiency may lead to delays in child development and growth. In the study conducted by Faisal, there was no significant association between zinc and nutritional status based on the height-for-age indicator. Meanwhile, there was a significant association between zinc and nutritional status based on BMI-for-age.[29]

The significant result between vitamin C intake and BMI in this study was not in line with the study conducted by Purnakarya et al.[30] who found no significant association between vitamin C intake and nutritional status because the mean intake of vitamin C was below the recommended mean intake. In the study conducted by Faisal, there was no significant association between vitamin C intake and nutritional status, either based on BMI-for-age or height-for-age indicators.[29] Vitamin C which

functions as a coenzyme and cofactor is related to the collagen formation. Collagen is a protein compound which affects the integrity of cell structure in all connective tissues in the body. In this study, it was found that vitamin C adequacy level had a significant correlation with nutritional status due to the high intakes of fruits and vegetables of the CP children. The fruits and vegetables were soft-textured, thereby making it easier for CP children to chew and swallow these types of food. This result was in line with the study of Gisel et al.[14]

The insignificant results on the correlation between most nutrients and nutritional status especially BMI were in line with the study of Rosmalina and Ernawati who found that there was no association between micronutrients and nutritional status.[31] The intake of energy and some macronutrients that did not meet the nutritional adequacy levels had contributed to low intake of micronutrients. This study has a limitation; i.e., the researchers have not used the appropriate RDA for the special requirement of CP children. Thus, further research is needed to be able to describe the RDA for CP children which is close to the actual condition.

4 Conclusion

CP incidence mostly occurred among children aged 6-12 years. It was more common in boys than girls. The subjects' eating frequency ranged from two to four times a day with three times a day main meal consumption and once a day snack consumption. The most widely consumed food sources of carbohydrates, animal and plant protein, vegetables, and fruits were rice, milk, tempeh, vegetable soup, and papaya. Based on BMI-for-age, most of the CP children were thin. The highest macronutrients and micronutrients adequacy levels that could be met by all subjects were protein and vitamin A. The significant results between variables were indicated by the relation of BMI to zinc and vitamin C adequacy levels.

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