Dietary Assessment of Children under Five using Calculator of Inadequate Micronutrient Intake (CIMI) Approach Study Case in Pandeglang, Banten Province Indonesia

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Abstract: Calculator of Inadequate Micronutrient Intake (CIMI Apps) is software to determine the energy, protein, and micronutrient intakes based on regional dietary patterns. CIMI apps is use to calculate the absolute intake of energy, macronutrients, retinol, ß-carotene, retinol equivalents, iron, and zinc. CIMI represents an informative dietary assessment tool to detect nutrient gaps concerning local eating habits based on the food group classification. Data of 24-hours recall from food intake of 110 respondents of children under five from Pandegelang district, Banten Province Indonesia was analyzed using CIMI. The result was the percentage of nutrients covered through the daily diet of the Children. The dietary pattern in that region is characterized by starchy food (72%), vegetables (12%), and fruits (7%). In addition, a considerable amount of fish and meat were consumed and a very low portion of dairy products. Every second of children had inadequate consumption of energy (55.2 %), iron (50%), zink (53%) and almost all the children have inadequate consumption of vitamin A (98%). The calculation using CIMI delivered information, that on average, the children's needs of energy, iron, and zinc were insufficiently fulfilled through their daily intake and extreme deficiency in the supply of proteins and vitamin A (retinol).

1 INTRODUCTION

The prevalence of undernutrition in Indonesia remains at a very high level. Based on the report of Basic Health Research (Badan Penelitian dan Pengembangan Kesehatan. Kementerian Kesehatan RI, 2007, 2013 and 2018), the prevalence of stunting among children under five years of age in Indonesia were in the range of 30.8% - 36.8%). The proportions were higher than the whole of Southeast Asia (25.7%) and even the prevalence globally (22.2%) (UNICEF, WHO and World Bank Group, 2018) while wasting is about 10.2% – 13.6% and underweight is at 17.7–18.4 %. Some programs have been done to overcome undernutrition through vitamin A supplementation for children and pregnant women, fortification of commonly consumed foods, and promotion of increasing the intake of vitamin and mineral-rich foods (ICN2, 2014; Kemenkes RI, 2018; Budiastutik and Nugraheni, 2018; The SMERU Research Institute, 2015). Unfortunately, they still need innovations that can adapt to the specific situation in Indonesia.

All age groups can be affected by malnutrition, whereas infants, young children, and pregnant or lactating women are the most nutritionally vulnerable groups because of their high physiological and nutritional requirements. Malnutrition by means of undernutrition mostly affects children under the age of five because of their more demanding dietary requirements. Undernourishment in childhood could affect the overall cognitive development, school performance, lifetime earnings, and vulnerability to infectious and chronic diseases in adulthood (higher risk of death and illness) (Global Panel on Agriculture and Food Systems for Nutrition., 2016).

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Malnutrition (which by means undernutrition) is usually correlated with insufficient consumption of nutritious food especially micronutrient deficiencies (FAO, 1992; Stewart CP, Iannotti L, Dewey KG, 2013; World Health Organization and UNICEF, 2019). Micronutrient deficiencies are believed to cause more detrimental effects on physical and cognitive development compared with a calorie deficit and also creates irreversible of failure growth.

Indonesia has plenty of local food resources, including numerous tubers, cereals, beans, fruits and vegetables. Due to the lack of information on the potential uses and the nutrient contents and the stigma of being inferior foods, some of them are underutilized. Many of the underutilized foods are gaining popularity nowadays because they have nutritionally rich compounds, which can be used to combat malnutrition and food and nutrition insecurity (Durst and Bayasgalanbat, 2014) and (Dandin and Kumar, 2016).

Food security includes food accessibility and food availability, was proven to correlate with the prevalence of stunting in Indonesia ((The SMERU Research Institute, 2015) and (BMKG, Kementan, BNPB, LAPAN, BPS, 2017). Data about food consumption is needed to ensure the possible driven factors of undernutrition in Indonesia. Table 1 presents the recommendation of nutrients intake of some of the essential macro and micronutrients for children up to 6 years old in Indonesia.

To assess the nutritional condition and predict the micronutrient deficiency, an express instrument is needed. Calculator of Inadequate Micronutrient Intake (CIMI Apps) has been used for the rapid assessment of micronutrient deficiencies in several countries like Ethiopia (Bosha, Lambert, Riedel, Gola, *et al.*, 2019; Bosha, Lambert, Riedel, Melesse, *et al.*, 2019), Ghana (Philipp *et al.*, 2019) and Indonesia (Radix *et al.*, 2014). This method has advantages compared to clinical testing for blood or urine assay which takes a relatively long time and the action cannot be carried out directly on site.

Table 1. Recommended Nutrient Intake (RNI) Children Under Five in Indonesia.

Nutrition		Unit	Recommended Nutrient Intake (RNI)			
			0-6 months	7-11 months	1-3 years	4-6 years
1	Energy	kcal	550	725	1125	1600
2	Protein	g	12	18	26	35
3	Vitamin A	mcg	375	400	400	450
4	Fe	mg	2.5	7	8	9
5	Iodine	mcg	90	120	120	120
6	Zink	mg	2.75	3	4	5

(Ministry of Health RI, 2013)

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2 METHODOLOGY

Food consumption of 24-h recall was collected from the respondent of children under five and the data was entered into the Calculator of Inadequate Micronutrient Intake (CIMI) program to calculated the amount of energy intake, protein, carbohydrate, fats, iron, zinc, pre-formed vitamin A, carotenoids, retinol equivalents (RE) with a carotenoid conversion factor of 1:6 or 1:12 and percent of total energy intake. The individual data will automatically generate. Percent of the recommended intake of energy, protein, iron, zinc, and vitamin A intake were calculated based on the FAO/WHO age- and sex-specific RNI (Jati *et al.*, 2014).

The data were analyzed using SPSS statistics 22 (IBM, Armonk, NY, USA). The general level of significance was set at $p < 0.05$. The results are expressed in percentages or means-SD/median. Tests applied were the Kolmogorov–Smirnov test, the student's t-test/Mann–Whitney test, and univariate ANOVA/Kruskal–Wallis test.

In order to ascertain amongst which groups a significant difference was found, the Duncan posthoc test was performed, or in case of non-normal data the Mann–Whitney test with subsequent correction of the

alpha inflation (cumulative Type I error) according to Bonferroni. To elucidate associations between two continuous variables, the Pearson/Spearman correlation was applied. Sets of categorical data were assessed by Pearson's chi-square test or Fisher's exact test.

2.1 Ethics Approval and Consent to Participate

As part of the research about the nutritional condition of children under five in Banten, the study conformed to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000). Eligible children were included only on the basis of the informed consent of their caretakers. The baseline study is registered with the study code No: 840/UN6.C.10/PN/2017 at the Health Research Ethics Committee Faculty of Medicine Universitas Padjadjaran Bandung, Indonesia (July 28th, 2017) and approved by the *Badan Kesatuan Bangsa dan Politik* (Board of national and political unity) code No: 070/160-kesbangpol/2017 (Oct 2nd, 2017). Before enrolment, a full explanation of the study purpose was given to the communities, and informed consent was obtained either by signature or thumbprint.

3 RESULT AND DISCUSSION

The study was conducted from 7th October 2017 until 13th October 2017 in two villages Kadomas and Kalanganyar of Banten Province Indonesia. The data was collected from a total of 105 children (aged 7-61 months) of 56 (53.3%) boys and 49 girls (46.7%). In regard to the data collection of 24-h recall, 105 caretakers participated. The main caretakers were mothers (78.2% with 14 are single parents), followed by 18.1 % grandparents and aunty or other relatives (3.7 %). Around 53.3% of children recruited in this study were boys. The majority (76.2%) of the children lived in a nuclear family.

The age of the children (n = 105) was, on average 31.6 ± 16.0 months at baseline with no significant difference in the age distribution between both sexes. The data about the nutritional condition of children under five were explained in another paper.

3.1 Dietary Intake of The Children

Data of 24-h recall of children under five were collected during the household visit and the mother/caretakers were helped to fill the form with the illustration to predict the total consumed foods. Table 2 presents the percentage fulfillment of nutrient consumption which is processed with CIMI apps from data of 24-h recall. Every second of children have inadequate consumption of energy (45%), micronutrient of iron (50%), Zink (53%) and almost all the children have inadequate consumption of vitamin A (98%).

There were no differences in consumption between gender except for iron (p=0.000). The consumption of energy is not significantly different among of age group (p=0.19), while shown to a significant difference for micronutrient iron and zinc (p=0.000). The inadequate consumption of Iron is significantly increasing by the age of children, it is shown that the drastic increase from the age group of 1-2 years to age group 2-3 year from 9% into 21%. Similarly, with the zinc, or the same age group, the inadequate consumption increasing from 10% up to 22% in children age 2-3 years. All the age group has the high level of inadequate consumption of vitamin A, with the highest of the age group 2-3 years as 28%. Table 3 presents the fulfillment of nutrients based on gender and age group of children under five.

The result also confirmed the Fe deficiency was observed in 4.1–8.8% of the children, the percentage of children with dietary intakes of energy, protein, and vitamins A below the Indonesian RNI was high and differed across urban and rural areas and age groups (The SMERU Research Institute, 2015; United Nations Children's Fund (Unicef), 2018). The same finding was also funded in India (Meshram *et al.*, 2012) the health problem among tribal children in India are associated with food security, food intake, socioeconomic condition, literacy of parents, and personal hygiene.

Table 2. Nutrient Intake of The Children Under Five in The Research Area.

Total	n	RNI[a]	Mean	Sd	Median	Min	Max	Adequate* (%)	Inadequate (%)
Energy (kcal)	105	1200	1,196.9	505.9	1,076.6	160.8	2,585.5	58 (55.2)	47 (44.8)
Protein (g)	105	32	33.6	13.6	33.8	4.0	68.2	102 (97.1)	3 (2.9)
Iron (mg)	105	8	4.85	2.8	4.8	0.0	13.1	52 (49.5)	53 (50.5)
Zinc (mg)	105	4	4.9	3.5	4.01	0.4	18.8	49 (46.7)	56 (53.3)
Vitamin A (mg)	105	400	167.8	86.9	164.3	0.0	448.1	2 (1.9)	103 (98.1)

[a](Ministry of Health RI, 2013)

Table 3. The Dietary Intake and Nutrition Fulfillment Based on CIMI.

Total	n	Mean	Sd	Median	Min	Max	Adequate* (%)	Inadequate (%)
by Gender								
Energy (kcal) Boys	56	1,207.1	486.4	1107.3	322.9	2,263.5	32 (57.1)	24 (42.9)
Energy (kcal) Girls	49	1,185.2	528.9	1,007.9	160.9	2,585.6	26 (53.1)	23 (46.9)
Protein (g) Boys	56	33.1	13.3	32.8	9.2	68.2	54 (96.4)	2 (3.6)
Protein (g) Girls	49	34.1	13.9	33.8	4.0	59.5	48 (98.0)	1 (2.0)
Iron (mg) Boys*	56	4.9	2.9	5.1	0.0	13.1	31 (55.4)	25 (44.6)
Iron (mg) Girls*	49	4.8	2.8	4.6	0.7	11.1	20 (40.8)	29 (59.2)
Zinc (mg) Boys	56	4.5	2.9	4.1	0.7	16.6	25 (44.6)	31 (55.4)
Zinc (mg) Girls	49	5.3	3.9	3.9	0.4	18.8	24 (49.0)	25 (51.0)
Vit. A (mg) Boys	56	161.7	82.4	157.0	0.0	401.4	1 (1.8)	55 (98.2)
Vit. A (mg) Girls	49	174.6	91.9	174.8	0.0	448.1	1 (2.0)	48 (98.0)
by Age								
Energy ≤ 2 year	42	1,080.2	256.3	990.6	160.9	2,585.6	19 (18.1)	23 (21.9)
Energy > 2 year	63	1,278.8	495.8	1,187.9	467.3	2,450.5	39 (37.1)	24 (22.9)
Protein ≤ 2 year*	42	28.0	12.8	25.3	4.0	53.1	39 (37.1)	3 (2.9)
Protein > 2 year*	63	37.4	13.4	35.0	12.2	68.2	63 (60)	0 (0)
Iron ≤ 2 year*	42	3.1	2.4	2.6	0.0	7.6	11 (10.5)	31 (29.5)
Iron > 2 year*	63	6.0	2.7	5.3	0.0	13.1	41 (39.0)	22 (21.0)
Zinc ≤ 2 year*	42	2.8	1.9	2.5	0.4	6.6	8 (15.4)	34 (84.6)
Zinc > 2 year*	63	6.2	3.6	5.7	0.66	18.8	41 (64.3)	22 (35.7)
Vit. A ≤ 2 year	42	171.9	56.7	162.0	2.11	314.0	0 (0)	42 (40)
Vit. A > 2 year	63	173.8	92.5	170.6	0.0	448.1	2 (2.0)	61 (58)

*p-values are significant at $p < 0.05$

3.2 Dietary Intake (Food Consumption and Dietary Pattern)

Based on dietary intake and nutrition fulfillment in Table 1, only half (55.2 percent) of the children have the fulfillment of the energy, iron (50.5%) zink (53.3%) while almost all of them (98.1%) have insufficient consumption of vitamin A.

Monotonous food consumption which is dominated by carbohydrate sources (rice, cassava, and bread) and a small portion of vegetables and animal food sources resulted from the poor nutrition of consumption. Children require high value and diversity of food consumption for optimal growth and development. Poor diet always comes out with undernutrition as a result. The study

About the potential of food carrier for micronutrients in Indonesia also found that the low food diversity and less animal source, fruit and vegetables cause the undernutrition in some remote areas in Indonesia (Melse-Boonstra *et al.*, 2000) low divers diet of animal source foods (ASF) (Muslimatun and Wiradnyani, 2016) and dietary diversity and household food security (Pipi, Nanseki and Chomei, 2014) and (Meshram *et al.*, 2012).

The government of Indonesia has tried to improve the micronutrients intake with the regulation of food fortification (Melse-Boonstra *et al.*, 2000; Soekirman, Atmarita and Sanjaya, N. Elhusseiny, 2003) of iron in wheat flour and instant noodle; iodine in salt and monosodium glutamate; vitamin A in oil.

In terms of energy and protein consumption, the majority of Indonesia population has an adequate (60 %) even more than the normative reference on 50 % of food consumption, while the consumption of food derived from tubers, protein from animal sources, fruits, and vegetables are lower than the ideal or normative recommendations (Salim and Basuno, 2010). Furthermore, the quality of food consumption of the Indonesian people is still low due to low food diversification, nutritionally imbalanced, and unsafe cause by high contamination.

4 CONCLUSION

Food consumption of children under five in Banten province Indonesia is dominated by a monotonous diet in which rice is the main source of carbohydrates and a low portion of animal source food, vegetables, and fruits. The fulfillment of energy is sufficient while deficit in micronutrients (vitamins and minerals).

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