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EDITORIAL

Personalized Nutrition: How to make it possible?

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The advancing of economic and technology in the last 1–2 centuries that characterized by industrialization, urbanization, and globalization have changed human lifestyle worldwide. Abundance of food and the ease of getting it, the availability of calorie-dense processed foods, changes in dietary patterns, and sedentary lifestyles force the rapid accretion of the incidence of obesity and non-communicable diseases such as type 2 Diabetes mellitus, cardiovascular diseases (CVD), and cancer. Non communicable diseases (NCDs) are the leading cause of death worldwide, and one of the major health challenges of the 21st century.[1] In 2016, NCDs were responsible for 71% (41 million) of the 57 million deaths which occurred globally. The major NCDs responsible for these deaths included cardiovascular, cancers, chronic respiratory diseases, and diabetes.[2] Many epidemiological, observational, and clinical studies have shown that nutrition, as the main environmental factor, plays a pivotal role in these high-cost degenerative diseases.

Current nutrient intake guidelines are based on population estimates of the nutrient intake required to prevent malnourishment according to sex, age, and other physiological states such as pregnancy and lactation. People with metabolic risk factors or are identified to be have a high risk of NCDs typically get more specific advice based on pathophysiology of the disease. Then they are suggested to adopt one type of dietary patterns that claimed having better impact for health than others, and could prevent the morbidity of NCDs. However, this "one-size-fits-all" approach, was not succeeded on every person. It is known that individual responds differently to nutrients and the genetic factors play an important role in nutrient metabolism. Studying the interactions between nutrition and genetic provides a better insight into the variability in biological response to nutrients, and may explain the underlying inconsistent study results in the field of nutrition research. Study of diet-gene interactions has two approaches, i.e. how nutrition affects gene function (nutrigenomic), and how genetic variation affects nutritional response, food intake, and eating behaviors (nutrigenetic).

The sequencing of the human genome and identification of interactions between genes and nutrients transformed the concept of personalized nutrition. Personalized nutrition can be defined as an approach that uses information on individual characteristics to develop targeted nutritional advice, products, or services to assist people to achieve a lasting dietary change in behavior that is beneficial for health.[3,4] Ordovas et al[3] stated that

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"the overall goal of personalized nutrition is to preserve or increase health using genetic, phenotypic, medical, nutritional, and other relevant information about individuals to deliver more specific healthy eating guidance and other nutritional products and services."

Motivating to change one's dietary behavior is the greatest challenge for any nutrition interventions. Personalized nutrition is based on the concept that individualized nutritional advice, products, or services will be more effective than more conventional generic approaches. The Food4me study, an internet-based personalized nutrition randomized controlled trial that held at 6 country in Europe, showed that after a six-month intervention, an individual receives dietary recommendations on a personal basis is enough to positively affect his or her dietary behavior.[5] The effectiveness is higher, if the advice can be further personalized by providing detailed coaching on how each person can modify his/her existing food choices to improve his/her dietary habit.

The current evidence level of applying genomic information to tailor dietary recommendation is still at early stages, but the prospect of implementing nutrigenetics to the clinical practice is encouraging. Much qualified research, especially RCT, is needed before personalized nutrition can deliver the expected benefits.

It is very clear that industry captured the opportunities of personalized nutrition as a prospective and trendy business. Various companies are competing to be at the forefront of selling and getting profits from this kind of service. Some companies seek to sell personalized nutrition programs directly to consumers with claiming that the recommended diet is "the very best for you" or "based on the latest scientific research". With an attractive approach and convincing explanation, people who might have not sufficient knowledge about the current evidence and the effectiveness of personalized nutrition are finally persuaded to join this program. With relatively quite expensive cost, then customers get written report about the most suitable diet for them based on their genes. Ideally, this personalized nutrition packages must be completed by the "after-sales" programs which provides consultation service with well-trained health practitioners (doctors or nutritionists) who will explain how the diet will be carried out. Dietary behavior changes need some time to be adopted and people often struggle with temptation of "delicious but bad for health" menus around them. They often confuse about which food are good or bad for them while they are buying grocery or eating out. So, the program must also be completed with other tools or applications that they can access easily wherever they are.

However, there are also providers which only sell genetic examination services and genetic based diet arrangements through the internet without providing consulting services. Consumers are then advised to consult how to apply the diet recommendations based on the reports he/she obtained from the provider to their personal physician. Unfortunately, not all health practitioner concerned and keep his/herself updated in the field of nutrigenetics or nutrigenomics. Thus, they might be do not have enough capability to direct their patient/clients to implement personalized nutrition. Furthermore, nutrigenetic and nutrigenomic science developed in the last 1–2 decades and these knowledges have not been included in every medical curriculla yet, especially in developing countries.

It is premature to make health claims that personalized nutrition based on genotype is the best nutritional approach that can reduce the morbidity and mortality of NCDs as endpoint indicators, because there's no scientific evidence yet. But many studies showed the effect of personalized nutrition on surrogate/intermediate endpoints as measurable and obtainable parameters that has been supported by strong evidence of its relationship to morbidity/mortality of NCDs. Livingstone et al[6] evaluate the efficacy of personalized nutrition intervention for improving consumption of Mediterranean diet. In this study, participants were randomly assigned to receive conventional dietary advice or personalized nutrition, and the MedDiet scores were calculated at baseline and 6 months interventions. The MedDiet score was converted from participant's dietary intakes based on food-frequency questionnaire. The researchers conclude that higher MedDiet scores at baseline were associated with healthier lifestyles (higher physical activity level) and lower adiposity (lower body

mass index, BMI). After the intervention, MedDiet scores were greater in individuals who received personalized intervention than in controls, with the addition of DNA-based dietary advice showed the largest differences in MedDiet scores.

The future success of personalized nutrition will depend on the public knowledge about this approach. The review of Fallaize et al[7] regarding the public acceptance of nutrigenomic-based personalized nutrition assume that individuals with a heightened perceived susceptibility to disease, who has few risk factors, might be an ideal target group for nutrigenomic-based personalized nutrition. These people contribute significantly to disease events and are more willing to engage with personalized nutrition.

The role of technology in personalized nutrition is also essential and very important. Internet and mobile phone technology has become integral to our daily activities. Using the internet and mobile communications, consumers could have a choice of direct interfaces in any situation to support appropriate food choices.[4] Nutrition apps could be a powerful tool to support consumers to improve their dietary habits if it had a decision engine capable of providing personalized dietary advice. The eNutri is one of web app capable of delivering automated personalized dietary advice from participants' adherence to an 11-item modified US Alternative Healthy Eating Index (m-AHEI), which referred as Healthy Eating Score in the report, after they complete the online FFQ. This app will automatically select three dietary changes that the participant is recommended to consider based on the three m-AHEI components with the lowest score. This app has been evaluated by 32 nutritional experts, i.e. for the appropriateness, relevance, and suitability of advice given by using 2 pre-defined scenarios. A number of improvements to this app were suggested, such as including greater participant profiling (weight, lifestyle) and links to recipes and sources of further information.[8] As a supporting tool, this kind of service could be beneficial, but it couldn't be take over the role and importance of face-to-face consultation with capable health practitioner, especially in delivering more complex personalized nutrition advice based on dietary habits, lifestyle, health status, phenotype, and genotype.

As summary, to accelerate and make personalized nutrition possible, the following are several important things that must be considered:

1. Enhance qualified nutrigenomic/nutrigenetic research
2. Enhance multidisciplinary collaborations between basic and applied scientist, physicians, nutritionists, psychologists, pharmaceutical laboratories, information technologists (IT), and health educators to design a holistic personalized nutrition services. So customers will get the complete packages with maximal benefit.
3. Train the health practitioner about genomic medicine and include the genomic medicine in medical curriculum
4. Educate the general population on topics related with genetics and personalized medicine/nutrition
5. Use a non-invasive examination for genetic testing (saliva/cheek swab) to increase consumer acceptance
6. Adjust dietary recommendations completely based on unique individual characteristics, starting from genetics, phenotype, eating habits, food preferences, and stages of willingness to change.
7. Use any of technological advancing in the field of communication, to monitor and provide feedback to consumer (via internet or mobile apps).

Conflict of Interest

Authors declared no conflict of interest regarding this study.

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ORIGINAL ARTICLE

Comparing The Anthropometric Measurements of Intra-Extra Uterine Period between Stunting and Non-stunting Children Aged 6-24 Months Old in Bogor Tengah Sub District, Bogor City, West Java

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Abstract

Introduction Stunting in 6-24 months old children has many negative health consequences in later life. However, stunting could be detected earlier by using anthropometry indicators. This study aims to compare the anthropometry of the intrauterine and extra uterine period between stunting and non-stunting children aged 6-24 months.
Methods This comparative cross-sectional study was part of Bogor longitudinal study on child growth and development (BLSCGD) held by National Health Research and Development (NHRD), Indonesia. Inclusion criteria were children aged 6-24 months, born full term from single pregnancy (not twins) and had >24 months age difference with previous sibling. Subjects with birth defect were excluded. Data were collected by measuring anthropometric sizes using WHO standard. Primary and secondary data collection was done from July 2017 to February 2018 at the BLSCGD. Statistical analysis was used to compare anthropometric sizes between stunting and non-stunting groups (p value <0.05).
Results There were 38 stunting and 46 non-stunting children who met the study criteria. Maternal height (p<0.001), birth weight (p=0.009) and length (p=0.025) were significantly lower in stunting group compared to non-stunting group. Extra uterine factors such as weight gain at six months of age (p=0.002), neonatal weight gains per month in the first six months (p=0.002), increase of body length in age six months old (p<0.001), body length gains per month in the first six months (p<0.001) were significantly lower in stunting children.
Conclusion The anthropometrics of stunting children during intrauterine and extra uterine period was significantly lower compared to non-stunting. It is essential to monitor the anthropometry of intra-extra uterine period to prevent stunting at age 6-24 months old.

Keywords stunting, intrauterine, extra uterine factors

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Introduction

Children grow rapidly in the first 1000 days and have high nutrition requirements. There are many challenges to fulfill their nutritional needs, especially during under two years old of age.[1] The cause of stunting in age under two years old is an imbalance of requirement and intake in a prolonged period.[2] The low intake of food, infection, the transition period from exclusive breast feeding to weaning of complementary food commonly occur in children aged less than two years old.[3,4] Meanwhile, studies showed that maternal stature is one of the many factors that influenced height for age z-score (HAZ) in early life.[5–7]

Intra and extra uterine factors can cause stunting. Maternal chronic nutritional deficiencies from conception until birth is an intrauterine factor. This causes small fetus size shown by low birth weight or short birth length.[8] This can be measured with intrauterine anthropometry which consists of maternal height, maternal body mass index before pregnancy, weight gain during pregnancy, baby birth weight and length. Extra uterine factors are formed from birth to six months of age. After six months old, infants should receive complementary foods.[9–11] At age 12-23 months old, the fulfillment of daily energy needs from breast feeding is 35-40% and 60-65% is from complementary foods.[12] Indicators of extra uterine anthropometry are weight gain and increase of body length at six months old, monthly body weight, length gain and arm circumference profile from birth until six months old.

Stunting is a preventable condition. Finding an early curable risk factor will reduce stunting prevalence in children aged up to two years old. This study aimed to compare the anthropometry measurements of intra and extra uterine period between stunting and non-stunting children aged 6-24 months.

Methods

The design of this study was comparative cross-sectional nested to BLSCGD in order to obtain data on the child's and mother's medical history during pregnancy and data on the child's growth from birth until aged six months. The BLSCGD research was done by the NHRD, Ministry of Health research team in the District of Bogor Tengah, City of Bogor from 2012 to 2032. The data collection was done from July 2017 until February 2018 at the Health Research and Development Center - Community Health Efforts, Ministry of Health, Bogor, West Java.

The estimated numbers of subject calculated was 162 children. Subjects were divided into two groups namely stunting group (81 children) and non-stunting group (81 children). Consecutive sampling was used to select the subjects and standardized questionnaire was used for subject screening. Inclusion criteria were children 6-24 months old who were registered member of BLSCGD, born from full-term, single pregnancy, had age difference >24 months with the previous sibling and the mother's age more than 20 years old when pregnant with the subject. Lastly, all subjects' mothers have agreed and signed informed consent to participate in this research. Subjects were excluded if they have birth defect.

Subjects were defined as stunting if their height for age Z-score was more than two standard deviations below the WHO Child Growth standards median. This research was approved by the Ethical Committee for Research in Human from the Faculty of Medicine, Universitas Indonesia (No. 540/UN2.F1/ETIK/2017) and by Director of NHRD of Health Ministry of Republic Indonesia. (No. LB.01.03/1/3471/2017).

Primary data collected were child identity, birth date and body length. Secondary data, using a standardized form, were collected from BLSCGD as follows: (1)to identify intrauterine anthropometric factors: mother's height and weight before and while pregnant, mother's monthly weight gain while pregnant, subject's birth weight and length, (2)to identify extra uterine anthropometric factors: subject's weight and length gains at first six months of age, mean of monthly weight and length gains at first six months of age, arm circumference at age one week, arm circumference gain at first six months of age, mean of monthly increase of arm circumference at first

six months of age. All of the measurement meets the WHO standards.

The data was then analyzed by the SPSS version 20 program. The normality of variables was tested using a Kolmogorov-Smirnov test. Classification and a correlation between variables were analyzed using a Spearman or Pearson test or independent T-test.

Results

During data collection one subject was excluded due to having cleft palate, one subject excluded due to born as twins and several others did not agree to participate in this study. Hence the total numbers of subject collected were 84 children. The selected children were grouped into stunting and non-stunting. Subject characteristics were are shown in Table 1.

As seen in Table 1, there was no significance of data difference between stunting and non-stunting group.

Intrauterine predisposing factors are presented in Table 2, which describes differences in maternal anthropometry size before and during pregnancy and the size of newborns. Maternal height before pregnancy, birth weight, and birth length were significantly lower in stunting children compared to non-stunting children.

As expected, the numbers of mother with short stature are more significant in stunting group. Numbers of subjects who had birth weight less than 3 kilograms and short birth length are also more significant in stunting group.

Table 1. Subject baseline characteristics

Variable	Stunting (n=38)	Non-stunting (n=46)	p value
Age (month)	16.3±5.3	16.1±5.1	0.888[TT]
Gender (n,%)			
Boy	17 (44.7)	22 (47.8)	
Girl	21 (55.3)	24 (52.2)	0.778[CS]
Mother's age (years)	28±5.7	29.1±5.4	0.567[TT]
Mother's educational level (n,%)			
Did not attend school	1 (2.6)	-	
Did not graduate elementary	-	-	
Elementary graduated	8 (21.1)	5 (10.9)	
Junior high graduated	9 (23.7)	15 (32.6)	
Senior high graduated	17 (44.7)	22 (47.8)	
University graduated	3 (7.9)	4 (8.7)	0.884[KS]
Occupation (n,%)			
Unemployed	-	1 (2.2)	
Government officials	3 (7.9)	3 (6.5)	
Entrepreneur	-	2 (6.5)	
Farmer/laborer/fisherman	-	4 (8.7)	
Housewive	35 (92.1)	36 (78.3)	0.871[KS]

Table 2 Anthropometric measurement differences between stunting and non stunting group

Anthropometric measurements	Stunting (n=38)	Non stunting (n=46)	p-value
Mother's height (cm)	148.8±4.9	154.0±4.5	**<0.001** TT
Short stature <150	21 (55.3)	9 (19.6)	
Normal stature ≥150	17 (44.7)	37 (80.4)	**0.001** CS
Mother's BMI before pregnancy (kg/m^2)	22.5±4.3	22.9±3.9	0.631 **TT**
Underweight <18.5	5 (13.2)	4 (8.7)	
Normal 18.5-24.9	24 (63.2)	31 (67.4)	
Overweight /Obese ≥ 25	9 (23.6)	11 (23.9)	0.802 LR
Maternal weight gain(kg)	10.1±5.6	12.2±6.7	0.137 TT
Less (<11.5)	25 (65.8)	21 (45.7)	
Appropriate (11.5-16)	7 (18.4)	16 (34.8)	
More (16)	6 (15.8)	9 (19.6)	0.154 CS
Subject's birth weight (kg)	2.9±0.2	3.1 (2.5–4.5)	**0.009** MW
LBW <2.5	1 (2.6)	-	
Normal 2.5-2.9	15 (39.5)	9 (19.6)	
Ideal ≥3	22 (57.9)	37 (80.4)	**0.019** LLA
Subject's birth length (cm)	47 (45–50)	48.8±2.1	**0.025** MW
Short <48	22 (57.9)	21 (45.7)	
Normal ≥48	16 (42.1)	25 (54.3)	0.269 TT

MW Mann Whitney, TT Unpaired T-test, CS Chi-square, LR Likelihood Ratio, LLA Linear by Liner Association

Table 3. The differences of anthropometry between stunting and non stunting subjects

Variables	Stunting (n=38)	Non-stunting (n=46)	p-value
Weight gain aged six months (kg)	3.6±0.7	4.2±0.9	**0.002** TT
Weight gain per month at first six months after born (kg)	0.6±0.1	0.7±0.1	**0.002** TT
Length increase aged six months (cm)	14.1±2.3	16.0±2.1	**<0.001** TT
Length increase per month at first six months after born (cm)	2.3±0.4	2.7±0.3	**<0.001** **TT**
Birth arm circumference/AC (cm)	10.0 (8.3–12.7)	10.9 (7.0–12.4)	0.266 MW
Increase of AC aged six months (cm)	3.6±1.1	3.5±1.4	0.751 TT
Increase of AC per months at first six months after born (cm)	1.0±0.3	1.0±0.4	0.751 TT

MW Mann Whitney, TT Unpaired T-test, CS Chi-square, AC: Arm Circumference

Extra uterine predisposing factors, which describe differences of anthropometric measurements between subjects with stunting and non stunting, are shown in Table 3.

The increase of body weight and length during the first six months, and also monthly weight and length gain were significantly smaller in stunting than non-stunting children.

Discussion

In this study subjects in both groups had similar characteristics of mother's age, subject's age and gender. There was no significant difference in parent's educational background and job between both groups. Educational background overview shows there are still parents who never attended school or completed elementary school education. Data from Center of Statistic Bogor City in 2017 shows in general Bogor city residents work in trading and services sector with junior and senior high school as most common educational background.[13] Almost all biological mothers from 84 subjects are housewives and are high school graduated. Parent's educational background and job showed that the subjects came from middle to lower economic class families. Stunting children under five years of age generally came from middle to lower class families.[2,14]

Table 2 shows that maternal height before pregnancy, birth weight, and birth length were significantly lower in stunting compared to non-stunting children. Correspondingly, the proportions of mothers short stature, subject's birth weight less than three kilograms and body length <46 cm are still more significant in stunting children.

This study showed that maternal height before pregnancy and intra uterine fetal growth are essential factors for the incidence of stunting in children aged 6-24 months. The result of this research is in line with the meta-analysis study by Addo et al.[15] It was done in five cohort studies in Brazil, India, Guatemala, the Philippines, and South Africa with a total sample of 7,630 pregnant women. Observations were done from pregnancy to delivery until the children were two years old, less than seven years old and adulthood. The study found that maternal height was positively related to birth weight and childbirth: mothers with height less than 150.1 cm had 3.2 times more risk to birth children who will be stunted at 2 years of age compared to those with height more than or equal to 150.1 cm.[15]

A retrospective study involved 412 children in Guatemala found that there was a significant positive relationship between maternal height and body length for age z scores of infants aged 6 and 12 months old.[16] Short statured mothers were more likely to have stunting children because the phenotype for stunted growth would be passed on to the next generation.[7] A research by Lestari et al[17] on 110 stunting and non-stunting children aged 6-24 months old in Aceh found the most dominant risk factor for the incidence of stunting in early life (children aged 6-24 months) was maternal or paternal short stature. Consistent with this research, a hospital-based study in Japan by Inoue et al.[18] found that a significant relationship between short maternal stature with low birth weight in 17.150 pairs of Japanese mothers and newborns.

The newborn baby with low birth weight or low birth length become stunting at 6-24 months. This result corresponds with literature study which suggests that maternal height contributes to birth weight, and birth weight contributes to incidence of stunting in children under two years old.[5] Short statured mothers have higher risk to birth children with low birth weight.[2] The pathophysiology of relationship between babies with low birth weight and birth length born from mother with short stature is still unclear. However, some researchers speculate that fetal growth patterns are imprinted by maternal short stature phenotypes, thus their offspring adapt to subsequent growth patterns, known as intergenerational effect.[19–21]

Although not significantly different, the mean maternal weight gain during pregnancy in stunting group was 2.1 kg lower than non-stunting group. Moreover, 65.8% mothers of stunting children had history of less than 11.5 kg weight gain from early until late pregnancy. Weight gain during pregnancy describes the nutritional adequacy of pregnant women and indirectly describes intra uterine fetal growth. Irawati and Rachmalina's[22] research on 94 pregnant women in Bogor concluded that the maternal body mass index before pregnancy was the most influential risk factor for maternal weight gain during pregnancy. The causes of the low birth weight and length in this study was unknown because this study did not evaluate the food intake of pregnant women and maternal physical activity during pregnancy.

Changes in growth patterns presented in Table 3 show that weight gain and body length in

the first six months of extra uterine life of stunting children were significantly smaller compared to non-stunting children, so do the average weight gain and body length in the first six months. At 3 months old until around 12-18 months old babies grow rapidly.[23] The weight gain in the first six months and the average monthly weight gain in a stunting child are less than non-stunting children. Stunting children should get more attention from their mothers in food intake and infection control in order to catch up with growth. The complete monthly weight and length data obtained in this study may indicate that the mothers are diligent in monitoring monthly children growth. However, they need to be given knowledge and skills to overcome problems about slow growth rate in children.[24]

The average monthly increase of child body length in stunting and non stunting group were 2.3 cm and 2.7 cm, respectively. The children growth rate in up to one-year-old is approximately 25 cm/year, then the linear growth rate will decrease to around 10 cm/year starting at 4 years old. In other words children's linear growth rate at age 6-24 months old is around 0.8–2 cm/month.[23] The results of this study shows that the children's linear growth rates were still relatively healthy.

There are several limitations to this study. First, this study did not provide maternal intake during pregnancy, neonatal intake history (breastfeeding or food). Secondly, subject's activities was not collected, thus the balance of nutritional demand in intrauterine and extra uterine period could not be evaluated.

In conclusion, intrauterine and extra uterine predisposing anthropometric characteristics of stunting children aged 6-24 months old are short mother's stature, low birth weight, low birth length, less weight gain in the first six months, low monthly weight gain in the first six months, low body length for the first six months, less monthly increase in body length in the first six months.

The significant intrauterine predisposition factors of stunting children are mothers' anthropometric status before and while pregnant. It was shown that mother's height, which represented mother's nutrition pool before pregnancy, was an essential factor of fetal development. Recent studies are consistent with this result, even though intervention studies in pregnant woman did not show improvement of fetal development, weight or height. Monitoring height of adolescent girls will prevent short maternal stature. Also, routine anthropometric measurements of mothers during pregnancy and babies in the first six months old would prevent stunting at age 6-24 months old.

Conflict of Interest

There was no conflict of interest regarding this study

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Fructose Intake and Its Correlation with Carotid Intima-Media Thickness in Male Employees with Hypercholesterolemia in *Harapan Kita* National Cardiovascular Center Hospital, Jakarta, Indonesia

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Abstract

Introduction Atherosclerosis is the main cause of cardiovascular disease that is detectable early by ultrasound examination of the carotid intima-media thickness (IMT). One of the risk factors is dyslipidemia, which can be affected by high fructose diet. **Methods** This cross sectional study was conducted to investigate the correlation between fructose intake and IMT in male subjects with hypercholesterolemia aged 19–49 years old. Data analyzed by using Statistical Package for Social Sciences (SPSS) version 20.0. Univariate analysis with normality test Kolmogorov-Smirnov. Bivariate analysis was using Pearson or Spearman correlation test. **Results** Of 47 subjects, median age was 41 (33–45) years old. In 57.4% subjects, low density lipoprotein (LDL) was found high and very high levels, 29.8% subjects had low high density lipoprotein (HDL) level, and 27.6% subjects had high and very high triglycerides levels. Most subjects have normal systolic and diastolic blood pressure. Around 72.3% subjects were classified as obese and 66.0% were classified as having central obesity. Majority of subjects were light smoker and 49.8% performed light activity. In IMT carotid examination, median of 1 (0.8–1.4) mm was found with 63.8% subjects developed thickness. Median total energy intake was 1209 (1020–1645) Kcal/day, mostly with adequate carbohydrate, protein, and fat, fiber intake was inadequate in 100% subjects, and mean fructose intake of 31,97 ± 15,48 gram/day. Bivariate analysis did not demonstrate any correlation between fructose intake and carotid IMT. **Conclusion** There was no correlation between fructose intake and carotid IMT.

Keywords atherosclerosis, fructose, hypercholesterolemia, intima-media thickness

Introduction

Cardiovascular disease is the number one cause of death in the world. Data from World Health Organization (WHO) in 2012 reported 17.5 million (31%) of death annually due to cardiovascular disease. Of those numbers around 7.4 million deaths were due to coronary heart disease.[1] Atherosclerosis is the main cause of cardiovascular disease that usually develop gradually over the years before overt clinical symptoms appears.[2-6] One way to examine atherosclerosis can be performed by measuring intima-media thickness (IMT) using non-invasive methods with ultrasonography. American Heart Association recommended the IMT measurement as the best

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method to identify the presence of atherosclerosis.[7] One of the modifiable risk factor of atherosclerosis is dyslipidemia.[3,6] Data in Indonesia according to Basic Health Research or *Riset Kesehatan Dasar (Riskesdas)* in Biomedical in 2007 showed that prevalence of dyslipidemia based on total cholesterol levels >200 mg/dl were 39.8%.[4]

Several studies suggested that blood cholesterol levels can be affected by food intake, one of them is high carbohydrate diet particularly simple carbohydrate that correlated with increased level of triglycerides and decreased level of high density lipoprotein (HDL).[8,9] According to result analysis from Individual Food Consumption Survey (*Survei Konsumsi Makanan Individu*/SKMI) in 2014 reported that consumption of sugar and confectionary category by Indonesian people was 15.7 gram per person per day, amongst them the most consumed in this category was cane sugar (13.6 gram/person/day). The proportion of population who consumed sugar more than 50 grams, was found the highest in the age group above 55 years old (6. 8%) and the lowest in age group 0 – 59 months (1.3%). Meanwhile according to gender, more male individuals (6.4%) consumed sugar more than 50 grams compared to female (3.1%).[10]

Fructose is a monosaccharide mainly contained in honey along with glucose, also in fruits, flower nectar, and vegetables. Fructose can be processed and used commercially as sweeteners. Light beverages largely utilize high fructose corn syrup as sweetener substance.[11-2] According to SKMI 2014 beverages in package were consumed by 8.7% of population, followed by other beverage (1.8%), carbonated beverages (1.1%), and the lowest alcohol containing beverages (0.2%). Beverages in package were the most consumed in all age groups.[10]

Various studies demonstrated that as consumption of food/beverage containing fructose increased, a rise in prevalence of various symptoms of metabolic syndrome such as dyslipidemia, central obesity, hypertension, hyperuricemia, and type 2 diabetes mellitus was observed.[12] A review article of fructose effect on post prandial triglycerides by Kolderup et.al.[13] showed that normal fructose consumption (approximately 50–60 gram/day) did not increased risk of atherosclerosis, type 2 diabetes mellitus, or obesity more than other sugar consumption. However, fructose high consumption especially when combined with other high energy intake in the form of glucose, may exert negative effect to health. A study by Soo et.al.[14] on high fructose and its correlation with cardiovascular disease in rats during growing period resulted in an increased of total fat weight, increased serum triglycerides levels, and increased aorta abdominal wall thickness. Meanwhile, Bo et.al.[15] conducted a study on rabbits (*Watanabe* heritable hyperlipidemic rabbits) demonstrated that atherosclerosis increased significantly on high fructose and high fat diet.

By recognizing atherosclerosis risk factors particularly those of modifiable amongst other food/beverage intake and early detection by examining carotid IMT also based on sugar and beverage in packages consumptions in Indonesian population who largely utilize fructose as sweetener substance, this study was conducted to investigate the correlation between fructose consumption and carotid IMT in adult subjects with hypercholesterolemia anticipating to prevent cardiovascular disease.

Methods

Subjects and Study Design

This study with a cross sectional design was conducted in *Harapan Kita* National Cardiovascular Center Jakarta started in December 2017 that aimed to investigate the correlation between fructose consumption and carotid IMT in adult subjects with hypercholesterolemia. This study is part of Dr. Diana Sunardi, M.Gizi, SpGK et.al. research titled "The Effect of Giving Milk Formula Enriched with Soluble Fibers on Lipid Profile Improvement in Adult Male Subjects with Mild to Moderate Hypercholesterolemia". This study was obtained ethical approval from Medical Research Ethics Committee of Faculty of Medicine University of Indonesia with number 819/UN2.F1/ETIK/VIII/2017. Inclusion criteria for subjects were males, age between 19–49 years old, total cholesterol levels ≥200 mg/dl and agreed to take part in the study by signing informed consent. Subject exclusion criteria including having history

of cardiovascular disease, diabetes mellitus or impairment in liver functions as identified by history taking and also consuming drugs that may affect lipid or glucose metabolism within 3 months from history taking. Out of 139 hospital's employees who enrolled in the selection process, 47 subjects met the study criteria.

Data collection

Subject characteristic data collection included age, education, and income was conducted by interview. Food intake data (total energy, carbohydrate, protein, fat, and fibers) was collected by using 24-hours foods recall and for fructose intake by using semi-quantitative food frequency questionnaire. Data obtained were converted to gram by using food substance analysis list and analyzed with Nutrisurvey for windows 2007 software. Physical activities assessment (physical activity level/PAL) was determined based on duration and types of activities routinely done during 24 hour-period. Degree of smoking was determined by Brinkman Index (BI).

Anthropometric measurement includes body weight (BW), body height (BH), and waist circumference. Body weight was measured by using a weight scale (SECA brand), body height measurement using Microtoise staturemeter and waist circumference with an unstretchable tape (SECA). BW and BH data were used to calculate body mass index (BMI) which then categorized according to Asia Pacific classification to determine nutritional status.

Blood pressure measurement was performed by using a sphygmomanometer (A&D Medical) and a stethoscope (Riester). Blood pressure data included systolic and diastolic blood pressure. Lipid profile laboratory examinations were performed after a period of minimal 10 hours fasting by using spectrophotometry method.

Carotid IMT examination was performed by using an ultrasound machine (Logiq E) with a high frequency linear transducers (7–12 MHz). Subjects were asked to rest comfortably in the supine position, neck slightly extended with the head turned 45 degrees in the opposite direction from the part to be examined. The examiner was on the side of the subject or above the subject's head. The examination began by attaching the transducer from the supraclavicle directed towards the cranial to the mandibular angles. Examination was carried out twice on the right and left necks in each of the two places—the common carotid artery and internal carotid artery.

Statistical Analysis

Data analyzed by using Statistical Package for Social Sciences (SPSS) version 20.0. Univariate analysis with normality test Kolmogorov-Smirnov was performed in continuous data. Normally distributed data ($p \geq 0.05$) is presented with mean and standard deviation, when not normally distributed ($p < 0.05$) data is presented as median and minimum-maximum range. Categorical data is presented in the form of frequency distribution (n%). Bivariate analysis to assess correlation between fructose intake and carotid IMT is using Pearson or Spearman correlation test. Similar assessments were performed between age, lipid profile, blood pressure, BMI, waist circumference, physical activities, smoking and food intake (carbohydrate, protein, fat, fiber) and carotid IMT with levels of significance $p < 0.05$.

Results

Table 1 shows median age of subjects in this study i.e. 41 years old, 72.3% of them have high education levels, and 91.5% of these individuals earn sufficient income.

Table 1. Baseline Characteristics Data of Subjects (n=47)

Variables	Result
Age (year-old)	41 (31–45)[1]
Education, n(%):	
Low	-
Middle	13 (27.7)
High	34 (72.3)
Income, n(%):	
Low	4 (8.5)
Sufficient	43 (91.5)

[1]: median (minimum-maximum)

Subjects underwent lipid profile laboratory examination comprising LDL, HDL and triglyceride whose results are presented in Table 2. Subjects' mean LDL level was 164.26 ± 27.93 mg/dl with 57.4% classified as high and very high levels, mean HDL level was 45.51 ± 9.82 mg/dl

with a considerable proportion 29.8% within low category while median triglyceride level was 154 (113–208) mg/dl with around 27.6% categorized as high and very high.

Most of subjects have normal blood pressure both systolic and diastolic. Systolic blood pressure median was 120 (110–130) mmHg with 6.4% categorized as high while diastolic blood pressure median was 80 (70–80) mmHg with 17.0% categorized as high.

According to nutritional status based on BMI 72.3% subjects were obesity. In addition, from waist circumference measurement around 66.0% subjects have central obesity with mean waist circumference of 94.41 ± 9.23 cm. Also it can be found that 48.9% subjects were in light physical activities category.

Table 2 also shows that most of subjects are categorized as light smokers i.e. in 93.6% and from carotid IMT ultrasound examination results a median of 1 (0.8–1.4) mm was observed with 63.8% categorized as not normal/developing thickening.

In Table 3, it shows that median total energy intake of subjects was 1209 (1020–1645) kcal/day. Carbohydrate intake in most of subjects were considered sufficient i.e. in 59.6% subjects, similar observation with protein and fat intake that is 87.2% and 44.7% respectively, while fibers intake was considered insufficient in all subjects (100%). It can also be found from the table that mean fructose intake of subjects was 31.97 ± 15.48 gram/day.

Results from this study shows that by using Spearman correlation test, no significant correlation was observed between fructose intake and carotid IMT (r= 0.148, p =0.320), that can be seen in Table 4. In this study correlation tests were also performed between age, lipid profile (LDL, HDL, triglyceride), blood pressure, BMI, waist circumference, physical activities, smoking, food intake (carbohydrate, protein, fat, fiber) and carotid IMT.

Table 2. Subject Characteristic Distribution Based on Lipid Profile, Blood Pressure, Nutritional Status, Waist Circumference, Physical Activities, Smoking, and Carotid Intima-Media Thickness (n=47)

Variables	Result
Lipid Profile :	
LDL (mg/dl):	164.26 ± 27.93[2]
Optimal, n(%)	1 (2.1)
Near optimal, n(%)	2 (4.2)
Borderline high, n(%)	17 (36.2)
High, n(%)	19 (40.4)
Very High, n(%)	8 (17.0)
HDL (mg/dl):	45.51 ± 9.82[2]
Low, n(%)	14 (29.8)
Normal, n(%)	31 (66.0)
High, n(%)	2 (4.3)
Triglyceride (mg/dl):	154 (113–208)[1]
Normal, n(%)	21 (44.7)
Borderline high, n(%)	13 (27.7)
High, n(%)	12 (25.5)
Very High, n(%)	1 (2.1)
Systolic Blood Pressure (mmHg):	120 (110–130)[1]
Normal, n(%)	44 (93.6)
High, n(%)	3 (6.4)
Diastolic Blood Pressure (mmHg):	80 (70–80)[1]
Normal, n(%)	39 (83.0)
High, n(%)	8 (17.0)

Table 2. (continued)

Variables	Result
BMI (kg/m^2)	26.73 ± 3.69[2]
Nutritional Status according to BMI,n(%):	
Underweight	-
Normal	7 (14.9)
At risk	6 (12.8)
Obesity 1	27 (57.4)
Obesity 2	7 (14.9)
Waist circumference (cm):	94.41 ± 9.23[2]
Normal, n(%)	16 (34)
Central obesity, n(%)	31 (66)
Physical Activities:	1.7 (1.63–1.77)[1]
Light, n(%)	23 (48.9)
Moderate, n(%)	21 (44.7)
High, n(%)	3 (6.4)
Smoking,n(%):	
Light	44 (93.6)
Moderate	3 (6.4)
Heavy	-
Carotid intima-media thickness (mm):	1 (0.8–1.4) [1]
Normal, n(%)	17 (36.2%)
Thickened, n(%)	30 (63.8%)

HDL: high density lipoprotein, BMI: body mass index, LDL: low density lipoprotein

[1] : median (minimum-maximum)

[2] : mean ± standard deviation

Table 3. Subject Characteristics Distribution Based on Total Energy, Carbohydrate, Protein, Fat, Fibers and Fructose Intake (n=47)

Variables	Result
Total energy intake (kcal/day)	1209 (1020–1645)[1]
Carbohydrate intake (gram/day):	183 ± 55.53[*]
Insufficient, n(%)	6 (12.8)
Sufficient, n(%)	28 (59.6)
Over sufficient , n(%)	13 (27.7)
Protein intake (gram/day):	44.1 (32.4–55.1)[1]
Insufficient, n(%)	6 (12.8)
Sufficient, n(%)	41 (87.2)
Over sufficient, n(%)	-
Fat intake (gram/day):	41.43 ± 22.76[2]
Insufficient, n(%)	13 (27.7)
Sufficient, n(%)	21(44.7)
Over sufficient, n(%)	13(27.7)
Fibers intake (gram/day):	6.3(4.6–9.6)[1]
Insufficient, n(%)	47(100)
Sufficient, n(%)	-
Fructose intake (gram/day)	31.97 ± 15.48[2]

Table 4 demonstrates Spearman correlation tests result that no significant correlation between age, lipid profile, blood pressure, BMI, physical activities, smoking, carbohydrate, protein, and fiber intake and carotid IMT. However, significant positive correlation was found between waist circumference (r =0.330, p =0.023) and fat intake (r=0.330, p=0.024) and carotid IMT.

As observed in Table 4, dominant factors (p<0.25) related to carotid IMT are LDL, HDL, systolic blood pressure, BMI, waist circumference and fat intake. Further analysis with multiple linear regression test was performed as presented in Table 5. Analysis result found that only fat intake has a statistically significant correlation to carotid IMT with p =0.015.

Table 4. Correlation between Fructose Intake, Age, Lipid Profile, Blood Pressure, Body Mass Index, Waist Circumference, Physical Activity, Smoking, Food Intake and Carotid Intima-Media Thickness (n=47)

Variables	**Carotid Intima-Media Thickness (mm)**	
	r	***P***
Age (years-old)	0.163	0.274^{S}
Lipid Profile:		
LDL (mg/dl)	0.207	0.163^{S}
HDL (mg/dl)	-0.188	0.206^{S}
Triglyceride (mg/dl)	-0.007	0.962^{S}
Systolic Blood Pressure (mmHg)	0.242	0.102^{S}
Diastolic Blood Pressure (mmHg)	0.087	0.561^{S}
BMI (kg/m^2)	0.234	0.114^{S}
Waist circumference (cm)	0.330	**0.023$^{\#S}$**
Physical activities	-0.159	0.285^{S}
Smoking	0.045	0.762^{S}
Food intake :		
Carbohydrate (gram/day)	-0.019	0.900^{S}
Protein (gram/day)	0.118	0.429^{S}
Fat (gram/day)	0.330	**0.024$^{\#S}$**
Fiber (gram/day)	-0.003	0.983^{S}
Fructose (gram/day)	0.148	0.320^{S}

p: levels of significance <0.05, r: correlation,
HDL: high density lipoprotein, BMI: body mass index, LDL: low density lipoprotein, ^{S} : Spearman test,
$^{\#}$: statistically significant

Discussion

Correlation between Fructose Intake and Carotid Intima-Media Thickness

This study is aimed to seek correlation between fructose intake and carotid IMT. Study result demonstrated that no significant correlation was found between fructose intake and carotid IMT (r =0.148, p =0.320). Study on fructose intake and its relation with carotid IMT assessed by IMT ultrasound examination is still limited. Soo et.al.[14] conducted a study regarding high fructose intake and its correlation with cardiovascular disease in rats that in growing period, one of the parameter assessed is the abdominal aorta wall thickness as a marker of the presence of atherosclerosis. Result suggested that in rats fed with high fructose diet (regular diet with 30% fructose) have thicker abdominal aorta wall compared to those fed on regular diet, mean thickness of 23.6 ± 0.9 μm on high fructose diet compared to mean thickness of 18.5 ± 0.5 μm on regular diet. In this study result, no correlation was found between fructose intake and carotid IMT that is possibly due to fructose intake in study subjects were not high.

Lower fructose intake might be accountable for several factors such as subjects' insufficient intake of food containing fructose like fruits, vegetables or food/beverage with artificial sweeteners that high in fructose content. Also it

may be caused by lack of fructose intake data during interview using *semi-quantitative food frequency questionnaire*, that is due to lack of subjects' recall on food intake, inaccuracy in food estimation, portion/serving and intake frequency. Lack information on fructose content in industrial food/beverages may also cause lack of data on fructose intake in this study subjects. Carotid intima-media thickness can be used as an initial marker or early diagnosis of atherosclerosis. According to several studies, high fructose intake may become on of the risk factors for atherosclerosis. This is because high fructose intake significantly correlated with DNL activity increase that resulted in increased blood cholesterol levels..[7,13]

In this study subjects, most of them have already developed carotid wall thickness hence advised to control/limit fructose intake particularly derived from food and beverage containing artificial sweetener substances to prevent increasing risk of atherosclerosis.

Correlation between Age, Lipid Profile, Blood Pressure, Body Mass Index, Waist Circumference, Physical Activity, Smoking, Food Intake and Carotid Intima-Media Thickness

This study also performed tests to correlate age, lipid profile, blood pressure, BMI, waist circumference, physical activity, smoking, and food intakes with carotid IMT. Results showed no significant correlation between age, lipid profile, blood pressure, BMI, physical activity, smoking, food intake (carbohydrate, protein and fibers) and carotid IMT. However, positive significant correlation was found between waist circumference ($r = 0.330$, $p = 0.023$) and fat intake ($r = 0.330$, $p = 0.024$) to carotid IMT. Meanwhile in multivariate analysis of dominant factors (($p<0.25$) resulted in statistical correlation only between fat intake and carotid IMT ($p = 0.015$).

Similar result was reported in a study by Mulyanto[16] on 62 subjects aged 36-77 years old in Semarang that fat intake ($p = 0.011$) and age ($p = 0.005$) have significant correlation with carotid IMT. Fat intake particularly saturated fatty acids usually from animal when consumed excessively will significantly increase LDL cholesterol levels. A number of studies performed analysis that suggested that every 1% increase in calories from saturated fats will resulted in 2% increase in LDL levels. High levels of LDL especially those of oxidized one may cause damage and thickening of the blood vessel walls.[4] Different from study by Azarpazhooh et.al.[17] on 431 subjects aged 35–64 years old in Iran that found significant correlation between age ($r = 0.56$, $p < 0.001$), BMI ($r = 0.12$, $p < 0.05$), systolic blood pressure ($r = 0.22$, $p < 0.01$), diastolic blood pressure ($r = 0.19$, $p < 0.01$) and carotid IMT and from multivariate analysis it was demonstrated that age ($p < 0.01$) and male gender ($p < 0.05$) were significant predictor of IMT. Meanwhile in study by Jarauta et.al.[18] on 138 subjects aged 20–79 years old di Spain found that significant factors to IMT were age ($p<0.001$), male gender ($p = 0.027$), systolic blood pressure ($p = 0.029$) and LDL ($p = 0.029$). A longitudinal study in 13 years conducted by Herder et.al[19] di Norway on 2,743 subjects aged 55–74 years old aiming to study long term risk factors and factors affecting IMT progressivity suggested that age and gender were strong predictors for IMT and total cholesterol was a predictor for IMT progressivity.

As recognized from several studies above that male gender is an influencing factor for carotid IMT. In this study, male gender is a controlled variable. Adult male individual has an increased risk of cardiovascular disease compared to female. Pre-menopausal women are relatively more protected against atherosclerosis compared to men of the same ages, without any other risk factors such as obesity, diabetes mellitus, dyslipidemia, or hypertension. Behavior and lifestyle may also affect increased risks in men such as smoking habits, alcohol drinking and poor eating pattern.[20,21] In this study age did not have significant correlation with carotid IMT. This when compared to other previous studies may be due to difference in age criteria in study subjects that is difference in age range. In older ages the possibility of carotid wall thickening development is greater. Age is a non modifiable risk factor for cardiovascular disease, risk increases as age progresses. To anticipate it modification of other risk factors is needed. In atherosclerosis, plaque accumulation develops over the course of years, progressive in nature and usually do not manifest clinically until

reaching critical threshold in the middle or older ages.[20,22]

Conclusion

In this study there was no correlation between fructose intake and carotid IMT. Waist circumference and fat intake have positive significant correlations with carotid IMT. Further multivariate analysis showed that fat intake has a significant positive correlation with carotid IMT.

Conflict of Interest

Authors declare there was no conflict of interest regarding this study.

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OVERVIEW

An Overview of Hydration Status and Its Relation to Occupational Heat Stress among Workers

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Abstract

Working in high temperature environment is unavoidable condition for an outdoor worker, especially the outdoor workers in to tropical countries such as Indonesia. Heat stress leads to various heat-related illnesses, such as heat stroke, hyperthermia, heat exhaustion, heat cramps or heat rashes. A mild and moderate heat stress usually less serious and did not harm general health condition, however it could cause individual fatigue and unfocused, which will interfere the working performance and productivity. Numbers of studies showed that there were strong correlation between occupational related heat stress and workers' hydration status. Unfortunately, there were still very limited recommendation and guideline specifically regulated the importance of hydration toward outdoor worker as well as those who were working in high temperature working environment.

Keywords heat stress, heat-related illness, workers, hydration

Introduction

Working in high temperature environment is unavoidable condition for an outdoor worker, especially for outdoor worker in tropical countries such as Indonesia as well as worker in industry dealing with hot temperature environment. The similar environment also applies to worker in industry or factories with extremely high temperature and heated environment. A study in Indonesia reported that during 2012 – 2013 there were numerous of heat and high temperature occupational exposure cases in Indonesia, which was including 13 death cases and 7 among them were showing heat stress with moderate workload. According to this report, one of the potential medical condition suffered by outdoor workers are heat stress.[1]

Numbers of studies showed that there were strong correlation between occupational related heat stress and workers' hydration status. Unfortunately, there were still very limited recommendation and guideline specifically regulated the importance of hydration toward outdoor worker as well as those who were working in high temperature working environment.

Occupational Heat Stress: Definition and How It Affects Physiology of Worker

Occupational heat stress defined as a net load to which a worker exposed from the various or combined factors or exposures of metabolic heat,

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environmental factors and clothing worn which was results in an incremental heat storage in the body.[2] Heat stress leads to various heat-related illnesses such as heat stroke, hyperthermia, heat exhaustion, heat cramps or heat rashes.[3] A mild and moderate heat stress usually less serious and did not harm general health condition, however it could cause individual fatigue and unfocused, which will interfere the working performance and productivity. Heat stress will had caused physiologic response of the body, as it needs to reduce the increased temperature inside the body, this is known as heat strain condition.[4]

Skin evaporation through sweating were the most dominant mechanism of the body in order to reduce the elevated body temperature. Apart of ambiance temperature, the impermeable clothing would also prevent the normal body evaporation mechanism. ACGIH has defined threshold value for working in hot place to maintain the body's core temperature in +1°C from normal temperature (37°C). The limit of body's core temperature can be excessive under certain conditions with selected populations, environment and physiological monitoring and other controls. Assessment in evaluating whether a worker in extreme hot environment experiences heat stress and heat strains is very important for health professionals to prevent the occurrence of disease caused by heat (Table 1).

Central nervous system

The central nervous system is responsible for the function of thermoregulation. The hypothalamus as part of the central nervous system structure acts as a location to control body temperature. The anterior hypothalamus acts as a thermostat and posterior hypothalamus as a determinant of the set point of core body temperature and initiates a normal physiological response to temperature changes. The ratio of sodium and calcium plays an important role in regulating this thermoregulation system. The posterior hypothalamus is responsible in physiological mechanism to maintain body temperature. When the ambient temperature exceeds the set point, through the sympathetic nervous system, the blood vessels will expand and the sweating process begins, intended to restore body temperature to normal.[6]

Working capacity and muscle work activity

The proportion of aerobic capacity needed to do certain jobs. First, the cardiovascular system will respond to increase oxygen demand when working in a hot environment by increasing pump volume (stroke volume) and heart rate. When stroke volume achieved, an increase need for cardiac output done by increasing the heart rate. Problems will arise if the work intensity is high enough in the hot place and carried out for a long time. Second, muscle work activity is associated with an increase in muscle temperature and will have an impact on the body's core temperature, which in turn will affect the thermoregulation control. Third, the high workload in a hot environment can result in insufficient oxygen tissue demand.[7]

Circulation system

The circulation system is responsible in oxygen distribution and nutrients to all body's tissue. In certain conditions, the heart is unable to fulfill oxygen and body heat expenditure needs. The autonomic nervous system and endocrine system will help blood flow to overcome this need.[8]

Sweating mechanism

Sweat glands founded in almost all skin tissue. This gland stimulated by sympathetic nerve and produce hypotonic fluid out of the skin surface. Sweat production up to 1 L/hour in industrial worker recorded and illustrated a large body cooling process. Each liter of sweat produced represented 580 kcal of heat to the environment. Too much sweat loss will threaten the function of thermoregulation due to a decrease for body fluids progressively and if the body fluids is not replaced immediately, the body temperature will rise rapidly. The main composition of sweat is salt or sodium chloride.[9]

Table 1. Health effect to hot environment exposure

Disorder	Cause	Symptoms	Treatment
Heat Cramp	Excessive sweating with loss of body's salt	- Ache, spasm in the arm, feet and stomach - Sudden - Hot and moist skin	- Drink water - Massage in cramp area - Take a rest
Heat Exhaustion	Dehydration non acclimatization	- Excessive sweating - Thirsty - Pale, moist and cold skin - tachycardia - Fatigue - Fainted	- Move to the shady area or air conditioned room - Take a rest with higher feet - Loosen the clothes - Drink water
Heat stroke	Excessive heat exposure and lead to body regulator to malfunction	- Body temperature increase - Sweat decrease - Redden, hot, and dry skin - Breath difficulties	- Emergency action - Emergency call - soak the patient in water - Cold compression

Source: ACGIH TLVs & BEI Book 2011

Salt requirement in normal people is 2.3–3 grams per day, but loss of fluid while working in moderate activities in hot environment reaches an average of 0.8 liters per hour, so the sweat that is produced every 8 hours can reach more than 6 liters per day, while sodium loss that comes out with sweat can reach 4.8–6 grams which is equivalent to 10–15 grams of salt.[10]

Potassium loss in sweat can also lead to blood potassium deficiency, which will lead to heat stroke. Fluids replacement for loss of fluid due to sweating is very necessary. If fluid is not immediately given, there will be a shrinkage of the extracellular and interstitial spaces and plasma volume. Evidence show that sweat production is highly dependent on hydration status, so hypo hydration progression can be caused by excessive sweating and will increase body temperature which will lead to danger of heat stroke.[9,10]

Heat acclimatization

Workers exposed to heat will show distress signs and discomfort characterized by body temperature and pulse increase, headache, nausea and even fainting. The level of acclimatization determined by workers' physical fitness and the work period in the hot place.[11]

Heat Related Illness among Outdoor Workers

When the body tries to tolerate hot temperatures, the body will experience heat stress, which manifests in body temperature and pulse increase. The body will compensate for the hot environment by sweating to reduce body temperature. If the humidity is high enough, the sweat will be difficult to get out, which prevents the body from releasing heat quickly. If this condition occurs continuously, workers can experience heat related illness such as heat cramps, heat exhaustion and even heat stroke that can lead to death.[12]

In a study conducted in several mining plant in Australia, reported that 40% of mining workers working in hypo hydration status (mild to severe),[13] while in a study conducted in India of 58 firefighters, 20% of firefighters had a health impact

caused by heat exposure in the form of heat exhaustion 18.3%, heat cramps 6.2% and heat syncope at 4.1%.[14] Factors influence heat stress are age, sex, acclimatization, health status, body mass index, type of clothing used, direct exposure to sunlight, fluid intake, and workload.[10]

Of these factors, fluid intake is the easiest factor to control in preventing the effects of heat stress on workers. The type of fluid consumed to replace electrolyte loss due to sweating is a factor that needs to be investigated in an effort to prevent the effect of heat stress. The variation in the body's response to heat exposure varies from mild to severe. This disorder triggered by an increase in body core temperature with lack of fluid complication. The prognosis depends on rapid treatment to reduce body temperature and fluid and electrolyte intake (Table 1).[9, 10, 13]

Hydration Status and Heat Stress in Outdoor Workers

Most of the studies in heat acclimatization[15-19] focused on physiological responses to heat. In terms of physiological adaptation, long-term heat-acclimatized individuals are reportedly to have smaller rises in core temperature during heat exposure [20,21] and an advantage in body fluid regulation[19], in which they indicate the ability to deal with stress from any given heat exposure.[22,23]

Numbers of literature to date examining the effects of hydration status on cognition, exercise in the heat used as the dehydration protocol. Such studies typically result in hypo hydration of ~ 2% body mass loss and have demonstrated decrements in various cognitive functions, including working memory, vigilance and perception.[24–28] However, some studies have reported no effect of exercise induced hypo hydration on short-term memory, concentration and choice reaction time.[29–31]

In resting conditions, the body requires fluid intake of 2 liters per day, and in moderate physical activity, fluid requirements can increase to 3.5 liters per day. Fluid loss while working in moderate activities in hot environments reach an average of 0.8 liters per hour, so the sweat that is produced every 8 hours can reach more than 6 liters per day, while sodium loss that comes out with sweat can reach 4.8–6 grams which is equivalent to 10–15 grams of salt.[10]

Drinking and Rehydration to Treat Heat Stress

Working in hot temperature environment, the body will be easily dehydrated due to sweat production as body mechanism to release heat generated from physical activity. Too much sweat production will release electrolyte. Salt is the most excreted electrolyte with an average loss of 4.8 – 6 grams of sodium for 8 hours of working or equivalent to 10 – 15 g of salt. Significant loss of electrolyte in the worker in extreme hot environment, need electrolyte replacement from fluid intake. Appropriate ion drink will provide a quick replacement for the body's electrolyte loss.[32]

Although the American College of Sports Medicine Guidelines on Nutrition and Athletic Performance recommend the amount of fluid intake.[33] In a recent study shows that deep-ocean water taken from the coast of Hualien, Taiwan at a depth of 662 m improves recovery following a dehydrating exercise, evidenced by accelerated recovery of aerobic capacity, increased lower-body muscle power performance and significantly reduced levels of exercise-induced muscle damage markers compared to participants drinking purified tap-water.[34]

Another study reported that a deep-ocean mineral water was shown to increase the exercise performance of gerbils, compared to distilled water, measured by retention rates during a 90-min treadmill exercise.[35] Considering the established connection between hydration status and exercise performance, these data suggest that mineral water may provide optimal rehydration for performance recovery following high-intensity exercise. A study suggested that mineral water had the potential to improve lower-body muscle strength as well as acute rehydration rate after dehydrating exercise.[36]

Conclusion

Potential risk of heat stress and heat related illnesses are higher among outdoor and high temperature work place-based workers. The mechanism and pathophysiology of heat stress and heat related illnesses are well studied, however an

intervention study focus on rehydration are still needed to demonstrate the benefits of it in reduce the heat stress and heat related illnesses in high risk population of workers.

Conflict of Interest

AM currently is The Leader of Occupational Health and Medicine Chief SKK MIGAS, RWB is Head of Medical Nutrition Services Department in Nestle Nutrition Institute Indonesia. Other author declares no conflict of interest.

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ABSTRACT

Correlation Between Docosahexaenoic Acid Intake and It's Content in Breast Milk of Lactating Mothers in Jakarta

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Objective: Docosahexaenoic acid (DHA) is the predominant structural fatty acid in the brain and one of the most important nutrient for cognitive development in early life. During early life, there is very limited metabolic capability to convert omega-3 fatty acids to DHA. Therefore, newborn intake of DHA completely depends on preformed DHA in mother's breast milk. This study aims to determine DHA intake among lactating mothers and their association with breast milk's DHA.
Methods: This cross-sectional study was conducted in Grogol Petamburan and Cilincing Public Health Centre in Jakarta. Eighty healthy lactating mothers aged 20–35 years old in 1–6 months postpartum was taken using consecutive sampling method. Mother's DHA intake was assessed with a semi quantitative food frequency questionnaire. Post-feed breast milk specimens were collected in the morning, transported with cool boxes, and stored in the laboratory at -70° C before the analyses. Breast milk DHA content was analyzed using Gas Chromatography with Mass Spectrometry. Descriptive analyses and Spearman rho test was used with a 95% confidence level.
Result: This study showed the median of subjects' DHA intake was 158.5(13.9–719.7) mg/day, i.e. 67.5% of the subjects was below Food and Agriculture Organization (FAO) recommendation (200 mg/day). The median of breast milk DHA was 51.7(19–184.7) mg/day, only 42.5 % of the subjects had breast milk DHA to meet the minimal requirement of their infant based on FAO recommendation (0.1% of total energy requirement). There was a moderate correlation between subject DHA intake with breast milk's DHA content ($r = 0.478$, $p < 0.001$).
Conclusion: More than half of the subjects had DHA intake below FAO recommendation. Our finding showed a positive moderate correlation between DHA intake and breast milk DHA among lactating mothers.
Keywords: docosahexaenoic acid, DHA, breast milk, lactating mothers

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ABSTRACT

Zinc Deficiency Among Lactating Mothers in Jakarta : Associated Factors

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Background: Deficiency of zinc is prevalent worldwide mostly in developing countries. However, its prevalence among vulnerable group such as lactating mothers is still unknown in most populations.
Objectives: This study aimed to determine the prevalence of zinc deficiency among lactating mothers in Jakarta and factors that influence it.
Methods: A cross sectional study was conducted in Puskesmas Kecamatan Grogol Petamburan, West Jakarta and Puskesmas Kecamatan Cilincing, North Jakarta between February and April 2019. A total of 75 lactating mothers at 3–6 months postpartum, aged 20–40 years old were recruited using consecutive sampling method. Subjects were interviewed for education levels, occupation, physical activity, types of breastfeeding (exclusive or not), and numbers of parity. Dietary assessment of zinc and protein was carried using semi quantitative food frequency questionnaire (FFQ). Weight and height were measured to assess the body mass index (BMI). Blood samples were taken to analyze serum zinc concentrations. Descriptive analysis, one way ANOVA, and unpaired t-test were used, p-values ≤0.05 were considered significant.
Results: The mean of serum zinc was 62.33 ± 11.89 and zinc deficiency was found in 76% of the subjects. There were no significant differences of serum zinc related to education levels, occupation, types of breastfeeding, number of parity, zinc intakes, protein intakes, and categories of BMI. Significant difference of serum zinc was found between levels of daily physical activity (p = 0.008) – light, moderate, and vigorous.
Conclusion: Zinc deficiency was prevalent among lactating mothers in Jakarta. There was a significant difference of serum zinc between different levels of daily physical activity.
Keywords: zinc, lactating, breastfeeding, physical activity

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ABSTRACT

Correlation Between Hair Zinc Level and Cognitive Function in Elderly

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Background: Neurodegenerative disease is the most problem in elderly. Amyloid β (Aβ) accumulation is the major cause of cognitive impairment. Zinc has an important role in antioxidant and Aβ accumulation process.
Objectives: This study aimed to evaluate the correlation between hair zinc level and cognitive function in elderly.
Methods: A cross sectional study was conducted involving 58 subjects of elderly in Jakarta. Subjects were recruited by consecutive sampling. Hair zinc level was measured by inductively coupled plasma emission spectrometer (ICPS) and cognitive function assessed by abbreviated mental test (AMT). Data analysis was done by spearman rank correlation test and p-value less than 0.05 was considered statistically significant.
Results: The mean of age was 65.4 ± 4.4 years old and 56.9% of subjects were female. The mean of hair zinc level was 123.23 ± 69.71 µg/gram hair and 32.8% subjects had hair zinc deficiency. There was 91.4% subjects had normal cognitive function. The study showed no correlation between hair zinc level and cognitive function in elderly (p=0.871; r= -0.022).
Conclusion: There was no correlation between hair zinc level and cognitive function in elderly. Further research is expected to be performed with different level of cognitive function.
Keywords: hair zinc level, cognitive, elderly

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ABSTRACT

Correlation Between Serum High Sensitivity C-Reactive Protein with Dietary Intake of Indonesian Lactating Mothers

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Background and Objectives: Chronic low-grade inflammation has emerged as important pathophysiology of non-communicable diseases, which can cause negative effects to mother and baby. Dietary intake has been known as important factor to affect inflammation, which can be measured by high-sensitivity C-reactive protein (hs-CRP). This study aimed to examine the correlation between serum hs-CRP with dietary intake in lactating mothers.
Methods: A cross-sectional study was conducted by consecutively enrolling 71 lactating mothers, 3-6 months post-partum, age 20-35 years old, visiting Grogol Petamburan and Cilincing community health center between February and April 2019. Dietary assessment was conducted using semi-quantitative food frequency questionnaire. Anthropometric measurements included were pre-pregnancy weight, post-partum weight, and body height. Serum hs-CRP was measured by immunoturbidimetry method. Spearman correlation was used, with $p<0.05$ considered significant.
Results: Correlation was found between serum hs-CRP and energy ($r = 0.372$, $p = 0.001$), carbohydrate ($r = 0.295$, $p = 0.013$), and vitamin B6 ($r = -0.285$, $p = 0.016$) intake. We also found that serum hs-CRP was correlated with pre-pregnancy ($r = 0.296$, $p = 0.012$) and post-partum BMI ($r = 0.430$, $p<0.001$).
Conclusion: Energy, carbohydrate, and vitamin B6 intakes are positively correlated with serum hs-CRP level.
Keywords: C-reactive protein, dietary intake, breastfeeding

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ABSTRACT

Vitamin E and Vitamin C Intakes Among Lactating Mothers in Jakarta

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Background and Objective: Vitamin E is a lipid soluble vitamin which is obtained only through diet. Vitamin E has many functions including antioxidant and well known to prevent lipid peroxidation in cell membrane. Vitamin C helps to regenerate vitamin E back into non radical. Vitamin E and C intakes among vulnerable group such as lactating mother are still unclear, especially in Jakarta. The aim of this study to determine level of vitamin E and C intake among lactating mothers in Jakarta
Method: A total of 60 lactating mothers aged 20–40 years old in 1–6 months postpartum were recruited in Grogol Petamburan and Cilincing Public Health Centre in Jakarta. This cross sectional study held from March 2019 until April 2019. Vitamin E and C dietary intake were collected using semi quantitative food frequency questionnaire. Descriptive analysis was used in this study.
Results: This study showed that median value of vitamin E intake was 6.50 (1.20-43.10) gram/day with 91.7% subjects does not meet vitamin E recommended daily intake (RDA) recommendation (19 gram/day), otherwise 70% vitamin C intake was above RDA recommendation (100 gram/day) with median value is 120.05 (23.0-479.2) gram/day.
Conclusion: Vitamin E intake among lactating mothers in Jakarta was not adequate and far below RDA recommendation but vitamin C intake among lactating mothers in Jakarta was adequate and met RDA recommendation.
Keywords: Vitamin E, Vitamin C, lactating, breastfeeding mothers

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ABSTRACT

Profiles of Nutrition and Non-Nutrition Factors Related to Anemia Status Among Lactating Mothers in Jakarta

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Background and Objective: Anemia is a major health problem affecting every phase of life. However less attention given to lactating mothers where anemia can give bad impacts to the mothers themselves and their babies. Less knowledge also known about nutrition and non-nutrition factors related to anemia. Therefore, this study aims to profile nutrition and non-nutrition factors related to anemia status among lactating mothers.
Method: This cross-sectional study was conducted in Grogol Petamburan and Cilincing Public Health Centre in Jakarta in February–April 2019. Seventy fours lactating mothers aged 20–35 years old who delivered within the last 3–6 months recruited using consecutive sampling method. Nutrition factors examined were energy, protein, iron, folate, vitamin B6, vitamin B12, vitamin C intakes, and body mass index (BMI). Non-nutrition factors examined were level of education and family income. Basic characteristic data was collected by interview and dietary intake was assessed using a semiquantitative-food frequency questionnaire and 24-hours food recall for two non-consecutive days. BMI and laboratory assessments (haemoglobin, ferritin serum, and c-reactive protein) were done.
Results: Anemia prevalence was 8% and 11% was iron deficient. Prevalence of iron deficiency anemia was 3% (37.5% from prevalence of anemia). Based on Indonesia Recommended Dietary Allowance, around 58% subjects had low iron intake, 39% with low vitamin B6 intake, 27% with low vitamin B12 intake, 40% with low vitamin C intake, and no subject with low folate intake. Around 53% of subjects had BMI < 22.9 kg/m^2. Almost 70% of the subjects had middle level of education and 50% had family income lower than regional minimum wage.
Conclusion: Prevalence of anemia among lactating mothers in Jakarta was 8%. Non-nutrition factors had higher proportion compared to nutrition factors related to anemia status. Further studies are needed to determine the possible causes of anemia in lactating mothers.
Keywords: anemia, Indonesia, iron deficiency anemia, lactating mothers

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ABSTRACT

Correlation of Beta Carotene and Nutrition Status with Malondialdehyde Levels in Breastfeeding Mothers

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Background: Malondialdehyde (MDA), one of the products of polyunsaturated fatty acid (PUFA) peroxidation detected in breast milk (BM). MDA levels depicted BM's oxidative status. BM oxidative balance could prevent oxidative stress in babies. MDA could be influenced by antioxidant food source such as beta carotene as well as body mass index (BMI).
Objective: To analyze beta carotene intake and BMI and their correlation with BM MDA levels in nursing mother
Methods: Eighty breastfeeding mothers who were 20–40 years old, came to Cilincing and Grogol Petamburan Public Health Centre February–April 2019 and had 1–6 months old babies were enrolled in this cross-sectional study. The BM was extracted in the next day. Mothers were asked to empty one of the breast 2 hours prior to extraction. Beta carotene intake was assessed using semi quantitative food frequency (SQ-FFQ). Body weight and height was measured on the first day. The BM MDA levels were assessed using thiobarbituric acid reactive substance (TBARS) assay. The correlation of beta carotene intake and MDA as well as BMI and MDA was assessed using Spearman test with level of significance of $p<0.05$.
Results: Subject's median age was 27 (20–35) years old, median BMI was 23.21 (15.25–39.55) kg/m^2. Beta carotene's median intake was 8039.8 (1697.7–34028) µg/day with 72.5% of the subjects were considered to have low intake. BM MDA level's median was 1.953 (0.739-4.928) nmol/ml. Beta carotene intake ($r = 0.247$, $p = 0.027$) and BMI ($r = 0.285$, $p = 0.010$) had a weak correlation with BM MDA level.
Conclusion: The beta carotene intake and the BMI of the subjects correlate significantly with the BM MDA level. It showed that the mother's intake and body composition contribute to the oxidant level in BM, therefore influenced the level of oxidative stress transferred to the babies.
Keyword: Breast milk, MDA, breastfeeding, beta carotene, babies

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ABSTRACT

Association between Exclusively Breastfed Infant and Picky Eating Behavior in Children below Five Years Old: A Cross-Sectional Study

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Background: Picky eating behaviors are prevalent during childhood and often linked to nutritional problems. Environmental factors play a role in taste and eating preferences, such as genetics, learning experiences, and culture including exclusive breast fed for six months. Nutritional problems deserve special attention for its long term consequences such as malnutrition, stunting, infection, social and cognitive impairment. In Indonesia, 50-60% parents have problems with picky eating behavior with their children.[1]
Objective: To investigate association between exclusively breastfed infant and picky eating behavior.
Methods: A cross-sectional study with purposive sampling was performed in 208 children at age below 5th years old in Serang. To assess picky eating behavior, the writer use Children Eating Behavior Questionnaire especially for food fussiness section (CEBQ-FF). Based on WHO recommendation, breast fed infant is infants that receive only breast milk for 6 months as an optimal way of feeding infants. Statistical analysis using chi square with p value < 0.05 considered being significant and odds ratio >1 considered have causal effect.
Results: Among 208 children, there are 123 children (59%) that have picky eating behavior and 43 children of them are exclusively breast fed. There is a relationship between exclusively breast fed infant and picky eating behavior (p=0.037). Exclusively breast fed is protective to picky eating behavior in children below 5th years old (OR= 0.43; CI 95%=0.51-0.6).

Exclusive breast fed	Picky eaters		p value	OR (95% CI)
	Yes	No		
Yes	43	47	0.037	0.43 (0.51-0.6)
No	80	38		

Conclusion: From this study, there are 59% children that have picky eating behavior. Exclusively breast fed for six months is protective to picky eating behavior in children below 5th years old, which corresponds well with WHO recommendations.

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ABSTRACT

Correlation between Omega-3 Fatty Acids Plasma Levels with Muscle Mass and Handgrip-Muscle Strength in Head Neck Cancer Patients undergoing Radiotherapy in Ciptomangunkusumo Hospital, Jakarta

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Background: Cancer cachexia is common in head neck cancer caused by increasing pro-inflammatory cytokines, has effect on hypermetabolism, increased nutritional needs, anorexia, decreased muscle mass and body weight. Omega-3 fatty acids play a role in reducing inflammation, improving muscle mass and handgrip.
Objective: This cross sectional study, conducted in Department of Radiotherapy Dr. CiptoMangunkusumo Hospital, aimed to investigate correlation between omega-3 fatty acids plasma with muscle mass and hand grip-muscle strength in head neck cancer subjects undergoing radiotherapy.
Methods: This study was conducted from June to August 2016. The subjects were head neck cancer patients in stage I–IV (18–65 years old) and had received >25 times radiation, and obtained by consecutive sampling method. Total omega-3 fatty acids intake was obtained by semi quantitative Food Frequency Questionnaire. Anthropometric measurements used ShorrBoard and Smic® ZT-120, muscle mass used Omron HBF375®, and handgrip used Jamar® dynamometer. Omega-3 fatty acids plasma were examined by gas chromatography flame ionized detector. Correlation omega-3 fatty acids plasma with muscle mass were analyzed by Pearson, and correlation with handgrip by Spearman.
Results: There were 52 subjects completed all examinations, received radiotherapy ≥25 times combined with chemotherapy, 57% male, 50 years old. Most sites at nasopharynx, mostly stage IV, 25% subjects had normal body mass index, 75% were low. Most subjects had nutritional problems caused by inadequate intake of energy, protein, fat, and omega-3 fatty acids. Majority (75%) had small muscle mass (28.4±4.7%), mostly (75%) normal handgrip, median 37.1(25.7–68.5) kg, and all subjects had very low omega-3 fatty acids plasma (2.5±0.8%). There was strong correlation between omega-3 fatty acids plasma with muscle mass ($r = 0.6$, $p < 0.05$) and handgrip ($r = 0.8$, $p < 0.001$) who received radiotherapy (>60–70 Gy), no correlation less than those doses.
Conclusion: There was correlation between omega-3 fatty acids plasma with muscle mass and handgrip, at radiotherapy doses >60–70 Gy.

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Keywords: head neck cancer, radiotherapy, omega-3 fatty acids, muscle mass, handgrip

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ABSTRACT

Zinc Intake in Lactating Mothers in Jakarta

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Background: Maternal zinc deficiency may cause hindrance in breast milk ejection and low zinc content in breast milk. This may cause zinc deficiency in babies. Therefore, adequate zinc intake is crucial to maternal and baby's health. Food source of zinc are mainly protein rich foods. High intake of fiber may decrease zinc bioavailability as they usually contain phytate.
Objective: This study aimed to profile zinc, total protein, and fiber intake among lactating mother in Jakarta.
Methods: This was a cross sectional study conducted in Grogol Petamburan Public Health Center, West Jakarta and Cilincing Public Health Center, North Jakarta between February and April 2019. Consecutive sampling method was used to recruit 95 lactating mothers aged 20-35 who were nursing 1-6 months old babies. Basic characteristic data such as socioeconomic level and education level was collected during interview process. Semi questionnaire food frequency questionnaire was used to gain zinc intake data and 24 hours food recall was used to gain protein and fiber intake data.
Results: The prevalence of zinc deficiency in Jakarta was 76.8% although 56% had taken enough daily protein. 99% of the samples had low fiber intake. Around 47% of subjects have monthly income lower than regional minimum wage and 68% of the samples has middle level of education.
Conclusion: Zinc intake among maternal diet in Jakarta is below the recommendation although more than half of the samples had taken enough daily protein and very low fiber. The protein intake must furthermore be specialized into animal and vegetable protein to increase the accuracy of the data. A specialized education about the importance of zinc for maternal health and food sources of zinc must be conducted among lactating woman. The need of zinc supplementation might be considered.
Keyword: Zinc, lactating, maternal diet, socioeconomic level, education level

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