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Inadequacy of Macronutrient and Micronutrient Intake in Children Aged 12-23 Months Old: An Urban Study in Central Jakarta, Indonesia

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***Abstract*—**Optimal feeding, including optimal micronutrient intake, becomes one of the ways to overcome the long-term consequences of undernutrition. Macronutrient and micronutrient intake were important to a rapid growth and development of young children. The study objective was to assess macro and micronutrient intake and its adequacy in children aged 12-23 months. This survey was a cross-sectional study, involving 83 caregivers with children aged 12-23 months old in Senen Sub-district, Central Jakarta selected through simple random sampling. Data on nutrient intake was obtained through interview using single 24-hour recall. Repeated 24-hour recall to sub-sample was done to estimate the proportion of nutrient inadequacy. The highest prevalence of nutrient inadequacy was iron (52.4%), followed by vitamin C (30.9%) and zinc (28.8%). Almost 12% children had inadequate energy intake. More than half of children (62.6%) were anemic (25.3% were severely anemic). Micronutrient inadequacy, especially iron, was more problematic than macronutrient inadequacy in the study area.

***Keywords*—**Micronutrient, macronutrient, children under five, urban setting.

I. Introduction

OPTIMAL feeding is very important for young children, especially children under two years of age because of their rapid growth and development. The period from birth to two years of age is the 'critical period' for optimal growth, development, and health because all important aspects of child growth and development happen during the first two years of age. In the first two years, the child is having higher risk to growth faltering, micronutrient deficiencies and also certain illnesses that lead to undernutrition. Any disturbance in this period will affect the life of the children, and it is not reversible [1]. The consequences of undernutrition in children, include a higher risk of childhood morbidity and mortality, not optimal physical growth, poor cognitive and mental development, decreased school performance, have multiple long-term and short-term effects on human and economic development burden [2].

Children aged 12-23 months have a great dependence on the caregivers. They have different phases of child feeding that need special consideration during the transition period. The nutrient needs from breast-milk alone are no longer adequate to fulfill the requirement of children in this age group [3]. Low-quality of complementary foods in which inadequate micronutrient intake, put children aged 12-23 months old in developing countries at high risk for undernutrition. Additionally, children received low-quality complementary feeding is also more susceptible to diarrhea and respiratory infections [4].

Research suggested that complementary feeding practices received by children under two years of age in Indonesia were still inadequate, especially on the micronutrient intake. Children were given the inappropriate type of food, according to their age. Also, the quality (macronutrient and micronutrient) and quantity of complementary food do not meet the recommendations [3], [5].

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II. Methods

A. Data Collection

This study is a cross-sectional study and intended as a preliminary study for further intervention study in Paseban Village, Senen Sub-district, Central Jakarta. Simple random sampling using Nutrisurvey (Generate Random Table) was performed to select the respondents.

The interview was done to 83 caregivers of 12-23 months old children living in 8 hamlets. The interview was conducted using pre-tested and structured questionnaires. The interview took approximately 45 minutes for each caregiver. The interview was conducted in Integrated Health Post (IHP) or caregivers` house. The questionnaires for caregivers consisted of questions on demographic data, caregivers` knowledge and practice in child feeding, food availability, food taboo, food belief, and food preference.

A single 24-hour-recall was also part of the interview to gather information on energy intake one day preceding the data collection. Repeated 24-hour recall was conducted in sub-sample (n=35) based on age group. Hemoglobin assessment was done by using HemoCueHb 201+. One drop of blood was collected in HemoCuemicrocuvette and hemoglobin concentration was read directly in the field. Peripheral blood was obtained from the tip of the middle or ring finger. The assessment was read twice for every child with less than five seconds between two readings. This study was conducted after getting the ethical approval from the Ethical Committee of the Medical Faculty of the University of Indonesia.

B. Data Analysis

Estimation of energy intake from food were calculated and

analyzed using Nutrisurvey2004 and energy from breast milk using WHO guidelines [6] with the average energy intake for children aged 12-23 months old who lived in developing country was 350 kcal/ day.

The cut-off for energy and nutrient inadequacy was based on the 2004 Indonesian RDA (77% RDA for energy and protein intake), EAR (for micronutrients, except iron) and full probability approach [7]. The EAR was calculated by dividing the RDA with EAR conversion factor for each nutrient [7]. The proportion of children with nutrient inadequacy was then calculated using the PC-Side software. The inadequacy of iron was calculated using the full-probability approach because the iron requirement of the children aged 12-23 months was not symmetrical in term of their EAR [7]. Table I shows nutrient requirement of children aged 12-23 months.

TABLE I
NUTRIENT REQUIREMENTS AND RECOMMENDED CUT-OFF ADEQUACY FOR CHILDREN AGED 12-23 MONTHS

Nutrient	RDA[1]	Conversion Factor	Cut-Off Adequacy
Energy (kcal)	1000	-	770**
Protein (g)	25	-	19.25**
Zinc (mg)	8.2	1.2	6.83*
Vitamin C (mg)	40	1.2	33.33*
Vitamin A (µgRE)	400	1.4	285.71*
Calcium	500	1.2	416.66*
Iron (mg)***	8	-	-

[1]Indonesian RDA 2004 [7]; ** 77% Indonesian RDA; *EAR = Indonesian RDA/ conversion factor [7]; ***Full Probability approach [7].

For anemia status, the children were categorized as anemic if their hemoglobin level is less than 11.0 g/dl and severe anemia if less than 9.5 g/ dl [8].

III. RESULTS

A. General Characteristics of Households

In this study, the household is defined as people living in one house and using the same kitchen within a house for daily cooking. Results show that the caregiver was mostly a housewife and graduated from senior high school as presented in Table II.

The major source of money to buy basic food is parents. The majority caregivers of children were housewives. The majority of their time was spent for their children, even though they work outside. For working mothers, they usually do not work for a whole day, and they had alternative caregivers such as husband, parents, or other family.

B. Child Feeding Practices

The majority of children were already given solid food, more than 50% children were still breastfed at the time of the interview, and 31.9% were given mixed of breast milk and formula milk. Almost all children have diverse food intake (consumed >4 food groups) and 69.8% children were given food more than three times a day. Based on dietary diversity group, nuts/legumes was the food group that was least consumed by the children (22.7%).

TABLE II
HOUSEHOLD'S CHARACTERISTICS

Variables	Caregiver n=83
	n (%)
Occupation	
Housewife	72 (86.7)
Private employee	3 (3.6)
Daily Worker	2 (2.4)
Entrepreneur	2 (2.4)
Others[1]	8 (9.7)
Level of education	
Elementary school	11 (13.3)
Junior high school	17 (20.5)
Senior high school	46 (55.4)
University	9 (10.8)
Number of children under five within a house[2]	1 (1 - 4)
Number of household members who earn money[2]	2 (1- 6)
Source of money to buy basic foods[3]	
Parents	72 (86.7%)
Grandparents	3 (3.6 %)
Other Relatives	2 (2.4 %)
Sharing among family	7 (7.3%)

[1]Civil servant, student, entrepreneur

TABLE III
CHILD FEEDING PRACTICE OF THE CHILDREN

Variable	n (%)
Current status of breastfeeding (n=79)	
Yes, still breastfed	45 (54.2)
No, stop breastfed	34 (41.0)
Type of food given at current age (n=83)	
Solid	61 (73.5)
Semi-solid	22 (26.5)
Meal frequency in a day(n=83)	
< 3 times/ day	25 (30.2)
≥ 3 times/ day	58 (69.8)
Min. Snack frequency in a day (n=83)	
< 2 times/ day	45 (54.2)
≥ 2 times/ day	38 (45.8)
Min. Dietary diversity score(n=83)	
Diverse (DDS>4)	78 (94)
Not diverse (DDS ≤ 4)	5 (6.0)

The median intake of energy, protein, vitamin C, vitamin A, and calcium among children was more than the recommended dietary allowance.

TABLE IV
MACRO AND MICRONUTRIENTS INTAKE OF CHILDREN

Macro and micronutrients intake	Indonesian RDA	Median intake (25-75th percentile) n=83
Energy (kcal)	1000	1170.6 (828.8 – 1417.1)
Protein (g)	25	37.2 (24 – 50.8)
Zinc (mg)	8.2	5.3 (3.3-8.6)
Iron (mg)	8	9.7 (5.1-15.6)
Vitamin C (mg)	40	60.8 (38.6-99.9)
Vitamin A (µgRE)	400	115.9 (15.4-386.1)
Calcium (mg)	500	595.7 (279.6-1091.9)

C. Macronutrient and Micronutrient Intake

The highest prevalence of inadequacy was iron intake (52.4%) compared to other micronutrients. Moreover, 12% children had inadequate energy intake. The proportion of energy inadequacy was almost similar to the proportion of protein inadequacy.

Source-food and majority sources of vitamin A among children in this study were carrot, green leafy vegetables, and fortified-food e.g. biscuit. Only half of the children consumed fruits and vegetables as the source of vitamin A.

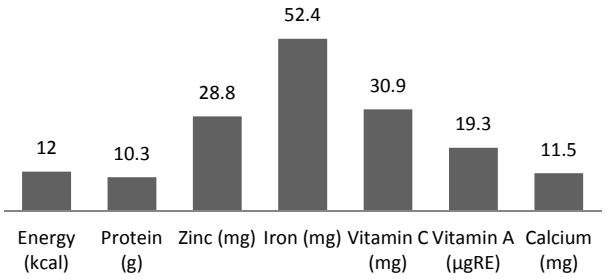

Fig. 1 Proportion of inadequacy of macronutrient and micronutrient intake (n=34). The percent inadequacy of energy and protein were calculated based on 77% of Indonesian RDA. The percent inadequacy of zinc, vitamin C, vitamin A, and calcium were calculated based on EAR. Percent inadequacy of iron was calculated based on full probability approach

In addition, this survey measured micronutrient status of the children, i.e. the hemoglobin status with the average hemoglobin level for boys and girls were 10.12 g/dl and 10.41 g/dl respectively and the mean for total hemoglobin level was 10.27 g/dl.

IV. Discussion

More than 50% children were still breastfed. Continued breastfeeding became an important nutritional contribution well beyond the first year of life. Therefore, after six months of age, while receiving complementary foods, breastfeeding should be continued for up two years of age [9]. Breast milk contributes 35-40% of total energy need for children at 12-23 months. Breast milk contains relatively high fat compared to most complementary food, thus it can be a key source of energy and essential fatty acid [10].

Age 12 months is a period to introduce family food, starting point of age to shift their complementary food from semi-solid, such as mashed rice, rice porridge, and steamed rice, into solid food [13]. How to start and introduce those kinds of food was very challenging. In this study, the majority of children were given solid food, but there were some children (26.5%) who still receive semi-solid food, such as porridge and soft rice because the children refused when the mother gave rise. There were 73.5% of caregivers gave solid food to the child. The consistency of complementary food given has to be appropriate for children's aged 12-23 months old because they should receive a variety of food to ensure proper growth and development [13].

Based on the result of meal frequency, there were more than half of children that have meals ≥ 3 times a day. This is in line with WHO guideline [8] which mentions that children aged 12-23 months old should receive meal at least three times of meals per day considering their requirement and need. Frequency of snack also become an important part for children aged 12-23 months old because offering snack 1-2 times a day can fill the gap between nutrient intake and their requirement [11]. Appropriate meal and snack frequency is needed for young children because the amount of energy required from complementary foods is divided by the number of meals provided and also assumed that the gastric capacity in children aged 12-23 months old is 30g/ kg body weight [13]. Based on this study, there were 45.8% caregivers who gave snacks for the children at least 2 times a day. The majority of children received diverse food from caregivers. Providing a variety of foods will help to ensure their growth and development, their vitamin and mineral will be fulfilled by those variety foods [13].

In this study, 12% and 10.3% children have inadequate protein and energy intake respectively. The higher prevalence of protein inadequacy might be reflected in the high prevalence of protein malnutrition among children [12], [13]. Both nutrients are very important macronutrients for children's growth and development. The rapid rate of growth and metabolic rate during the first year of life is high. Thus protein and energy are needed to fulfill their requirement.

Other nutrition problems that found in this study were micronutrient deficiency e.g. iron, zinc, vitamin C, and vitamin A deficiency that contributed to impair growth and development [9], [14]-[17]. In the first two years of life, growth and development are faster in children, and they need a higher amount of iron. Studies demonstrated that more than half children in this period may suffer from inadequate intake of total iron [5]. This is in line with finding of this study in which52.4% children have an inadequate iron intake. Inadequate intake of iron among children might be associated with the quality and quantity of iron intake. Based on the 24-hour recall, animal source foods, particularly chicken liver, were among the iron source foods of children in addition to green leafy vegetables. However, the amount might be not sufficient to meet the requirement.

Hemoglobin assessment indicated that anemia was a very high public health problem among children in the study area. In this study, boys had a higher prevalence of anemia than girls. Published study mentioned that the higher prevalence of anemia among boys has to do with their higher growth rate. During the boys' growth stage, their bodies need a higher amount of iron which cannot be supplied by the daily diets [16].

One of the main causes of anemia was a low intake of iron sources food [18]. Although direct association between iron inadequacy and prevalence of anemia was not carried out in this study, the study found that the both condition (high percentage of iron inadequacy and high prevalence of anemia) exist among subjects in this study. Absorption of iron is influenced by many factors, such as the presence of enhancer

and inhibitor. One of the enhancers of iron absorption is vitamin C since it may increase the bioavailability of iron [16]. In this study, the inadequacy of vitamin C was found in 30.9% children, and more than 50% of children did not consume fruits and vegetables known as the main vitamin C-rich foods. Also, vitamin A-rich foods were only consumed by 57.8% of children, and almost one in five children had inadequate vitamin A intake. The published study revealed that the inadequacy of vitamin A has a relationship with anemia among children, although the mechanism has not been fully explained [16], [17]. In this study, there were 28.8% children who have inadequate zinc intake. Zinc inadequacy may be associated with immune function and impaired growth and development of children [17], [18].

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