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## Anthropometric Measurements and Inflammatory Marker in Obese Women

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### ABSTRACT

**Background:** Obesity is one of global epidemic health problems and its prevalence is higher among women. Obesity can cause low grade chronic inflammation mechanism in adipose tissue, which is characterized by the increase of proinflammatory cytokines and adipokines. Neutrophil lymphocyte ratio (NLR) is a simple inflammatory marker which can be reliable in evaluating the inflammatory status occurring in obese women. Waist to height ratio (WHtR) and waist to hip ratio (WHR) are anthropometric measurements, have been reported to be associated with obesity and risk of metabolic syndrome.

**Objective:** This study aimed to determine the correlation of WHtR and WHR with NLR in population of obese women.

**Materials and Methods:** This was a cross sectional study enrolling 80 obese women with Body mass index (BMI) > 27 aged 30 - 50 years in National Diponegoro Hospital Semarang, Indonesia. WHtR was determined by dividing waist circumference by height and WHR was determined by dividing waist circumference by hip circumference. NLR was examined manually from automatic hematology analyzer by dividing absolute neutrophil count (ANC) and absolute lymphocyte count (ALC). Spearman correlation test was performed,  $p < 0.05$  was considered as statistically significant.

**Results:** There was significant weak positive correlation between WHtR and NLR in obese women ( $p = 0,046$ ;  $r = 0,224$ ). There was no significant correlation between WHR and NLR in obese women ( $p = 0,961$ ;  $r = 0,006$ ).

**Conclusion:** The present study showed that WHtR is one of better anthropometric measurement because it is associate with NLR as a simple marker of inflammation in obese women.

**Keywords:** WHtR; WHR; NLR; Obesity

### BACKGROUND

Obesity is one of the global health problem whose prevalence continues to increase every year. World Health Organization (WHO) in 2016 stated that 1.9 billion adults with 18 years of age or over are overweight and more than 650 million are obese. Based on WHO, approximately 13 % of world adult population were obese that more cases found in woman (15%) than man (11%)<sup>1</sup>. Results of Basic Health Research (Riskesdas) 2007-2018 in Indonesia also shows an increasing trend of obesity, namely 10.5% (2007), 14.8% (2013) and 21.8% (2018)<sup>2</sup> and in Central Java, Indonesia prevalence obesity cases in woman (27,53 %) are higher than in man (13.09 %)<sup>3</sup>.

Obesity is defined as s abnormal or excessive fat accumulation that presents a risk to health. Obesity increase the risk of chronic diseases including type 2 diabetes mellitus (Type 2 DM) and cardiovascular disease<sup>4</sup>. There are two types of obesity based on where fat accumulate in body namely android obesity and gynoid obesity. Abdominal, central, or android obesity characterized by fat distributed around the waist or Gynoid obesity that fat accumulate in the lower part of the body<sup>5</sup>. Risk factor of obesity are multifactorial including genetic, lifestyle, and environmental factors<sup>6</sup>. Women are more at risk for obesity than men because they have more sedentary lifestyle like physical inactivity, consumption food that high simple sugar, high calories and fat that are risk factor of obesity<sup>7</sup>. Body Mass Index (BMI) is anthropometric measurements which is more often used as a parameter of obesity. WHO criteria for obesity are if BMI is  $\geq 30$  kg/m<sup>2</sup>, while this study refers to the classification of obesity for Asia Pacific population which is having BMI  $\geq 27$  kg/m<sup>2</sup><sup>8</sup>. Waist Circumference (WC), Waist to Hip Ratio (WHR), Waist to Height Ratio (WHtR) are another anthropometric measurements that also can be used to predict obesity. Kwang Pil Ko et al stated that WHR is a better method

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of predicting metabolic syndrome in obesity than WC, WHtR, and BMI<sup>9</sup>. A meta-analysis study by Labarrere et al in more than 300,000 multi-ethnic people, shown that measuring obesity with WHtR can better explain its association with cardiometabolic risk from inflammation than using BMI and WC<sup>10</sup>.

Obesity has a negative impact on tissues and body systems related to inflammatory mechanisms. Low grade inflammation due to obesity has been demonstrated in several studies using various markers of inflammation. Obesity measured using BMI parameters was shown to be positively associated with increased CRP levels, leukocyte count, IL-6, tumor necrosis factor alpha (TNF- $\alpha$ ), and neutrophil lymphocyte ratio (NLR)<sup>11</sup>. Neutrophil lymphocyte ratio is effective, simple, inexpensive parameter of inflammation and widely examined in various laboratory<sup>9</sup>. During the inflammatory process, neutrophil count can be increased up to five times the normal number, while the lymphocyte count tends to be constant due to continuous recycling by lymphoid tissue, lymph and blood. This difference in the distribution of cells during inflammation is the basis for the use of NLR. Neutrophil lymphocyte ratio is considered more stable as a marker of inflammation than the absolute leukocyte count which can change according to physiological and pathological conditions<sup>12</sup>. No further study on the correlation between WHtR and WHR and the NLR value in Indonesian obese women. This encourages researchers to determine the correlation between WHtR and WHR and NLR values in obese women.

## MATERIALS AND METHODS

This cross-sectional study was conducted in July - September 2020 at the Diponegoro National Hospital Semarang, Central Java, Indonesia.

### Subject of Study

Minimum subject for this study was 46 people that was calculate with formula below:

$$n = \left( \frac{Z_{\alpha} + Z_{\beta}}{0,5 \ln \frac{1+r}{1-r}} \right)^2 + 3$$

Although minimum subject for this study was 46 people, total subject in this study was eighty obese women with criteria aged 30-50 years, body mass index (BMI)  $\geq 25$  kg/m<sup>2</sup>, healthy and having normal vital sign, and have regular menstrual cycles for 6 months before join the study. Subjects which have history of DM, subjects with cardiovascular disease, hematological abnormality, or pregnant at the time this study was conducted, were excluded from this study. Screening for subject in this study that meeting all criteria using short interview and simple screening form.

#### a. Antropometric Measurements

##### 1. Body Mass Index (BMI)

Body mass index (BMI) in this study were calculated using weight data that obtained by using a digital scale and height data using microtoa with formula:

$$\text{Body Mass Index : } \frac{\text{Weight (kg)}}{\text{Height (meter)} \times \text{Height (meter)}}$$

##### 2. Waist to Hip Ratio (WHR) and Waist to Height Ratio (WHtR)

Waist circumference was measured with inelastic band at the midpoint between the last rib and the anterior superior iliac crest at the end of respiratory movement of expiration in standing position. Hip circumference was measured over thin clothing at the point of the maximum circumference of the buttocks. Both circumferences were measured to the nearest 0.1 cm.

#### b. Blood Analysis

Blood was collected by venipuncture and tested using automatic hematology analyzer (Sysmex XN L Series XS 500, Sysmex Asia Pacific Pte Ltd.) for absolute neutrophil count (ANC) and absolute lymphocyte count (ALC). The NLR value was calculated manually from ANC divided by ALC.

Statistical analysis in this study was performed in this study by SPSS 16.0, Correlation Test using Pearson if data from this study normally distributed and Spearman correlation test if data not distributed normally with  $p < 0.05$  was considered as statistically significant. This study was obtaining an ethical clearance from the Health Research Ethics Commission of the Faculty of Medicine, Diponegoro University / RSUP Dr. Kariadi Semarang No. 32/EC/KPEK/FK-UNDIP/III/2020. Study subjects were providing written informed

consent.

**RESULTS**

**Subjects Characteristics Data**

Total respondent in this study was 81 respondents, only 80 respondents that met the inclusion criteria. The mean age of respondent in this study was  $36.61 \pm 5.20$  years with mean body mass index (BMI) were  $31.97 \pm 4.49$  kg/m<sup>2</sup> and have regular menstrual cycles. Mean Waist Circumference respondent in this study were  $93.86 \pm 9.15$  cm with WHtR and WHR score were  $0.85 \pm 0.06$  and  $0.61 \pm 0.06$ . Respondent mean leukocytes count, neutrophil, and lymphocyte in this study were  $7.08 \pm 1.48$  (10<sup>3</sup>/μL),  $61.15 \pm 5.95$  (%),  $30.32 \pm 5.58$  (%). Average Neutrophil Leucocyte Ratio respondent in this study were  $2.13 \pm 0.63$ . The baseline characteristics of the subjects is presented in table 1.

**Table 1. Data on the Characteristic of Research Subjects**

Parameter	Mean ± SD	Min – Max
Age (years)	36.61	3
Body weight (kg)	76.83 ±	60.4 –
Height (cm)	154.93	145.0 –
BMI (kg/m <sup>2</sup> )	31.97	27.00 –
WC (cm)	93.86	80.00 – 1
WHR	0.85	0.71
WHtR	0.61	0.52
Leucocyte (10 <sup>3</sup> /μL)	7.08	4.50 –
Neutrophil (%)	61.15	47.00 –
Lymphocyte (%)	30.32	19.00 –
NLR	2.13	1.04

BMI : Body mass index, WC : Waist circumference, WHR: Waist to hip ratio, WHtR : Waist to height ratio

The Spearman correlation analysis test between WHtR and NLR showed  $p = 0.046$ ;  $r = 0.224$ , this indicates that there is a significant correlation between WHtR and NLR in obese women. The Spearman correlation analysis test between WHR and NLR showed  $p = 0.961$ ;  $r = 0.006$ , this indicates that there is no significant correlation between WHR and NLR in obese women. The results of the correlation test are shown in Table 2.

**Table 2. Spearman Correlation Test Result of WHtR, WHR, and NLR in Obese Women**

Variable	NLR	
	r	p
WHtR	0.224	0.046*
WHR	0.006	0.961

\* = p value <0.05 is significant

**DISCUSSION**

**Obesity**

In this study we determined several anthropometric measurements include Body Mass Index (BMI), Waist to Hip Ratio (WHR) and Waist to Height Ratio (WHtR). Body mass index (BMI) is common anthropometric measurements as parameter of obesity. People with BMI score  $\geq 25$  kg/m<sup>2</sup> categorized as obese people. All respondents in this study have met the criteria of obesity from BMI score. Lowest BMI score in this study was  $27$  kg/m<sup>2</sup> and highest BMI score was  $52$  kg/m<sup>2</sup>. Obesity is characterized by the accumulation of body fat and unfortunately, body mass index (BMI) cannot be used to determine body fat composition. Someone who has  $\geq 25$  kg/m<sup>2</sup> not necessarily having high body fat percentage because body weight also consist of muscle mass.

Waist Circumference (WC), Waist to Hip Ratio (WHR) and Waist to Height Ratio (WHtR) can be used as a better indicator to determine obesity. Waist circumference (WC) is better indicator that can predict fat deposit in abdominal area. Lowest waist circumference respondent in this study is  $80$  cm that has been

categorized as obese for adult Asian people ( $\geq 80$  cm)<sup>13</sup>. The WHtR distribution in this study ranged from 0.52 to 0.77. The criteria for central obesity were enforced if the WHtR was  $\geq 0.5$  so that all study subjects met the criteria for central obesity<sup>14</sup>. The WHR distribution of study subjects ranged from 0.71 to 1.00. The cut off points of WHR according to WHO is  $\geq 0.85$  in women to categorized people having central obesity<sup>15</sup>. There are 42 (52.50%) study subjects who fall into the criteria for central obesity and 38 (47.50%) study subjects who do not meet the criteria for central obesity. According to the previous study by Hastuti et al, 2017 in Indonesia, it is stated that obesity is central if the WHR is  $\geq 0.77$  in women<sup>16</sup>. Based on these criteria, there are 74 (92.50%) research subjects who fall into the criteria for central obesity.

### **Inflammatory Parameters**

This study using Neutrophil Leukocyte Ratio (NLR) to predict inflammatory state in obese respondents. Obese condition can lead to systemic inflammation in body that can increase Neutrophil Lymphocyte Ratio (NLR). An increase in NLR is determined by an increase of neutrophils and or reduction in lymphocytes. An increase in circulating neutrophils is thus suggestive of an acute or chronic inflammatory response. Chronic inflammation stimulating the release of immunoregulatory granulocytic myeloid-derived suppressor cells from the bone marrow, which can increase up to 10% of peripheral leucocyte and suppress lymphocyte counts and function<sup>17</sup>. The increase in NLR in the obese female population can be caused by increased neutrophils. An increase in the number of neutrophils in obesity is an acute inflammatory response to a chronic inflammatory state<sup>18</sup>. Neutrophils describe a nonspecific immune system condition that initiates the body's response to inflammation<sup>19</sup>. High levels of circulating neutrophils are associated with depressed activity of other immune cells such as T-lymphocytes and natural killer cells. Based on the results of several previous studies, obesity causes a chronic inflammatory condition associated with increased secretion of adipokines and cytokines proinflammatory of adipose tissue<sup>20</sup>.

Currently there is no definite NLR intersection point value. Various studies use NLR intervals (ditile or quartile) or use a receiver operator curve (ROC) to classify NLR values. According to study by Patrice Forget et al., (2017) it was concluded that the threshold value of NLR in a non-geriatric adult population with good health was 0.78 - 3.5<sup>21</sup>. Based on these criteria, there were 4 (5.00%) research subjects who had a value NLR above normal. Possibility factor that cause not all respondents having high NLR value is subjects in this study were not grouped based on their degree of obesity. Dixon et al. revealed that a significant increase in the number of neutrophils occurred in severely obese patients (BMI  $>40$  kg/m<sup>2</sup>) due to the mechanism of neutrophil activation by leptin through TNF- $\alpha$ <sup>22</sup>. Atmaca et al. through his study reported that there was no significant increase in the number of leukocytes in mild obesity (BMI  $<35$  kg/m<sup>2</sup>), besides that it was proved that inflammation which is characterized by an increase in the number of neutrophils and lymphocytes is parallel with the severity of obesity<sup>18</sup>.

### **Correlations of WHtR and NLR in Obese Women**

Increased abdominal adiposity has been reported in previous study as major risk factor of metabolic syndrome. Main pathway to describe the correlation between metabolic syndrome and VAT is insulin resistance (IR). Excessive VAT decreasing insulin sensitivity that lead to systemic inflammation beside inflammation also occur in obesity condition<sup>23</sup>. Increased secretion of inflammatory mediators from visceral fat in obese individuals reflects the ongoing chronic inflammation within the adipose tissue of the individual<sup>24</sup>. NLR is one of the inflammation indicator that simple and easy to do with measuring ratio between neutrophil and leucocyte. Spearman test in this study show that there are no significant correlation between Waist to Hip Ratio (WHR) with NLR in obese woman ( $p = 0.961$  and  $r = 0.006$ ) meanwhile, there was a significant weak positive correlation between WHtR and NLR in obese women ( $p = 0.046$  and  $r = 0.224$ ). The results of this study are in accordance with several previous studies. Study conducted by Rodriguez et al. in 2020 stated that WHtR had a significant positive correlation with NLR in the abdominal obesity population ( $p < 0.001$ ;  $r^2 = 0.011$ )<sup>25</sup>. According to Rodriguez, both obese men and women with chronic inflammatory conditions characterized by increased NLR had higher WHtR values. Serbanescu et al. in 2015 through his study also stated that WHtR had a significant positive correlation with NLR in obesity ( $p < 0.001$ ;  $r = 0.203$ )<sup>26</sup>. WHtR is better indicator to identify central obesity that have higher risk to lead systemic inflammation. According to the Bener study in 2013, WC and WHtR are anthropometric parameters that have a better correlation with central obesity than WHR and BMI and can be used as predictors of cardiovascular and metabolic disease<sup>27</sup>.

### **Correlations of WHR and NLR in Obese Women**

There was no significant correlation between WHR and NLR in obese women ( $p = 0.563$  and  $r = -0.74$ ). The results of this study differ from several previous studies. Study conducted by Carranza et al. in 2020 states that there is a significant positive correlation between WHR and NLR in a population of obese women at premenopausal age ( $p < 0.05$  and  $r = 0.374$ )<sup>28</sup>. Differences in study conducted by Carranza et al. with this study is the subject inclusion criteria. The inclusion criteria in the Carranza study were obese premenopausal women (42 - 55 years) with vasomotor symptoms indicating decreased estrogen. Whereas in this study the subjects were obese women of productive age who still experienced regular menstruation.

The results of this study are consistent with the study of Dev et al. in 2012 which revealed that WHR was not significantly associated with several markers of inflammation, especially CRP in obese non-comorbid female subjects. According to Dev, WHR is not as good as WC in explaining the correlation between increased markers of inflammation<sup>29</sup>.

No correlation between WHR and NLR can be caused by several factors. One of the factors that influence the results is the varied physical activity of the research subjects. According to study by Rias et al. in 2020 shows that moderate and excessive physical activity significantly reduces NLR in a population of women with type 2 diabetes mellitus with and without obesity<sup>30</sup>.

Another factor that can cause an insignificant correlation is that the subjects in this study were not grouped based on the degree of obesity. Dixon et al. revealed that a significant increase in the number of neutrophils occurred in severely obese patients ( $BMI > 40 \text{ kg/m}^2$ ) due to the mechanism of neutrophil activation by leptin through  $TNF-\alpha$ <sup>22</sup>. Atmaca et al. through his study reported that there was no significant increase in the number of leukocytes in mild obesity ( $BMI < 35 \text{ kg/m}^2$ ), besides that it was proved that inflammation which is characterized by an increase in the number of neutrophils and lymphocytes is parallel with the severity of obesity<sup>18</sup>.

The age factor also influenced the subject's NLR. According to study by Jian Li et al. in 2015, NLR was positively correlated with age in the healthy adult female population ( $p < 0.001$ ,  $r = 0.119$ )<sup>31</sup>. Jian Li's study showed that the NLR in the 40-49 years age group was higher than the 30-39 years age group. This is because the number of granulocytes shows an increasing trend with age and the number of lymphocytes shows a decreasing trend with age.

The limitation of this study is that only one type of inflammatory marker was used and the subjects were not classified based on the severity of obesity.

## CONCLUSIONS

WHR is one of better anthropometric measurement because it is association with NLR as a simple marker of inflammation.

## ACKNOWLEDGEMENT

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## Provision of Local Food-Based Formula Using *Pila Ampullacea*, Tempeh, and *Moringa Oleifera* Leaves to the Acceptability and Nutrition Intake in Hemodialysis Patients

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### ABSTRACT

**Background:** One of the actions that can be taken to overcome malnutrition in hemodialysis is to improve nutrient intake. It is necessary to provide local food-based formula using *Pila ampullacea*, tempeh with local soybean, and *Moringa oleifera* leaves for hemodialysis patients.

**Objective:** To analyze the effect of local food-based formula using *Pila ampullacea*, tempeh, and *Moringa oleifera* leaves to the acceptability and nutrition intake in hemodialysis patients.

**Materials and Methods:** This study was carried out in Dr. Sardjito Hospital, Yogyakarta, Indonesia from February to March 2020. Subjects were 54 maintenance hemodialysis patients who met the criteria of study. The independent variable was the provision of local food-based formula, while the dependent variable were the acceptability and nutrition intake.

**Results:** As many as 42.59% of subjects were able to consume all the formula given for three days and 50% of subjects have good acceptance of the local food-based formula. The effect of formula intake to the total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, iron showed p-value <0.05, but p-value ≥0.05 for protein, fat, sodium, and potassium. The effect of the non-formula intake to the total intake for all nutrients showed p-value <0.05.

**Conclusion:** Most of the subjects have a good acceptance of the local food-based formula. Formula intake affects total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, and iron, but does not affect total intake of protein, fat, sodium, and potassium. The total intake for all nutrients was affected by the subject's intake of non-formula sources.

**Keywords:** Acceptability; *Moringa oleifera* leaves; Nutrition intake; Snails (*Pila ampullacea*); Tempeh.

### BACKGROUND

Hemodialysis patients are at high risk of experiencing protein energy wasting which increases morbidity and mortality (1). One of the actions that can be taken to overcome malnutrition in hemodialysis is to improve nutrient intake, which can be done by providing additional food during hemodialysis (2). Providing nutritional support to hemodialysis patients can increase protein intake, reduce inflammation, risk of arterial transplant events, cardiovascular events, depression, secondary hyperparathyroidism, and hypertriglyceridemia (3, 4, 5).

Functional food as nutritional support for hemodialysis patients can be made by using a mixture of snails (*Pila ampullacea*), tempeh, and moringa leaves. Each of these local food ingredients contains beneficial nutrients for hemodialysis patients, so that a mixture of the three can form a nutritional support formula that has nutritional content in accordance with the principles of the hemodialysis dietary requirements. The main principle requirements of the hemodialysis diet include the provision of high protein and calcium, but low in phosphorus (6). The priority of providing nutritional support for hemodialysis patients is given orally, which is reported to reduce mortality by up to 35% (7, 8).

Several previous studies related to providing nutritional support to hemodialysis patients have been carried out. Starting from the provision of animal protein sources only in the form of catfish abon which can

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reduce creatinine levels, increase albumin levels, and significantly improve nutritional status based on subjective global assessment, but it can not increase hemoglobin levels of hemodialysis patients (9, 10, 11, 12). The recommendation for protein fulfillment in hemodialysis patients is that 50% of protein needs are met from animal protein and the rest from vegetable protein, which is strengthened by the update of the KDOQI clinical practice guidelines for nutrition in chronic kidney disease in 2020 (13, 14). Previous research related to mixing eel flour as a source of animal protein and tempeh flour as a source of vegetable protein obtained the best proportion of 1:1 (15). Nugget made by mixing eel flour and tempeh flour with a proportion of 1:1 turned out to have a low glycemic index so it can be given to diabetic hemodialysis patients (16). However, these nutritional support products have poor organoleptic results, so a new local food formulation is needed which is predicted to be well received by hemodialysis patients.

The local food-based formula for hemodialysis patients in this study was made from a mixture of local food from snail, tempeh with Indonesian local soybean, moringa leaves, and several food additives such as corn sugar, canola oil, cinnamon powder, rice flour. This formula provides a daily energy contribution of 259.78 kcal, 16.37 grams of protein, 6.23 grams of fat, 34.68 grams of carbohydrates, 6.08 grams of fiber, 1538.32 mg of calcium (17). The nutritional content of the formula has met the requirements for oral nutritional support, which can be given with the addition of 10 kcal/kgBW and 0.3–0.4 grams of protein per kg of body weight every day from daily intake (18).

Local food-based formulas are given in the form of powder and the subjects can turn it into thick liquid food by adding 125 cc of hot water at 90–96°C. The product image is shown in figure 1. Consumers are increasingly interested in functional foods (19).



Figure 1. The local food-based formula product in the form of powder

The organoleptic quality study on local food-based formula products showed that most of the panelists liked the products made from snail, tempeh, and moringa leaves based on the organoleptic quality result. There was no difference between the organoleptic quality studies of the moderately trained panelists group and the trained panelists group in the aspect of color, texture, taste, and aroma. The organoleptic quality study was performed on healthy people (17). Although this local food-based formula is nutritious and meets the requirements of a hemodialysis diet, based on the results of the organoleptic test, it is known that the local food-based formula product is still slightly fishy, slightly unpleasant, and has a bitter after-taste. Therefore, it is necessary to analyze the acceptability and nutritional intake of hemodialysis patients by providing the oral nutritional support formula product. This study aims to analyze the effect of local food-based formula on the acceptance and nutrition intake of hemodialysis patients.

## MATERIALS AND METHODS

This was an experimental research, which was conducted at Dr. Sardjito Hospital, Yogyakarta, Indonesia from February to March 2020. Subjects were 54 maintenance hemodialysis patients who were taken by purposive sampling, which were met the criteria of study. The inclusions criterias were maintenance hemodialysis patients 2 times a week with adequate hemodialysis, aged  $\geq 18$  years, having mild-to-moderate malnutrition based on the Dialysis Malnutrition Score (DMS), no allergy, and willing to be the subject. People with ascites, anasarca edema, having comorbid disease and blood pressure above 160/90 mmHg were excluded.

The independent variable of this study was the provision of local food-based formula, which was defined as the provision of local food-based formula to hemodialysis patients twice a day for three days. The dependent variables were the acceptability and nutrition intake. Acceptability was defined as the ability of hemodialysis patients to receive the local food-based formula which was known based on the food record form, and categorized into good acceptance (if the intake of local food-based formula was  $\geq 75\%$ ) and less acceptance (if the intake of local food-based formula was  $< 75\%$ ).

Nutrition intake was divided into total nutrition intake, formula-based nutrition intake and nonformula-based nutrition intake. Total nutrition intake was defined as the intake of energy, protein, fat, carbohydrates, fiber, water, calcium, phosphorus, sodium, potassium, iron from all foods, drinks, and supplement consumed by the patient, recorded using a 3-days food record form, calculated using Nutrisurvey software, compared to the patient's individual needs, then presented. Formula-based nutrition intake has the same definition as total nutrition intake, but the source of intake comes from the local food-based formula, while the sources of nonformula-based nutrition intake come from other than local food-based formula given.

Local food-based formulas are given in powder form weighing  $\pm 36$  grams per serving which can be diluted with 125 ml hot water at 90–96°C. Previous study showed that protein will be dissolved and denatured at a temperature of 100°C. The increase in heating temperature will cause the protein to be dissolved and denatured. Protein loses its binding power to water so that the water contained in the food will come out (20). Local food-based formulas are recommended to be consumed during the morning and evening interlude hours.

This study can be carried out with the ethical clearance from the Ethical Commission of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia Ref. No. : KE/FK/0989/EC/2019.

## RESULTS

This study involved 54 subjects who were taken by purposive sampling. The sampling process is shown in Figure 2.

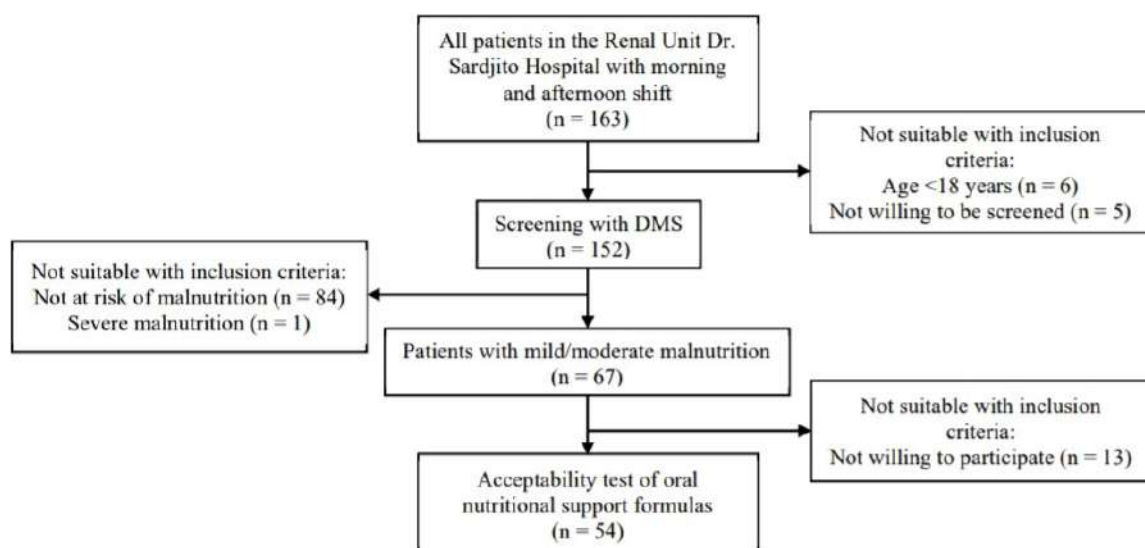


Figure 2. The flow of research

Subjects were given the local food-based formula for three days. Acceptability test was carried out for three days because the interdialytic time is between 3-4 days and a person's acceptability to food or drink could be seen within 3 days of administration. Subjects were asked to record food and drinks consumed during the three days using the food record form. Acceptance and nutritional intake of research subjects were evaluated on the fourth day. The subject's acceptance of the local food-based formula is shown in Figure 3.

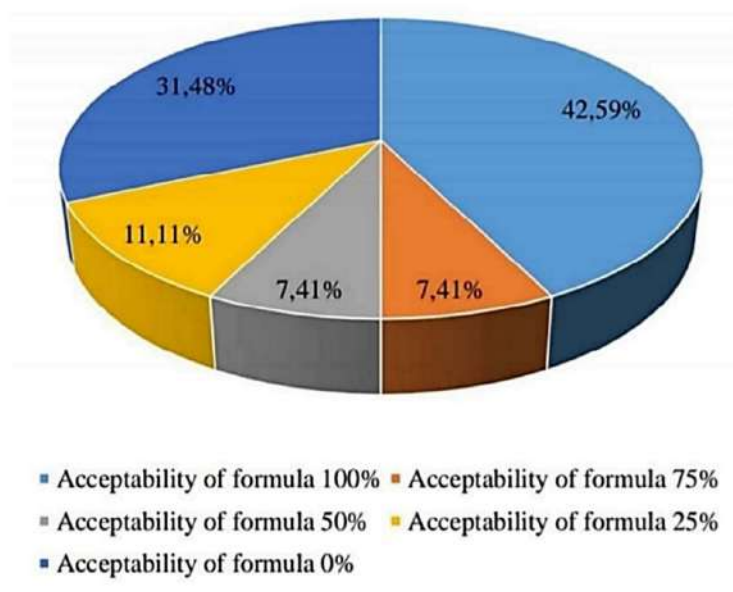


Figure 3. Acceptability of local food-based formula in hemodialysis patients

The results of the acceptance test reported that most of the subjects (42.59%) were able to consume all the local food-based formula given for three days. A small proportion of subjects (7.41%) were able to consume 75% and 50% of the local food-based formula provided by the researchers. There were 31.48% of subjects who did not consume the local food-based formula at all because they felt nauseous and vomited when they smelled the product.

Hemodialysis patients who are categorized as having good acceptance of the local food-based formula are those who are able to consume an average of at least 75% of the product given for three days. As many as 50% of subjects had good acceptance of the local food-based formula.

Table 1. Effect of formula intake and non-formula intake on total intake of hemodialysis patients

Nutrient	Unit	Mean ± SD			R <sup>2</sup>	
		Formula intake	Non-formula intake	Total intake	Formula intake on total intake	Non-formula intake on total intake
Energy	kcal	8,5 ± 7,3	71,2 ± 24,6	79,7 ± 25,9	*0,096	*0,920
Protein	g	14,9 ± 12,6	74,4 ± 30,3	89,3 ± 33,0	0,158	*0,854
Fat	g	6,1 ± 5,3	83,1 ± 34,8	89,2 ± 34,8	0,004	*0,977
Carbohydrate	g	8,2 ± 7,1	64,1 ± 25,4	72,3 ± 27,2	*0,140	*0,933
Fiber	g	11,1 ± 9,0	21,3 ± 17,0	32,4 ± 19,7	*0,263	*0,791
Water	ml	25,5 ± 21,3	79,8 ± 31,1	105,3 ± 42,6	*0,512	*0,773
Calcium	mg	56,0 ± 45,7	85,2 ± 43,8	141,3 ± 58,1	*0,445	*0,397
Phosphorus	mg	7,2 ± 6,1	67,0 ± 27,6	74,2 ± 28,8	*0,088	*0,956
Sodium	mg	2,0 ± 1,6	18,5 ± 14,8	20,4 ± 14,8	0,021	*0,992
Potassium	mg	2,8 ± 2,3	35,2 ± 13,2	38,0 ± 13,7	0,048	*0,983
Iron	mg	31,7 ± 25,8	34,4 ± 16,8	66,0 ± 34,1	*0,772	*0,464

\*p-value is significant based on linear regression analysis

R<sup>2</sup> = the effect of the independent variable on the dependent variable, showed in %

The results reported in Table 1 show that formula intake affects the total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, and iron (p-value <0.05), but does not affect the total

intake of protein, fat, sodium, and potassium ( $p$ -value  $\geq 0.05$ ). However, the magnitude of the effect of formula intake on total nutrient intake is reported to be insignificant, so it is necessary to analyze the effect of non-formula intake on total intake. Analysis of the effect of non-formula intake on total intake was carried out to compare the magnitude of the effect of formula intake and non-formula intake on total intake.

The results of the analysis reported that the total intake for all nutrients was affected by the subject's intake from non-formula sources, including supplements ( $p$ -value  $< 0.05$ ). The magnitude of the effect of non-formula intake on the total intake on average was greater than the magnitude of the effect of formula intake on total intake for all nutrients except calcium and iron.

## **DISCUSSION**

The intake of the subject formula in this study depends on how much the subject accepts the local food-based formula given by the researchers. The acceptability of food is the acceptance of food served that can be accepted by consumers, the measure of the success of food management is that the food served is acceptable and the food is consumed without leaving food leftovers. Acceptance itself as a measure of patient satisfaction (21).

Acceptability of food is directly related to the interaction of food with consumers at any given moment. The factors that influence acceptance include consumer characteristics, sensory characteristics of food and taste factors. Consumer characteristics include consumer expectations, consumer innovation, consumer knowledge and trust, and consumer attitudes towards healthy and functional foods. In sensory characteristics, there are effects of aroma, appearance, taste, and texture on food acceptance (22).

Knowledge of composition, functional properties and to some extent processing steps influence whether a food product will be accepted or rejected by consumers (23). Consumers consume functional foods for health benefits such as disease prevention and access to the protective properties of food. The main factor that encourages the acceptance of functional food is its health characteristics (24). In this study, the subjects have known about the composition of the ingredients used to produce local food-based formulas, as well as the benefits that will be obtained when consuming these products, so as to increase acceptance of the local food-based formula products given.

The patient's acceptance of food affects the nutritional status of the patient. The low food acceptance will have a negative impact on nutritional status, clinical physical condition, and patient recovery (25).

This study shows quite good results, where 50% of the subjects have a good acceptance of local food-based formula products. Clinical formula intake had an effect on increasing the intake of protein, water, and calcium in subjects. The average intake of protein and water from non-formula sources alone is still in the low category ( $< 80\%$  of the need), but after adding the oral nutritional support formula, the total intake of protein and water of the subject is good (80-110% of the needs are met).

The food intake of the subjects in this study was known based on the results of the 3-days food record. The use of the 3-days food record method to determine the food intake of subjects in this study was in accordance with the 2020 Kidney Disease Outcomes Quality Initiative (KDOQI) recommendations regarding the use of the 3-days food record method to assess the nutritional intake of hemodialysis patients (14).

The nutritional requirements used as a comparison for the intake of subjects in this study are based on the KDOQI recommendations for 2020. The recommended protein intake for hemodialysis patients aged  $\geq 18$  years with a stable metabolic condition is 1.0–1.2 g/kg body weight per day. Recommended energy intake of 25-35 kcal/kg body weight per day based on age, sex, level of physical activity, body composition, achievement of expected weight status, and the presence or absence of comorbidities or inflammation in the hemodialysis patient's body (26).

Calcium intake in hemodialysis patients should be considered based on input from dietary calcium, calcium supplements, or calcium-based binders and concurrent use of vitamin D analogues and calcimetics to avoid hypercalcemia or excess calcium (14). The results of this study indicate that the average intake of calcium from non-formula sources alone is in the good category, but after adding oral nutritional support formulas, the average total calcium intake is actually excess ( $> 110\%$  requirement). This is because the subjects are still consuming 3x500 mg of calcium-based phosphate binders per day, so that it makes a big contribution to the calcium intake of hemodialysis patients.

The hemodialysis patient's phosphorus intake should be limited. Dietary potassium intake should be adjusted to maintain serum potassium within the normal range. The fulfillment of potassium from food intake or supplemental potassium is based on the patient's individual needs and the doctor's judgment. Sodium intake should be limited to less than 100 mmol/day (or  $< 2.3$  g/day) to lower blood pressure and

improve fluid volume control in the body. Reducing dietary sodium intake was undertaken as an additional lifestyle modification strategy to achieve better volume control and desired body weight (14).

The results of the analysis of the subject's intake showed that the average intake of total energy, carbohydrates, fiber, phosphorus, sodium, potassium, and iron was still in the low category (<80% requirement) even though it had been added with a nutritional support formula. The average total fat intake was in good category, although the contribution of fat intake from formula was only very small. These results indicate that the compliance of hemodialysis patients in fulfilling nutritional intake is still not good.

The process of hemodialysis can remove most of the waste products in a short time, but some beneficial nutrients are also lost from the body through this process such as protein and water soluble vitamins. Uremia can be accompanied by symptoms of anorexia, nausea, and impaired absorption of food, so as to reduce the nutritional intake of hemodialysis patients. Diet therapy management is very important to maintain hemodialysis stability. Hemodialysis patients need adequate intake of energy, protein, sodium, potassium, phosphorus, and water (26, 27).

The application of dietary management management increases the survival rate of hemodialysis patients and increases the adequacy of hemodialysis, but can cause increased psychological distress in the patient. Many difficulties may be experienced by hemodialysis patients in the practice of diet therapy management. These practical difficulties are related to changes in individual eating habits such as lack of family support, changes in taste, and lack of knowledge (28, 29). Knowledge, family support, attitudes, and behavior can influence dietary adherence of hemodialysis patients in fulfilling nutritional intake according to the recommended dietary therapy (30). Adherence appears to be a multidimensional phenomenon that is patient-related, socioeconomic conditions, therapy-related, health care-related factors and contributes to non-adherence to dietary guidelines and treatment of hemodialysis patients (31).

## CONCLUSION

Most of the subjects were able to finish the local food-based formula for three days. As many as 50% of subjects have a good acceptance of the local food-based formula. Formula intake affects total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, and iron, but does not affect total intake of protein, fat, sodium, and potassium. The total intake for all nutrients was affected by the subject's intake of non-formula sources, including supplements. The magnitude of the effect of non-formula intake on the total intake on average was greater than the magnitude of the effect of formula intake on total intake for all nutrients except calcium and iron. Further research is needed to determine the effect of provision of oral nutrition support formula to nutrition status, immune status, and inflammation status of hemodialysis patients.

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# Unhealthy Diets among Adult Populations in Sleman Districts, Yogyakarta: Pattern and Related Sociodemographic Determinants, Findings from Sleman HDSS

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## ABSTRACT

**Background:** In Yogyakarta Province, the Sleman Regency has the second-highest life expectancy at birth and a high prevalence of non-communicable diseases (NCDs). One of the common NCD risk factors is an unhealthy diet. Thus, it is important to understand the factors that influence an unhealthy diet.

**Objective:** This study aimed to determine sociodemographic factors associated with an unhealthy diet intake in the Sleman Regency population.

**Materials and Methods:** Cross-sectional data from 4,963 adult respondents of the Sleman Health and Demographic Surveillance System was analyzed. A Descriptive test was done to measure the consumption frequency of sweet food and beverages, salty food, high-fat food, and food with monosodium glutamate (MSG). Generalized logistic regression was used to determine socioeconomic factors (residential area, age, gender, education level, marital status, and household wealth) that were associated with a higher frequency of unhealthy food consumption.

**Results:** The majority of respondents reported frequent consumption of sweet food and beverages (82.4%), food that contains high fat (62%), and MSG (75.5%). About 46% of respondents reported frequent consumption of salty food.

**Conclusion:** Education level, sex, age, household wealth status, and residential area are important determinants of a healthy diet.

**Keywords:** Eating habits, Non-communicable diseases, Risk factors, Sociodemographic

## BACKGROUND

Non-communicable diseases (NCDs) are no longer an “affluent countries’ problem”. Low-income and middle-income countries (LMICs) are facing an increase in NCDs while still struggling to control infectious diseases and malnutrition-related problems. According to the World Health Organization report, 71% of global deaths (40.5 million people) in 2016 were attributable to NCDs<sup>1</sup>. Over 75% of NCDs-related deaths occurred in LMICs, and NCDs were also the cause of almost half of premature deaths in these countries<sup>2</sup>.

In 2016, NCDs caused 73% of mortality among Indonesians, mainly due to cardiovascular diseases<sup>3</sup>. In 2019 the estimated six of the top ten causes of death in Indonesia was NCDs<sup>4</sup>. The Indonesia Basic Health Research (RISKESDAS) reported that the prevalence of NCDs among adults in Indonesia has increased between 2013-2018, with increased cases of high blood pressure from 25.8% to 34.1%, stroke from 7.0 per thousand to 12.1 per thousand, and diabetes mellitus from 1.5% to 2.1%<sup>5,6</sup>.

The high prevalence of NCDs undoubtedly put a heavy economic burden on the health and social system, especially in LMICs<sup>7</sup>. Premature mortality and needs for long-term care<sup>8</sup>, due to NCDs, increased the burden on the universal health system, and loss of productivity could hamper the LMCs’ future economic growth<sup>9</sup>. Therefore, NCDs prevention measures are urgently needed in LMICs, especially primary prevention programs that target risk factors to prevent these diseases before they occur. NCDs have been known to have common risk factors, such as elevated blood pressure, high blood total cholesterol, obesity, and lifestyle-related factors e.g., such as low physical activity, tobacco use, excessive alcohol consumption, and unhealthy diets<sup>10</sup>. Unhealthy diets or diets that are associated with a higher risk of NCDs are diets high in sodium, fats, and sugar<sup>10,11</sup>.

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In order to develop a successful intervention, it is important to identify characteristics of sub-population with higher NCD risk factors. For instance, a previous study showed that NCD risk factors were more prevalent in the older age group<sup>12</sup>. In Indonesia, Sleman Regency, Daerah Istimewa (DI) Yogyakarta Province, is among the regencies with the highest life expectancy at birth in Indonesia in 2015 (74.57 years old<sup>13,14</sup>). Consequently, Sleman's older population is increasing<sup>15</sup> and so does the prevalence of NCDs. The 2013 and 2018 RISKESDAS reported that Sleman regency had a relatively higher prevalence of cancer (6.1 per thousand in 2013) and diabetes mellitus (3.1% in 2013, 2.47% in 2018) with an increasing incidence of coronary heart disease (0.7% in 2013)<sup>5,6</sup>.

As for the risk factors of NCDs, Sleman had a lower number of active smokers (around 19% in 2013 and 2018) compared with other regencies in Yogyakarta. However, inadequate physical activity was high (79.5% in 2013) and the consumption of adequate fruits and vegetables (6.8% in 2013, 9.3% in 2018) was low<sup>5</sup>. Most people in Sleman Regency had a frequent consumption of sweet food (77.6%) and high-fat food (53.3%). On the other hand, a lower percentage of the Sleman population had a frequent consumption of salty food (14.5%) and food with monosodium glutamate (MSG; 72.1%)<sup>5</sup>. These findings show that an unhealthy diet is one of the major NCDs risk factors in Sleman Regency. However, research on the factors associated with unhealthy diets, especially in LMICs, is scarce<sup>16</sup>. Thus, the present study used data from the Sleman Health and Demographic Surveillance System (HDSS) Wave Two to describe the patterns of unhealthy diets in the Sleman adults and to determine the sociodemographic factors associated with the frequent consumption of unhealthy food.

## MATERIALS AND METHODS

### Data Source

The present study used data from the Sleman HDSS Wave two (Release 8-0-0). The Sleman HDSS is a population-based survey that gathers data on demographic dynamics and changes in various health problems, including NCDs, infectious diseases, reproductive health, and access to health services. Its first data collection was conducted in 2015, and by 2019, five waves of data collection have been completed. Details concerning the survey methods employed in Sleman HDSS have been described elsewhere<sup>17</sup>. Sleman HDSS data is available for the scientific community upon application for secondary data analysis. More details on data access are available in <https://hdss.fk.ugm.ac.id/>

### Study Sample

There were 4,996 households (20,450 persons) participated in the second wave of Sleman HDSS. Questions regarding the frequency of unhealthy food consumption were asked to the main respondents (head of household or their spouse) in each Sleman HDSS household. A total of 4,965 respondents answered the unhealthy food questionnaire. However, two respondents did not have data on education level; thus, only 4,963 respondents were included in the analysis.

### Main Outcomes

In this study, an unhealthy diet was defined as a diet high in sugar, fat, and sodium. The questionnaire used to assess unhealthy diets was adapted from RISKESDAS 2013. Respondents were asked about how often they consumed sweet food and beverages, salty food, and high-fat food on an average per day, week, month, or year. Their answers were converted into frequency per week, assuming 1 week = 7 days, 1 month = 4 weeks, and 1 year = 48 weeks. The respondents were then divided into three groups according to the frequency of food and beverage consumption: <1/week as rarely (R), 1≤<4/week as occasionally (O), and 4≤/week as frequently (F) consumption groups.

The four types of food were defined as follows: (i) Sweet food and beverages are high in sugar contain, e.g., pastries, candies, cookies, cakes, *dodol* (traditional confection made from sticky rice and palm sugar), *gudeg* (shredded young jackfruits stewed in spices, palm sugar, and coconut milk, canned fruits, processed juice, and syrup-based beverages). Fresh fruit juice, soft drinks, and other beverages labeled as zero-calorie or low sugar were not included in this group. (ii) Salty foods are high in sodium content, e.g., salty snacks and salted food such as salted fish, salted duck eggs, and food that contains soy sauce and shrimp paste. (iii) Food with MSG is any food that contains MSG as a flavor enhancer. (iv) High-fat food includes organ meats (e.g., liver, heart, and brain), egg yolk, shrimp, and coconut milk, as well as assorted fritters (e.g., *tempe* fritters and tofu fritters)<sup>18</sup>.

## Covariates

The residential areas were classified as urban and rural, as defined by Statistics Indonesia. Sex was dichotomized as men and women. Highest education attainment was categorized as low (never schooled or primary education), middle (middle and high school), and high (college and university)<sup>19</sup>. Marital status was categorized as married (currently married) and not married (single or divorced). Household wealth status was derived using principal component analysis based on landholding, durable good ownership (e.g., refrigerator, television, bicycle, motorcycle, and car), and house characteristics (the type of floor, roof, and wall)<sup>20</sup>. The PCA analysis resulted in 5 household wealth quintiles from the highest to the lowest. In this study, we re-categorised them into three household wealth groups, i.e., low/lower-middle, middle, and middle-high/high.

## Statistical Analysis

A total of 4,963 respondents were included in the analysis. Descriptive analysis was conducted to examine the pattern of unhealthy food consumption. Then generalized ordered logistic regression tests were used to determine socioeconomic determinants of higher frequency of unhealthy food consumption<sup>21,22</sup>. This test was used as some of our independent variables violated parallel regression model assumptions, which were tested using the Brant test. Our logistic model, first, was built by regressing each of the food groups in each sociodemographic variable. Then, independent variables found to be significant were entered into the multivariable model. We used post-stratification weighting in both descriptive and inferential tests to reduce sampling error and potential nonresponse bias. Stata 13.1 (StataCorp LLC., Texas, USA) was used to perform all analyses.

## Ethics Approval and Consent to Participate

Sleman HDSS received ethical approval from the Medical and Health Research Ethics Review Committee of the Medical Faculty, Universitas Gadjah Mada (KE/FK/842/EC). Written consent was obtained from Sleman HDSS' respondents after they received an explanation regarding the objectives, design, and procedure of the study. They were also informed that their responses are confidential and that they could withdraw their participation from this study anytime.

## RESULTS

**Table I. Sociodemographic Characteristics of Respondents**

Sociodemographic variables	Weighted proportion (%)	Number of observations (n)
Gender		
Men	50.1	1,791
Women	49.9	3,174
Age group (years)		
18–49	72.4	2,563
50+	27.6	2,402
Education level		
Low	19.0	1,483
Middle	62.9	2,679
High	18.3	801
Marital status		
Not married	34.5	1,033
Married	65.5	3,932
Household wealth		
Low/lower-middle	39.2	2,015
Middle	20.5	977
Middle-high/high	40.3	1,973
Residential area		
Rural	16.5	828
Urban	83.5	4,137

Table I present the weighted proportion of respondents' sociodemographic characteristics. The proportion of men and women in this study was in balance. Most of them were aged 18 to 49 years (72%), had middle-level education (63%), were married (65%), lived in urban areas (83%), and from a household with higher economic status (40%).

More than half of the respondents reported that they frequently consumed food and beverages that contain high sugar (82.4%), as well as food with high-fat content (62%) and MSG (75.5%), and around 46% reported frequent consumption of salty food (Figure 1).

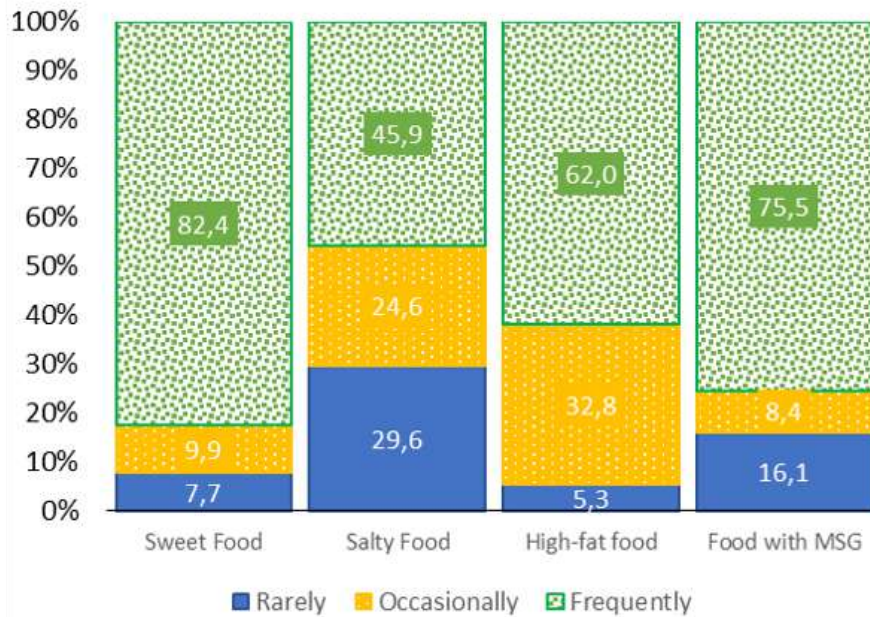


Figure 1. The Distribution of Categorical Response to Each Food/Beverage Type

Results from multivariable generalized ordered logistic regression tests are shown in Table II. We found some covariates tested did not meet the parallel regression assumption. For age group and education (salty and MSG models) and sex (sweet and high-fat food models), the odds ratios (OR) that describe the relationship between the lowest versus all higher categories of the covariates were not the same as those that describe the relationship between the next lowest category and all higher categories.

Our results showed that women and people with higher education levels are less likely to have frequent consumption of sweet food and beverages. The OR for women was less than one and decreased across outcome categories (R vs. O&F, OR=0.7 95% confidence interval [CI]=0.5–0.9; R&O vs. F, OR=0.5 95%CI=0.4–0.7), which showed that women were more likely to consume sweet food and beverages occasionally compared to men. The opposite effect was observed for household wealth. Higher household wealth was associated with 1.4 times higher frequency of sweet food and beverage consumption (Table 2) and predicted probability of the outcome is available in the appendix.

Similarly, women consumed salty food more frequently compared to men (OR=1.2 95%CI=1–1.4). People with a higher education level had 1.5 times higher odds of consuming salty food occasionally or frequently (R vs. O&F, OR=1.5 95%CI=1.1–2.1). On the other hand, being older (more than 50 years) was associated with less frequent consumption of food with high salt content (R vs. O&F, OR=0.6 95% CI=0.5–0.7; R&O vs. F, OR=0.8 95% CI=0.7–0.9).

Concerning the consumption of high-fat food, people who lived in urban areas (OR=1.4 95%CI=1.1–1.7) and those from households with higher socioeconomic status (OR=1.4; 95%CI=1.1–1.8) consumed fatty food more frequently. On the contrary, older people consumed this food group less frequently (OR=0.7 95%CI=0.6–0.9). Sex was only significant when comparing the frequency of unhealthy consumption with a combination of rarely and occasionally (R&O vs. F, OR=1.3 95%CI=1.1–1.6). Indicating that the odds of having frequent or occasional instead of rare consumption were not different between men and women. However, women significantly had a higher OR of reporting frequent high-fat food consumption.

As for food with MSG, older age (R vs. O&F, OR=0.5 95%CI=0.4–0.6; R&O vs. F, OR=0.6 95%CI=0.5–0.7), higher household wealth (OR=0.6; 95%CI=0.5–0.8), and higher education level (R vs. O&F, OR=0.4 95%CI=0.3–0.6; R&O vs. F, OR=0.5 95%CI=0.4–0.7) were associated with less frequent consumption of food with MSG.

**Table 2. Multivariate Logistic Regression of The Association Between Sociodemographic Factors Among Sweet Food, Salty Food, High-Fat Food, and Food Containing MSG**

	Sweet food			Salty food			High-fat food			Food containing MSG		
	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI
Combined model												
Residential area (vs. rural)												
Urban	0.84	0.26	0.62 1.14	0.96	0.73	0.76 1.21	1.35	0.01	1.06 1.72	0.77	0.05	0.60 1.00
Sex (vs. Men)												
Women				1.18	0.05	1.00 1.39				0.86	0.14	0.70 1.05
Age group (vs. <50 years)												
50+	0.94	0.55	0.77 1.14				0.74	0.00	0.64 0.86			
Wealth status (vs. low)												
Middle	0.97	0.88	0.70 1.36	1.00	0.96	0.79 1.28	1.05	0.74	0.80 1.37	1.10	0.49	0.83 1.48
Higher middle/high	1.4	0.04	1.02 1.91	1.08	0.51	0.86 1.34	1.42	0.00	1.12 1.80	0.64	0.01	0.49 0.84
Education (vs. low)												
Middle	0.86	0.30	0.66 1.13				0.81	0.04	0.66 0.99	0.93	0.53	0.73 1.18
High	0.56	0.01	0.37 0.84				0.88	0.42	0.65 1.19			
Marital status (vs. not married)												
Married	1.14	0.32	0.88 1.49	0.89	0.26	0.73 1.09	0.94	0.61	0.75 1.18	0.95	0.69	0.74 1.22
Unique model: Rarely vs. Occasionally and Frequently												
Sex (vs. men)												
Women	0.72	0.04	0.52 0.99				0.81	0.29	0.56 1.19			
Age group (vs. <50 years)												
50+				0.62	0.00	0.53 0.73				0.49	0.00	0.40 0.59
Education (vs. low)												
Middle				1.17	0.15	0.94 1.45						
High				1.51	0.01	1.11 2.05				0.42	0.00	0.30 0.59
Unique model: Rarely and Occasionally vs. Frequently												
Sex (vs. Men)												
Women	0.54	0.00	0.42 0.69				1.34	0.00	1.11 1.61			
Age group (vs. <50 years)												
50+				0.80	0.00	0.68 0.93				0.58	0.00	0.48 0.69
Education (vs. low)												
Middle				0.96	0.69	0.77 1.18						
High				1.01	0.94	0.74 1.38				0.50	0.00	0.36 0.70

Note: Combined model is for covariates that follow parallel regression assumption; MSG, monosodium glutamate; OR, odds ratio; CI, confidence interval.

## DISCUSSION

The present research aimed to describe patterns of unhealthy food consumption in Sleman Regency, DI Yogyakarta Province, and to determine sociodemographic factors associated with frequent consumption of unhealthy food. We found mixed association between sociodemographic factors and each food group assessed.

In our study, the older Sleman population consumed salty, fatty, and food with MSG less frequently. Studies have shown that older populations tend to make food choices based on health considerations<sup>23–26</sup>. However, there was no significant difference in frequency of sweet food and beverages consumption by age group, around 82% of younger adults and 83% of older adults in this study reported frequent consumption of sweet food and beverages (data not shown). These findings seem to indicate that older adult in Sleman put more consideration on health value when deciding whether to consume food contains high sodium and fat but not for food and beverages with high sugar content.

Contextual factor e.g., culture, may have a significant influence on sweet food consumption in our population. Yogyakarta's cuisine is characterized by its sweet taste. Approximately 75% of Yogyakarta's traditional dishes require sugar<sup>27</sup>. Most of the traditional beverages also contain palm sugar or lump sugar. However, we suspect that the high frequency of sweet food and beverages consumption was related to the majority of Javanese people who drink traditional tea daily, which is called *teh nasgitel*. *Nasgitel* is an abbreviation of the Javanese words for *panas* means hot, *legi* means sweet, and *kenthel* means thick.

The importance of sugar in Javanese diets can be traced back to the Dutch colonization era. Between 1830 and 1940, *Tanam Paksa* ("Enforcement Planting") policy was implemented in Indonesia. In Java, export crops, such as sugarcane, had to be grown instead of rice. Thus, sugar became an energy source that was easily accessible by Javanese people<sup>27</sup>. As food and beverages with a sweet taste have always been part of their habitual food selection, adults in Sleman, especially older adults, may persist in their sweet food preference even when changes in their health required the opposite.

Our findings also showed that women and people with a high education level were more likely to consume sweet food and beverages less frequently. Higher education level was also associated with less frequent consumption of food with MSG and fatty food. Previous studies have reported that women have a healthier diet and they are more likely to take up and adhere to healthy behavior. Similarly, education level is also a known factor associated with dietary change in adulthood<sup>26</sup>. Adults with higher education have a better comprehension and uptake of health education or advice from health professionals<sup>26,28</sup>.

Surprisingly, we also found that adult women in our population consumed salty and fatty food more frequently. Similar findings were reported by RISKESDAS 2018. That is more women reported frequent consumption of salt (30.5% vs. 28.9%) and fatty (42.8% vs. 40.7%) food compared to men<sup>6</sup>. On contrary, a study conducted on university students from 23 countries in Europe and Asia reported that women were more likely to report consumption of fruits and restrict intake of high-fat foods and salt<sup>29</sup>.

Snacking habits might contribute to the sex-difference in fatty and salty food intake. Ovaskainen et al.<sup>30</sup> reported that a "snack-dominating meal pattern" was observed in 19% of men and 24% of women among a sample of 2,007 Finnish adults (25–64 years old)<sup>30</sup>. Kuczmarski et al. reported that 86% of African-American women prefer snacking<sup>31</sup>. The most frequently consumed snack groups are salty snacks (16.4%), grain-based desserts (14.8%), and then sweetened beverages (10.7%). A recent qualitative study from the World Food Program involving adolescents in Indonesia showed that the most favorite snack foods among the adolescents are meatball soup (*bakso*; 54%), fried snack (fritters; 53%), steamed fish dumplings with vegetables and peanut sauce (*siomay*; 46%), instant noodles (39%), and beverages and dessert (37%)<sup>32</sup>. These various foods contain a high fat and high salt content.

In our study, adults from the more affluent households reported more frequent consumption of food with high sugar and fat content but less frequent consumption of food with MSG. Household wealth and education level are resources that influence food choices. In making food selections, people are aware of their available resources<sup>33</sup>. In this study, having more economic resources allowed adults in Sleman to have more food or snack choices that have a high sugar and fat content. As mentioned before, the popular snacks in Indonesia are likely to have a high content of fat, salt, and sugar. Similar findings have been reported before, showing that the higher socioeconomic status was related to high energy and saturated fat consumption<sup>34</sup>.

On the other hand, being from a wealthy household gave them more decision-making power to choose food with no MSG. There is common knowledge that MSG is associated with harmful health effects and that several previous studies also support this claim<sup>35,36</sup>. Still, MSG is a popular flavor enhancer used by

food producers. The increasing demand for food without MSG increases its price. Radam reported that respondents are willing to pay more for food that has the label “No Added MSG”<sup>37</sup>. Therefore, the association between high household wealth and less consumption of food with MSG is more likely because they could afford to buy food without MSG.

In our study, frequent consumption of high-fat food was also associated with living in urban areas. One possible explanation is that modern/fast food is more available in urban areas and is characterized by its high-fat content. The differences in nutritional intake between people in urban and rural areas have already been reported. The 2011 China Health and Nutrition Survey found that children (4–17 years old) living in urban and rural areas have similar total energy intake, but children from urban areas have the highest consumption of fat and animal source (40% of daily energy intake)<sup>38</sup>. The urban population tends to consume more high-fat food because they are more exposed to easier access to cheap energy-dense food, higher-quality food, high-fat food availability, supermarket existence, and lower food prices<sup>34,39,40</sup>.

One strength of this study is related to the used of data from a population survey, the Sleman HDSS, making our findings more representative of the adult Sleman population in general. Additionally, we adopted an instrument used to measure our main outcomes from a National Survey (RISKESDAS), thus ensuring the comparability of our findings to other areas in Indonesia. However, we also acknowledge that because of the nature of the self-reporting instrument, our findings may overestimate or underestimate the true frequency of consumption. Also, we can not objectively define “unhealthy” diet in this study as there was no information about the amount of food or beverages consumed. Thus, future studies are needed to evaluate further examine sociodemographic factors associated with the actual salt, sugar, and fat intake in LMICs.

## CONCLUSION

Majority of adults in Sleman regency frequently consumed foods or beverages that high in sugars, fats, and contain MSG. Education level, sex, age, household wealth status, and residential areas are important determinants of a healthy diet in the Sleman adult population. These findings support the need for health intervention programs that target changes in food preference and consumption in Sleman adults’ populations. These programs should be designed by considering targets’ health and sociodemographic profiles.

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**Appendix**

Table A1. Predicted probability of Sweet Food, Salty Food, High-Fat Food, and Food Containing MSG consumption, overall and by covariate

		Sweet food			Salty food			High-fat food			Food containing MSG		
		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI	
<b>Rarely</b>	<i>Overall</i>	0.08	0.07	0.09	0.32	0.31	0.34	0.06	0.05	0.07	0.18	0.17	0.19
<b>Occasionally</b>	<i>Overall</i>	0.11	0.09	0.12	0.23	0.21	0.25	0.33	0.31	0.34	0.09	0.08	0.1
<b>Frequently</b>	<i>Overall</i>	0.82	0.8	0.83	0.45	0.43	0.47	0.62	0.6	0.63	0.73	0.72	0.75
<b>Rarely</b>	<i>Residential area</i>												
	Rural	0.07	0.05	0.09	0.31	0.27	0.36	0.07	0.05	0.09	0.15	0.12	0.18
	Urban	0.08	0.07	0.09	0.32	0.3	0.34	0.05	0.04	0.06	0.19	0.17	0.2
<b>Occasionally</b>	<i>Residential area</i>												
	Rural	0.1	0.07	0.12	0.23	0.21	0.25	0.37	0.33	0.41	0.08	0.06	0.09
	Urban	0.11	0.09	0.12	0.23	0.21	0.25	0.32	0.3	0.34	0.09	0.08	0.1
<b>Frequently</b>	<i>Residential area</i>												
	Rural	0.84	0.8	0.87	0.46	0.41	0.51	0.56	0.51	0.61	0.77	0.73	0.81
	Urban	0.81	0.8	0.83	0.45	0.43	0.47	0.63	0.61	0.65	0.73	0.71	0.74
<b>Rarely</b>	<i>Sex</i>												
	Men	0.06	0.05	0.08	0.34	0.32	0.37	0.05	0.04	0.06	0.17	0.15	0.19
	Women	0.09	0.07	0.1	0.31	0.29	0.33	0.06	0.05	0.07	0.19	0.17	0.21
<b>Occasionally</b>	<i>Sex</i>												
	Men	0.07	0.05	0.08	0.23	0.22	0.25	0.38	0.35	0.41	0.08	0.07	0.09
	Women	0.13	0.11	0.15	0.23	0.21	0.25	0.3	0.28	0.32	0.09	0.08	0.1
<b>Frequently</b>	<i>Sex</i>												
	Men	0.87	0.85	0.89	0.42	0.39	0.45	0.57	0.54	0.6	0.75	0.72	0.78
	Women	0.78	0.76	0.8	0.46	0.44	0.49	0.64	0.62	0.66	0.72	0.7	0.74
<b>Rarely</b>	<i>Age group</i>												
	18-49	0.08	0.06	0.09	0.27	0.25	0.3	0.05	0.04	0.06	0.13	0.12	0.15
	50+	0.08	0.07	0.09	0.37	0.35	0.39	0.06	0.05	0.08	0.24	0.22	0.26
<b>Occasionally</b>	<i>Age group</i>												
	18-49	0.1	0.09	0.12	0.25	0.23	0.28	0.3	0.28	0.32	0.08	0.07	0.1
	50+	0.11	0.09	0.12	0.21	0.19	0.23	0.35	0.33	0.38	0.09	0.07	0.1
<b>Frequently</b>	<i>Age group</i>												
	18-49	0.82	0.8	0.84	0.48	0.01	0.5	0.65	0.63	0.67	0.78	0.76	0.8
	50+	0.81	0.79	0.83	0.42	0.4	0.44	0.58	0.56	0.6	0.68	0.66	0.7
<b>Rarely</b>	<i>Wealth status</i>												
	Low	0.09	0.07	0.11	0.33	0.3	0.36	0.06	0.05	0.08	0.16	0.13	0.18
	Middle	0.09	0.07	0.11	0.33	0.29	0.37	0.06	0.05	0.08	0.14	0.12	0.17
	Higher middle/high	0.06	0.05	0.08	0.31	0.28	0.34	0.05	0.04	0.06	0.22	0.2	0.25
<b>Occasionally</b>	<i>Wealth status</i>												
	Low	0.12	0.1	0.13	0.23	0.22	0.25	0.35	0.32	0.38	0.08	0.07	0.09
	Middle	0.12	0.09	0.14	0.23	0.21	0.25	0.35	0.31	0.38	0.07	0.06	0.09
	Higher middle/high	0.09	0.07	0.11	0.23	0.21	0.25	0.29	0.26	0.32	0.1	0.09	0.12

		Sweet food			Salty food			High-fat food			Food containing MSG		
		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI	
<b>Frequently</b>	<i>Wealth status</i>												
	Low	0.8	0.77	0.83	0.44	0.41	0.47	0.58	0.55	0.62	0.76	0.73	0.79
	Middle	0.79	0.75	0.83	0.44	0.4	0.49	0.59	0.55	0.64	0.78	0.74	0.82
	Higher middle/high	0.84	0.82	0.87	0.46	0.42	0.49	0.66	0.63	0.7	0.68	0.65	0.71
<b>Rarely</b>	<i>Education level</i>												
	Low	0.07	0.05	0.08	0.35	0.32	0.39	0.05	0.04	0.06	0.15	0.13	0.18
	Middle	0.08	0.06	0.09	0.32	0.29	0.34	0.06	0.05	0.07	0.16	0.14	0.18
	High	0.11	0.08	0.15	0.27	0.22	0.31	0.06	0.04	0.07	0.29	0.25	0.34
<b>Occasionally</b>	<i>Education level</i>												
	Low	0.09	0.08	0.11	0.19	0.17	0.22	0.3	0.27	0.33	0.08	0.07	0.1
	Middle	0.1	0.09	0.12	0.24	0.21	0.26	0.34	0.32	0.36	0.09	0.07	0.1
	High	0.14	0.11	0.17	0.28	0.23	0.33	0.32	0.28	0.37	0.08	0.06	0.1
<b>Frequently</b>	<i>Education level</i>												
	Low	0.84	0.81	0.87	0.45	0.41	0.49	0.65	0.61	0.68	0.76	0.73	0.8
	Middle	0.82	0.8	0.84	0.44	0.42	0.47	0.6	0.57	0.62	0.75	0.73	0.77
	High	0.75	0.69	0.8	0.46	0.4	0.51	0.62	0.57	0.67	0.62	0.57	0.68
<b>Rarely</b>	<i>Marital status</i>												
	Not married/ divorced	0.18	0.15	0.2	0.3	0.27	0.34	0.05	0.04	0.07	0.18	0.15	0.2
	Married	0.18	0.17	0.2	0.33	0.31	0.34	0.06	0.05	0.07	0.18	0.17	0.2
<b>Occasionally</b>	<i>Marital status</i>												
	not married/ divorced	0.08	0.07	0.1	0.23	0.21	0.24	0.32	0.28	0.35	0.08	0.07	0.1
	Married	0.09	0.08	0.1	0.23	0.22	0.25	0.33	0.31	0.35	0.09	0.08	0.1
<b>Frequently</b>	<i>Marital status</i>												
	not married/ divorced	0.74	0.7	0.78	0.47	0.43	0.51	0.63	0.58	0.67	0.74	0.7	0.78
	Married	0.73	0.71	0.75	0.44	0.42	0.46	0.61	0.6	0.63	0.73	0.71	0.75

## Prevalence of Anemia and Correlation with Knowledge, Nutritional Status, Dietary Habits among Adolescent Girls at Islamic Boarding School

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### ABSTRACT

**Background:** Anemia is a globally public health problem, including in Indonesia (22.2%) and it has negative health impacts. Adolescent girls have high risk of anemia. Previous studies reported that adolescent girls at Islamic boarding school had low food intake and poor knowledge about nutrition in preventing anemia.

**Objectives:** To assess the prevalence of anemia and to analyze association between knowledge, nutritional status, and dietary habits and anemia in adolescent girls.

**Materials and Methods:** A cross-sectional study was conducted in November 2020 among adolescent girls at Islamic boarding school in Semarang. A total of 162 respondents were selected by cluster sampling. Anemia was determined by measuring the hemoglobin level in the blood by Cyanmethemoglobin method. Knowledge and dietary habits were collected through questionnaires. Nutritional status was assessed by measuring weight and height, then classified by body mass index for age using WHO Anthro. Bivariate and multivariate logistic analysis were used to test hypothesis and it was significant if  $p < 0.05$ .

**Results:** The prevalence of anemia was found to be 17.3%. In the bivariate analysis, overweight was more likely to have anemia ( $p = 0.044$ ). There was no association between father's education, mother's education, knowledge, frequency of staple food, breakfast habits, consumption of animal side dishes, consumption of vegetable side dishes, consumption of sweet tea and anemia. Multivariate model showed that overweight ( $OR = 3.658$ ;  $95\%CI = 1.224-10.932$ ;  $p = 0.020$ ) and good knowledge ( $OR = 3.652$ ;  $95\%CI = 1.221-10.922$ ;  $p = 0.020$ ) were significant associated with the anemia.

**Conclusion:** Nutritional status and knowledge were significantly associated with anemia among adolescent girls.

**Keywords:** anemia, adolescent girl, Islamic boarding school, knowledge, nutritional status

### BACKGROUND

Anemia is one of the global health problems which happened in the low, middle, and high income countries.<sup>1,2</sup> The group which has high risk of anemia is adolescent girls.<sup>3</sup> According to The Ministry of Health Indonesia, adolescents are individuals in 10-18 years age group.<sup>4</sup> Adolescent girls have high risk of anemia because of some conditions such as increased need of iron intake, blood loss during menstruation, lack of iron intake, worm infections, early marriage, and teenage pregnancy.<sup>3,5</sup> Adolescent girls can suffer from anemia if their blood hemoglobin level is less than 12 g/dl.<sup>5</sup>

Anemia is caused of many factors. The main factor is 50% iron intake deficiency.<sup>2,3</sup> Some studies have reported high iron diet consumption, nutritional status, and knowledge are related to anemia among adolescent girls.<sup>6-8</sup> Anemia can caused various adverse impacts on adolescent girls, such as decreasing immunity, easily exposed infections, decreasing physical fitness and thinking agility due to muscle cells and brain cells lack of oxygen, decreasing learning achievement and performance productivity.<sup>5</sup> A study in India have reported anemic adolescent girls had low scores on numeracy test and visual memory than non-anemic adolescent girls.<sup>9</sup> Anemic adolescent girls will have a high risk of anemia during pregnancy. It has negative impacts on the fetus' growth and development. Moreover, anemia in pregnancy have risks to pregnancy and delivery complications such as low birth weight, stunting, and child and maternal mortality.<sup>5,10</sup>

The prevalence of anemia among adolescent girls in the world is approximately 29%.<sup>2</sup> Some studies reported that anemia prevalence in Indonesia is estimated at 30%.<sup>3</sup> There are less study about anemia among Indonesian adolescent girls. The prevalence of anemia as a public health problem is categorized as follows:  $< 5\%$ , no public health problem;  $5-19.9\%$ , mild public health problem;  $20-39.9\%$ , moderate public health problem; and  $\geq 40\%$ , severe public health problem.<sup>2</sup>

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A study in Indonesia reported that anemia prevalence among adolescent girls at islamic boarding school was 52.25%.<sup>11</sup> Central Java, the third largest province in Indonesia, has 57.1% adolescent girls aged 10-18 years old who suffer from anemia.<sup>12</sup> Semarang is the capital city of Central Java. There has been no official report from *Dinas Kesehatan Kota Semarang* regarding the prevalence of anemia in adolescent girls. There is only a few study about anemia among adolescent girls in Semarang such as a study by Annisa reported 21.9% adolescent girls in Senior High School 11 Semarang had anemia.<sup>13</sup>

Islamic boarding school is one of choice to study for adolescent girls beside studying in public school. At islamic boarding school, students have food intake from their school. A study in 2019 showed that 72% of female students in islamic boarding school had bad dietary habits.<sup>14</sup> Islamic boarding school serves almost the same food menu every day. Therefore, adolescent girls at islamic boarding school have low food intake because they are bored of the food.<sup>15</sup> Low food intake quality and low iron bioavailability are the main factors of iron deficiency.<sup>16</sup> A previous study has reported that 54% adolescent girls had poor knowledges.<sup>17</sup> Studies about anemia among adolescent girls in Semarang especially at islamic boarding school is still limited. Measurement of hemoglobin (Hb) level to determine anemia status in previous studies used a portable hemoglobinometer. It is used for screening of anemia. Cyanmethemoglobin method is a method to measure Hb level recommended by International Committee for Standarization in Hematology (ICSH). In this study, the researchers used Cyanmethemoglobin to determine the Hb level. This study aimed to assess prevalence of anemia and to analyze association between knowledge, nutritional status, and dietary habits with anemia among adolescent girls at islamic boarding school in Semarang. This result of this study can be useful for supporting anemia prevention program among adolescent girls.

## MATERIALS AND METHODS

An observational analytic study with cross-sectional design was conducted in November-December 2020 among adolescent girls aged 14 to 18 years at islamic boarding school in Semarang. This study was an initial study from a study entitled "The Effectiveness of Iron-Folic Acid Tablet Supplementation and Anemia Education as Prevention Anemia Among Adolescent Girls in Semarang City". The inclusion criteria of the subjects are female students aged 14 to 18 years old living at islamic boarding school, capable to communicate well, and willing to be respondent in this study. Respondents taking iron-folic acid tablet for the last 3 months, having disease or getting treatment in one last month such as tuberculosis, intestinal worms, menstrual bleeding, and HIV/AIDS were excluded from the study. A total of 162 adolescent girls from 3 islamic boarding schools were selected as subjects for this study by *cluster sampling* (40, 40, 82 students from school A, B, C, respectively). This number has fulfilled the minimum sample size 94 which calculated by Lemeshow formula, which  $d=10\%$ ,  $P=0.58$ ,  $Z^2 \cdot 1-\mu/2=1.96$ .<sup>18</sup>

Ethical clearance was obtained from the Ethical Review Board of Faculty of Medicine, Diponegoro University No. 265/EC/KEPK/FK-UNDIP/XII/2020. The informed consent was given to respondent's parents through the islamic boarding school's trustee. To collect the data during the COVID-19 pandemic, the researcher and respondents always obey the health protocol in prevention COVID-19 such as wearing masks, maintaining distances, and washing hands with soap before entering and leaving the islamic boarding school.

Dependent variable was anemia status. Anemia was measured by taking the blood by laboratory analysis to assess Hb level by Cyanmethemoglobin method. Cyanmethemoglobin method is a method to measure Hb level recommended by International Committee for Standarization in Hematology (ICSH). Respondents were categorized anemia if Hb level  $<12$  gr/dl and normal if Hb level  $\geq 12$  gr/dl. Anemia was classified as mild anemia if Hb level 11.0-11.9 gr/dl, moderate anemia if Hb level 8.0-10.9 gr/dl, and severe anemic if Hb level  $<8.0$  gr/dl.

Independent variables were nutritional status, knowledge, and dietary habit. Demographic data such as age, parent's education was also observed as additional data. The researcher measured respondents' weight by digital scale and the height by microtoise staturmeter to assess body mass index (BMI). The digital scale and microtoise had been calibrated by the researcher. BMI for age was calculated by using WHO calculator with help of z scores tables. Nutritional status was determined by BMI results. Knowledge was tested through questionnaire which consist of 30 true or false questions. The questionnaires were about description, sign and symptom, risk factor, impact, and nutrition prevention of anemia. Knowledge level was classified into 'poor knowledge' if the correct answer was  $<75\%$  and 'good knowledge' if the correct answer was  $\geq 75\%$ . Dietary habits were staple food frequency, breakfast habit, snack habit, animal and vegetable side dishes consumption, vegetable and fruit consumption, sweet tea and street food consumption. The dietary habit was collected by questionnaire.

Data was edited, entry and analyzed by univariate, bivariate, and multivariate using SPSS 20 software. The univariate analysis used descriptive test. Bivariate logistic regression was used to analyze factors associated with anemia. Variable observed in the bivariate logistic regression analysis with a p-value <0.025 were included in the multivariate binary logistic regression. Results with p-value <0.05 were considered statistically significant.

## RESULTS

### Prevalence of anemia

From a total of 164 students participated in this study, 162 (98.7%) responded for the enquiry. Twenty eight (17.3%) respondents had anemia and classified into mild anemia 13.6% and moderate anemia 3.7%. None of respondents was classified as severe anemia ([figure 1](#)).

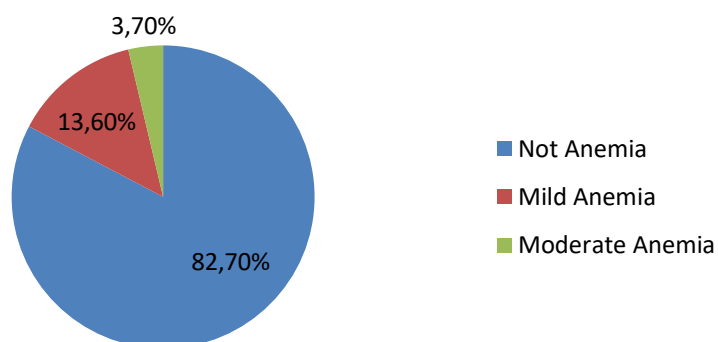


Figure 1. The prevalence of anemia among adolescent girls at Islamic boarding school in Semarang, 2020

### Respondent characteristics

The respondents were in the age range of 14-18 years old and in high school. High school graduated was the most parent's education. More than half (59.3%) respondents had normal nutritional status and good knowledge (66%) ([table 1](#)).

Table 1. Respondents characteristic, nutritional status and knowledge among adolescent girls at islamic boarding school in Semarang, 2020

Variable	Frequency n(%)	Mean ( $\pm$ SD)	Median (Min-Max)
<b>Age</b>		16.48( $\pm$ 1.059)	17(14-18)
<b>Father education</b>			
Primary school	43 (26.5%)		
Secondary school	42 (25.9%)		
Senior high school	62 (38.3%)		
Bachelor Degree	15 (9.3%)		
<b>Mother education</b>			
Primary school	41 (25.3%)		
Secondary school	50 (30.9%)		
Senior high school	58 (35.8%)		
Bachelor Degree	12 (7.4%)		
<b>Nutritional status</b>			
Underweight	15 (9.3%)		
Normal	96 (59.3%)		
Overweight	21 (13%)		
Obese	30 (18.5%)		
<b>Knowledge</b>			
Poor	55 (34%)		
Good	107 (66%)		

### Dietary habit

The majority (57.4%) of respondents had staple food 3 times a day, and 77.2% had snacks sometimes. The examples of snacks consumed by respondents were cakes, chips, bread and snacks sold in the school canteen. Most of the respondents (80.2%) answered that they sometimes consume animal side dishes in a day such as eggs, chicken, and fish. The majority (74.7%) of respondents admitted consuming vegetable side dishes every day, such as tempeh and tofu. There were 63.6% of respondents that eat vegetables every day such as soup, mustard greens, spinach, kale, and long beans. It was different from the habit of consuming fruit which most of respondents (74.1%) consumed fruit occasionally. The fruits were consumed by respondents were orange, watermelon, apple and papaya. Most of the respondents rarely consumed sweet tea (90.7%) and often consumed street food (93.2%) (table 2). The snacks were chips, fried foods, chocolate, and other snacks in the canteen.

**Table 2. Description of dietary habit for adolescent girls at islamic boarding school in Semarang**

<b>Variable</b>	<b>Frequency (%)</b>
<b>Staple Food Frequency</b>	
<3x /day	69 (42.6%)
3x /day	93 (57.4%)
<b>Breakfast Habit</b>	
Rarely	7 (4.3%)
Sometimes	94 (58%)
Always	61 (37.7%)
<b>Snack Habit</b>	
Rarely	18 (11.1%)
Sometimes	125 (77.2%)
Always	19 (11.7%)
<b>Animal Side Dishes Consumption</b>	
Rarely	28 (17.3%)
Sometimes	130 (80.2%)
Always	4 (2.5%)
<b>Vegetable Side Dishes Consumption</b>	
Rarely	2 (1.2%)
Sometimes	39 (24.1%)
Always	121 (74.7%)
<b>Vegetable Consumption</b>	
Rarely	12 (7.4%)
Sometimes	47 (29%)
Always	103 (63.6%)
<b>Fruit Consumption</b>	
Rarely	37 (22.8%)
Sometimes	120 (74.1%)
Always	5 (3.1%)
<b>Sweet Tea Consumption</b>	
Rarely	147 (90.7%)
Often	15 (9.3%)
<b>Street Food Consumption</b>	
Rarely	11 (6.8%)
Often	151 (93.2%)

### Associated factors of anemia among adolescent girls

There was a significant association between nutritional status ‘overweight’ (p=0.044;OR=2.860;95%CI=1.026-7.969) with anemia. There was no relationship between father’s education level, mother’s education, staple food frequency, breakfast habit, consumption of animal side dishes, consumption of vegetable side dishes, sweet tea consumption, knowledge and anemia status (table 3). Multivariate logistic regression analysis showed that the variables associated with anemia were overweight

( $p=0.020$ ;  $OR=3.658$ ;  $95\%CI=1.224-10.932$ ) and good knowledge ( $p=0.020$ ;  $OR=3.652$ ;  $95\%CI=1.221-10.922$ ) (table 4).

**Table 3. Bivariate analysis of associated factors of anemia among adolescent girls in Semarang, 2020**

Variable	Anemia Status				p value	OR (95% CI)
	Anemic		Normal			
<b>Father education</b>						
Primary school	6	14%	37	86%	0.109	0.324 (0.082-1.285)
Secondary school	7	17%	35	83%	0.182	0.400 (0.104-1.536)
Senior high school	10	16%	52	84%	0.140	0.385 (0.108-1.368)
Bachelor Degree	5	33%	10	67%	1	
<b>Mother education</b>						
Primary school	5	12%	37	88%	0.666	0.676 (0.114-4.016)
Secondary school	7	14%	43	86%	0.814	0.814 (0.146-4.525)
Senior high school	14	24%	44	76%	0.577	1.591 (0.311-8.144)
Bachelor Degree	12	55%	10	45%	1	
<b>Nutritional status</b>						
Underweight	1	7%	14	93%	0.302	0.332 (0.041-2.698)
Overweight	8	38%	13	62%	0.044*	2.860 (1.026-7.969)
Obese	2	7%	28	93%	0.157	0.332 (0.072-1.529)
Normal	17	18%	79	82%	1	
<b>Knowledge</b>						
Poor	5	9%	50	91%	1	
Good	23	21%	84	79%	0.055	2.738 (0.979-7.658)
<b>Staple Food Frequency</b>						
Less than 3 times/day	10	14%	59	86%	1	
3 times/day	18	19%	75	81%	0.420	1.416 (0.608-3.296)
<b>Breakfast Habit</b>						
Rarely	1	14%	6	86%	0.852	1.231 (0.139-10.934)
Sometimes	16	17%	78	83%	0.806	1.320 (0.144-12.097)
Always	11	18%	50	82%	1	
<b>Animal Side Dishes Consumption</b>						
Rarely	6	21%	22	79%	1	
Sometimes	21	16%	109	84%	0.503	0.706 (0.256-1.952)
Always	1	25%	3	75%	0.872	1.222 (0.107-13.974)
<b>Vegetable Side Dishes Consumption</b>						
Rarely/Sometimes	4	10%	37	90%	0.149	0.437 (0.142-1.345)
Always	24	20%	97	80%	1	
<b>Sweet Tea Consumption</b>						
Rarely	24	16%	123	84%	1	
Often	4	27%	11	73%	0.319	1.864 (0.547-6.345)

\*significant if  $p \text{ value} < 0,05$

**Table 4. Multivariate logistic regression analysis of associated factors of anemia among adolescent girls in Semarang, 2020**

	B	p value	OR	95%CI	
				Lower	Upper
Nutritional status		0.015			
Underweight	-1.129	0.295	0.323	0.039	2.671
Overweight	1.297	<b>0.020*</b>	3.658	1.224	10.932
Obese	-1.194	0.128	0.303	0.065	1.412
Good knowledge	1.295	<b>0.020*</b>	3.652	1.221	10.922

\*statistically significant at  $p < 0.05$



## DISCUSSION

In this study, we found that the prevalence of anemia among adolescent girls at islamic boarding school was 17.3%. High prevalence of anemia at islamic boarding school was also founded in other studies in Kediri City, Indonesia of 29,93% adolescent girl.<sup>19</sup> This result was similar to study in Jakarta that showed anemia was founded in 19.6% of adolescent girls aged 12-15 years.<sup>20</sup> Those study was conducted in adolescent girls who live with their parents. It showed there was no difference about prevalence of anemia between adolescent girls at islamic boarding school with who living with their parents.

According to WHO, the anemia prevalence rate of 17.3% is categorized into a mild public health problem if prevalence <20%.<sup>2</sup> The respondents of this study were adolescent girls had no consume iron folic tablet for the last 3 months. It showed that the Indonesian government policy through the iron folic supplementation program for adolescent girls aged 12-18 years in school are not optimally implemented. Even though previous studies have shown that iron supplementation interventions can reduce the prevalence of anemia from 20.9% to 15.7%.<sup>21</sup>

This study found that 13% of adolescent girls had overweight BMI and 18.5% was obese. BMI can describe individual nutritional status at the time. One of the risk factors of anemia was nutritional status.<sup>22-25</sup> It was found that overweight was significantly related to the anemia in this study. The overweight girls tended to be at risk of anemia compared to normal weight girls. It was similar to previous study in children aged 2-19 years showed prevalence of anemia increased along the increasing of BMI from normal to overweight.<sup>26</sup> The lack of nutrients in thin woman affected to anemia case, but there was an increasing of hepcidine concentration in overweight women, especially extreme obesity which can interfere with iron absorption, so that iron deficiency anemia occurred.<sup>27</sup>

Nutritional status can be influenced by food intake.<sup>28</sup> An assessment of nutritional intake can be seen from dietary habits such as staple food frequency, breakfast habits, consumption of animal or vegetable side dishes, vegetable and fruit consumption and consumption of sweet tea after meals. The eating habits, frequency of meals, quantity of food and types of food such as animal and vegetable side dishes that were eaten by respondents at islamic boarding school tended to be the same. The variety of food menu provided by islamic boarding school was almost the same; therefore, all students consumed almost the same food every day.<sup>29</sup> It may be related to this study that dietary habits were not significantly associated with anemia among adolescent girls. It was in line with a study in Ethiopia explained that the tea consumption and side dishes consumption were not risk factors of anemia. The study in Canada also showed that the consumption of animal side dishes was not associated with anemia.<sup>30,31</sup>

In this study, good knowledge about anemia and nutrition for anemia prevention had a significant relationship with the anemia prevalence ( $p=0.029$ ). Adolescent girls with a good knowledge had a risk of anemia compared to adolescents with poor knowledge in this study. Good knowledge might not affect to behave well. Food intake consumed was provided by head of islamic boarding school. So, they could not choose the food. Beside that, adolescent girls had less attention to the food nutrition value. This result was in contrast with previous study which stated that adolescent girls with a poor knowledge were more risk to have anemia than good knowledge.<sup>22,32</sup> We found that there were more than one third of subjects (34%) had poor knowledge about anemia prevention in this study. So, it is necessary to provide information and counseling about anemia and nutrition to prevent anemia for adolescent girls.

The father and mother's educations are not related to anemia in this study as in several previous studies.<sup>20,24</sup> A higher education level will lead a better individual knowledge level. Parents with good knowledge about anemia nutrition will provide food that is suitable for the nutritional needs for adolescents. In this study, the adolescents did not live with their parents so that their food intake was not determined by the parents.

The limitations of this study are the precision to measure the sample size (10%), the food intake measurement by qualitative method has the weakness, namely there was bias about the differences between each respondent regarding the frequency and quality of meals. For further research, it is expected to use smaller precision samples and food intake quantitative assesment with the SQ-FFQ (Semi Quantitative Food Frequency Questionnaire).

## CONCLUSIONS

Anemia among adolescent girls at islamic boarding school in Semarang still becomes a public health problem where the prevalence is 17.3%. There was a significant association between nutritional status, knowledge about nutrition and anemia status among adolescent girls. It is necessary to provide a regular nutrition education and

monitoring from public health center to *Pos Kesehatan Pesantren* of islamic boarding schools (adolescent girls and head of islamic boarding school) about the importance of nutrition in adolescents to improve the knowledge about nutrition and change the behaviour of food intake. Head of islamic boarding school must provide the good nutritions for students, so students can keep the normal weight and it can decrease and prevent anemia among adolescent girls.

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## Differences in Eating Habits and Physical Activity Before and During Distance Learning

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### ABSTRACT

**Background:** The COVID-19 pandemic has led to the enforcement of distance learning. This may cause negative impacts on adolescents' eating habits and physical activity.

**Objectives:** This study aimed to analyse the differences in eating habits and physical activity before and during distance learning in adolescents.

**Materials and Methods:** A cross-sectional study was conducted on a sample of 95 adolescents aged between 15-18 years. Subjects were selected using a simple random sampling method. Eating habits and physical activity variables were measured using modified Eating Habit and Lifestyle Changes in COVID-19 and Eating Habits Questionnaire. Wilcoxon Signed-Rank and McNemar tests were used to analyse the data.

**Results:** There was an increase in frequency of meals two times/day (9.5%) and snacking three times/day (4.2%) reported during distance learning. There were significant differences in number of meals ( $p=0.014$ ) and snacking ( $p=0.034$ ), carbohydrates sources intake ( $p=0.046$ ), sweet food ( $p=0.014$ ), snack ( $p=0.016$ ), exercise ( $p=0.035$ ), exercise duration ( $p=0.004$ ), and exercise frequency ( $p=0.030$ ) before and during distance learning. There were no significant differences in protein-sources intake, vegetable, fruit, sweetened beverages, fried food, processed food, junk food, emotional eating, physiological eating, and ways of obtaining food before and during distance learning ( $p > 0.05$ ).

**Conclusion:** Significant differences were found in eating habits comprised of the number of main meals and snacking, intake of carbohydrates sources, sweet food, snack, and physical activity before and during distance learning

**Keywords:** eating habit; physical activity; distance learning; adolescent

### BACKGROUND

The 2019 Coronavirus disease (COVID-19) is an infectious disease that was first reported in Wuhan, China, in December 2019.<sup>1</sup> This disease is caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) virus transmitted through droplets of infected patients.<sup>2</sup> This disease has spread to more than 60 countries in the world within three months.

The COVID-19 pandemic led Indonesia to implement social restrictions policies regionally. Especially in Jakarta, the capital city of Indonesia. Jakarta is the most populous city in Indonesia so it had the highest number of COVID-19 compared to other cities.<sup>3</sup> This causes the activities of Jakarta residents to be severely restricted by the government, public places are closed, restaurants limit take-out or online delivery services, and social gatherings related to political, sports, entertainment, academic and cultural gatherings are stopped provisionally during the social restrictions. The public is advised not to engage in activities outside their house except to meet basic or medical needs. The restrictions include the temporary cessation of school activities so that all learning activities are carried out at their respective residences through the distance learning method.<sup>4</sup> Distance learning leads adolescents to feel stressed, causing discomfort such as fear and anxiety to the point that it might change their eating habits.<sup>5,6</sup> Staying at home leads to increased food consumption because the possibility of access to food is higher. This can disrupt mealtimes, which can maintain metabolism and protect the body from dysmetabolism and obesity.<sup>7</sup>

In addition, distance learning restricts adolescents to do spontaneous physical activities related to the necessities of daily life outside the house.<sup>8</sup> Distance learning can make teens spend hours sitting in front of a device or learning media, causing an increase in sedentary behaviour that triggers a decrease in energy levels.<sup>8,9</sup> Sedentary behaviour related to eating habits is directly proportional to energy intake, where energy intake is higher (an increase of 350 kcal) when sedentary behaviour increases (decrease in energy expenditure of 100 kcal).<sup>10</sup> Based on a recent study of Palestinian adolescents, there was an increase in food

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intake by 50% compared to before school closures. Subjects also experienced changes in eating habits with increases in vegetable intake by 40%, fruit intake by 33%, fried food by 37%, and sweet food intake by 47%. In addition, as many as 45% of adolescents reported no physical activity while schools are closed. Factors such as staying at home and keeping a distance from other people have a significant relationship with increased intakes.<sup>11</sup> Another previous research by Ruiz-Roso et al. during restriction, showed intake of vegetables and fruits were increased because subjects have time to cook and intake of fried and sweet food were increased because staying at home can trigger boredom and stress, causing a change in eating patterns and increasing food consumption.<sup>12</sup>

Another study in Italy stated that appetite increased significantly in subjects with relatively younger age. Regarding eating habits, 37% of subjects ate healthier food, and 36% of respondents ate less healthy food. In the consumption of junk food, there was a decrease in subjects who consumed 30% compared to subjects who experienced an increase of 26%. Decreased junk food intake correlates with healthy food consumption, while increased junk food intake correlates with increased food intake and hunger after dinner. During social restriction, physical activity increased slightly (38%), especially bodyweight training. The percentage of subjects who trained five days/week also increased by 10%. This happened because subjects have more time to exercise. However, subjects who were not used to do sports did not take the opportunity to start.<sup>13</sup> Social restrictions change people's eating habits and physical activity. Moreover, distance learning and the psychological impact on adolescents may cause a lack of physical activity that triggers an increase in sedentary lifestyles and changes in unhealthy eating patterns. Based on the description above, this paper aimed to analyse differences in eating habits and physical activity before and during distance learning in high school students as there have not been many studies on this topic in Indonesia, especially in Jakarta.

## MATERIALS AND METHODS

This study is an observational analytic study with a cross-sectional design—was conducted in December 2020 with the subject of public school's students in Central Jakarta. This research has obtained approval from the Health Research Ethics Committee, Faculty of Medicine, University of Diponegoro No. 06/EC/KEPK/FK-UNDIP/I/2021. The participants consented to participate in the study with a digital informed/parental consent form. The cluster random sampling method was used to determine which schools from 5 sub-districts in Central Jakarta are chosen to collect the data. The sample size was calculated using binomial proportions with  $\alpha = 0.05$ ,  $N$  (population of high school students in Jakarta) = 9,202 people,  $d = 10\%$ ,  $p = 0.5$  and the probability of dropout = 20%. Based on the calculations, the minimum sample size in this study was set at 114 samples. The data was collected using the simple random sampling method. The subjects were eligible if they were students of a public high school in Central Jakarta, between 15-18 years of age, implementing distance learning since March 2020, not on a specific diet, nor engage in a physical exercise program. Based on the screening results, 19 out of 114 subjects were dropped out of the study because they did not meet the inclusion criteria. Hence, the analysed subjects were 95 samples. The data was collected through a structured questionnaire created in Microsoft Forms—consisted of more than 60 questions about socio-demographic characteristics, eating habits, physical activity during distance learning, and the previous period.

The independent variable in this study is the school hours during distance learning. The school hours were measured using a questionnaire by dividing the duration into three categories based on Ministry of Education and Culture guidelines issued under special conditions such as COVID-19; <5 hours/day, 5 hours/day, and >5 hours/day. The dependent variables in this study are eating habits and physical activity. Data on eating habits and physical activity variables were collected from filling out modified of the Eating Habit and Lifestyle Changes in COVID-19 and Eating Habits questionnaires which have been tested for validity and reliability.<sup>13,14</sup> The eating habits questionnaire consisted of types and amounts of food and beverages consumed per day or per week. The subject recorded the number of main meals (1-4 times/day) snacking (0-4 times/day), amount of food consumed per day, including carbohydrates sources intake (<3 servings, 3-4 servings), >4 servings), animal and plant-based protein sources intakes (0 to >4 servings), vegetables (0 to >4 servings), fruits (0 to >3 servings), and amounts of certain food per week like sweet food, sweetened beverages, fried food, processed food, snacks, and junk food (do not consume, 1-3 servings, 4-6 servings, >6 servings).

Data on eating behaviour including emotional eating (never, seldom, sometimes, always), physiological eating consisting of changes in hunger/satiety perception (no, less appetite, more appetite), and sense of hunger (before mealtime, between mealtimes, after dinner), eat late at night (yes/no), portion sizes

per meal (1 portion, >1 portions), pay attention to nutritional intake (never, sometimes, always), changes eating habits (no, unhealthy, healthier), and ways of obtaining food (cooking/purchasing). The physical activity questionnaire consisted of 4 questions; exercise (yes/no), type of exercise (outdoor, indoor), exercise duration per day (<60 minutes, 60 minutes, >60 minutes), and exercise frequency per week (<3 times, 3 times, >3 times).

The data obtained were analyzed using IBM SPSS Statistics 25 software. Data analysis was initiated by testing the instrument's validity using the Principal Component Analysis (PCA) method to reduce the dimensions of interrelated variables while retaining most of the information in the data in an interpretable way.<sup>15,16</sup> The method is used to determine the factors that are considered relevant, describe whether the question items are included in the same factor or not, and reduce irrelevant question items in the questionnaire.<sup>17</sup> Two criteria need to be met to determine whether the data is eligible to be tested; Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)  $p > 0.50$  and Bartlett's Test of Sphericity  $p < 0.05$ .<sup>18</sup> If the data is eligible, factor analysis is carried out by looking at the extraction value with the communality standard variable  $p > 0.50$  considered high or ideally  $p \geq 0.70$ .<sup>19,20</sup> The number of existing factors can be determined if the components with total initial eigenvalues  $> 1.00$  in the total variance explained table.<sup>17</sup> The interpretation of the results is made by looking at the factor loading on the rotated component matrix table, which is significant at a value of  $> 0.30$ .<sup>18,21</sup>

The results of the construct validity test showed that there are 15 relevant factors out of 47 questions in the modified questionnaire of this study. The validity test results found that the  $p$ -value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) = 0.548 with Bartlett's Test of Sphericity  $p$ -value of  $X^2 = 3634.027$  and  $p$ -value = 0.00. The validity test using Pearson correlation and reliability test was found that the modification of the questionnaire on eating habits and physical activity was reliable with Cronbach's Alpha  $p = 0.704$ . There are 15 out of 60 items with an insignificant  $p$ -value; however, these items are habitual questions that are important to explore so they are still used.

Univariate analysis was performed using a frequency distribution to show the value of each variable in percentage. The data normality test was carried out using the Kolmogorov-Smirnov with a significance of 0.05 because it had a sample size of  $> 50$ .<sup>22</sup> All data were known to be not normally distributed, so the bivariate analysis was carried out using a non-parametric test. Bivariate analysis aimed to see the differences of dependent variables towards independent variable. Differences in eating habits comprised of the number of daily meals and snacking, amount and types of food consumed, eating behaviour (except ways of obtaining food), and physical activity comprised of exercise duration and frequency before and during distance learning were analysed using the Wilcoxon signed ranks test. Differences in the variable eating habits comprised of eating behaviour (ways of obtaining food) and the variable physical activity with the sub-variable exercise were analysed using the McNemar test. The test was carried out with a confidence interval of 95% and significant if  $p < 0.05$

## RESULTS

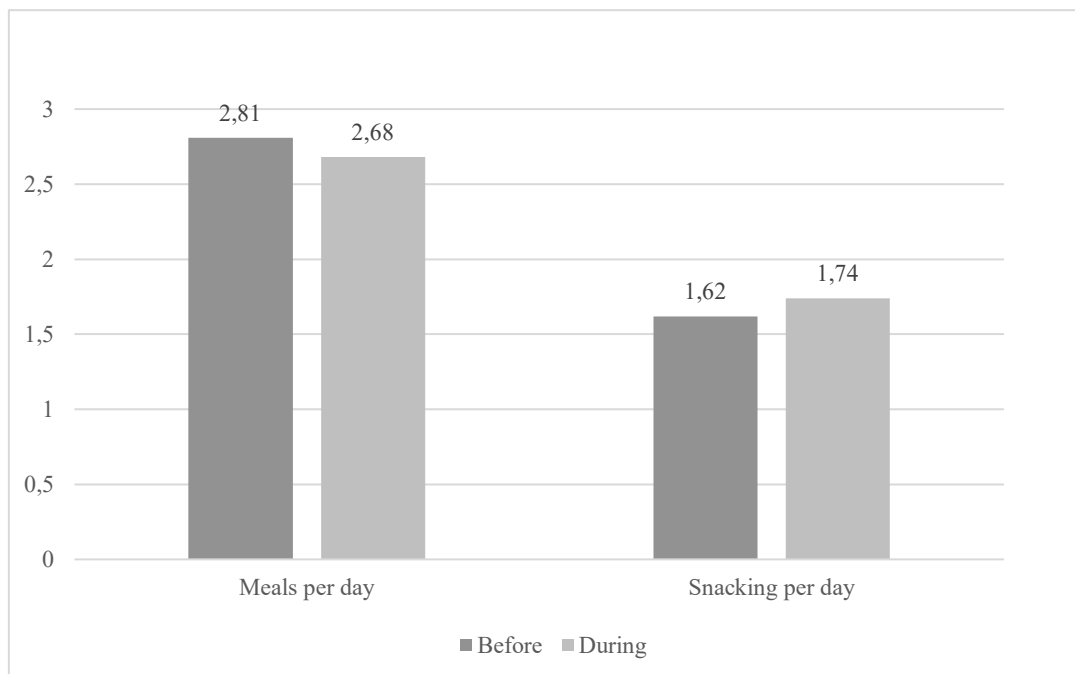
**Table 1. Socio-demographic Characteristics**

Characteristics	Frequency	Percentage
	(n= 95)	(%)
<b>Gender</b>		
Male	33	34.7
Female	62	65.3
<b>Age (years)</b>		
15	16	16.8
16	37	38.9
17	30	31.6
18	12	12.6
<b>Grade</b>		
10 <sup>th</sup>	24	25.3
11 <sup>th</sup>	35	36.8
12 <sup>th</sup>	36	37.9
<b>School hours during distance learning</b>		
<5 hours/day	14	14.7
5 hours/day	18	18.9
>5 hours/day	63	66.3

A total of 95 adolescents from several schools participated in this study. The characteristics of the subjects in the study, which included gender, age, school origin, grade, and school hours during distance learning, are presented in Table 1.

Table 1. shows that the subjects' age range is 15-18 years old and consisted of 34.7% males and 65.3% females. As many as 25.3% of the subjects are 10<sup>th</sup>-grade students, 36.8% are 11<sup>th</sup>-grade students, and 37.9% are 12<sup>th</sup>-grade students. Most students study for >5 hours/day during distance learning, while 18.9% study 5 hours/day, and 14.7% of students study <5 hours /day.

Table 2 and figure 1 presenting the frequencies of each variable and the bivariate analysis of subject eating habits.



**Figure 1. Mean of Food Intake (Meals and Snacking) Per Day Before and During Distance Learning**

Table 2 shows 9.5% increase number of subjects in 2 times/day-meals during distance learning from 20% into 29.5%. The average number of meals before distance learning presented in figure 1 was  $2.81 \pm 0.551$  times, whereas during distance learning was  $2.68 \pm 0.551$  times. There is an increase number of subjects in 3 times/day-snacking from 7.4% into 11.6% during distance learning. The average number of snacking before distance learning was  $1.62 \pm 0.702$  times, whereas during distance learning increased to  $1.74 \pm 0.703$  times. The frequency distribution table shows 10.5% decrease in carbohydrates sources intakes of 3-4 servings/day from 58.9% into 48.4% during distance learning. Most subjects consumed animal protein intakes of 2-4 servings/day and plant-based protein intake <2 servings/day during distance learning. Some subjects consumed <3 servings of vegetables/day and <2 servings of fruit/day during distance learning.

In certain types of food, there is an 8.4% decrease in subjects consuming sweet food of 4-6 servings/week from 15.8% before distance learning into 7.4% during distance learning and 8.5% increase in subjects who do not eat snacks during distance learning from 16.8% into 25.3%. Before and during distance learning, the average subject consumed sweetened beverages, fried food, processed food, and junk food as much as 1-3 servings/week. On average, before and during distance learning subjects sometimes have emotional eating, feel hungry after dinner, and obtain food by cooking.

Results of the analysis presented in Table 2. found that there are significant differences in the number of meals ( $p=0.014$ ) and snacking ( $p=0.034$ ), type and amount of carbohydrates sources intake ( $p=0.046$ ), sweet food ( $p=0.14$ ) and snacks ( $p=0.016$ ). No significant differences in the type and amount of animal protein ( $p = 0.317$ ) and plant-based protein ( $p = 0.366$ ), vegetables ( $p = 0.166$ ), fruits ( $p = 0.827$ ), sweetened beverages ( $p = 0.166$ ), fried food ( $p=0.109$ ), processed food ( $p=0.285$ ) and junk food ( $p=0.096$ ), emotional eating ( $p=0.467$ ) and physiological eating ( $p=0.190$ ), and ways of obtaining food ( $p= 1.000$ ) before and during distance learning with  $p > 0.05$ .

Table 2. Frequency Distribution and Bivariate Analysis of Eating Habits

Variables	Before (n= 95)		During (n= 95)		p
	n	%	n	%	
<b>The number of main meals per day</b>					
1	2	2.1	2	2.1	0.014 <sup>a*</sup>
2	19	20	28	29.5	
3	69	72.63	63	66.3	
4	5	5.3	2	2.1	
<b>The number of snacking per day</b>					
0	2	2.1	-	-	0.034 <sup>a*</sup>
1	41	43	38	40	
2	44	46.45	45	47.4	
3	7	7.4	11	11.6	
4	1	1.1	1	1.1	
<b>Carbohydrates sources intake per day (portion)</b>					
<3	38	40	47	49.5	0.046 <sup>a*</sup>
3-4	56	58.46	46	48.4	
>4	1	1.1	2	2.1	
<b>Animal protein sources intake per day (portion)</b>					
2-4	94	98.93	93	97.9	0.317 <sup>a</sup>
>4	1	1.1	2	2.1	
<b>Plant-based protein sources intake per day (portion)</b>					
0	8	8.4	7	7.4	0.366 <sup>a</sup>
<2	72	75.71	71	74.7	
2-4	14	14.16	16	16.8	
>4	1	1.1	1	1.1	
<b>Vegetables intake per day (portion)</b>					
0	15	15.15	15.8		0.166 <sup>a</sup>
<3	52	54.56	58.9		
3-4	27	28.24	25.3		
>4	1	1.1	-	-	
<b>Fruits intake per day (portion)</b>					
0	17	17.18	18.9		0.827 <sup>a</sup>
<2	57	60.57	60		
2-3	18	18.16	16.8		
>3	3	3.2	4	4.2	
<b>Sweet food intake per week (portion)</b>					
0	14	14.18	18.9		0.014 <sup>a*</sup>
1-3	63	66.67	70.5		
4-6	15	15.7	7.4		
>6	3	3.2	3	3.2	
<b>Sweetened beverages intake per week (portion)</b>					
0	10	10.9	9.5		0.166 <sup>a</sup>
1-3	61	64.68	71.6		
4-6	19	20.13	13.7		
>6	5	5.3	5	5.3	
<b>Fried food intake per week (portion)</b>					
0	8	8.4	9	9.5	0.109 <sup>a</sup>
1-3	67	70.71	74.7		
4-6	17	17.12	12.6		
>6	3	3.2	3	3.2	



Variables	Before (n= 95)		During (n= 95)		p
	n	%	n	%	
<b>Processed food intake per week (portion)</b>					
0	12	12.6	13	13.7	0.285 <sup>a</sup>
1-3	64	67.4	68	71.6	
4-6	17	17.9	10	10.5	
>6	2	2.1	4	4.2	
<b>Snacks intake per week (portion)</b>					
0	16	16.8	24	25.3	0.016 <sup>a*</sup>
1-3	62	65.3	58	61.1	
4-6	12	12.6	9	9.5	
>6	5	5.3	4	4.2	
<b>Junk food intake per week (portion)</b>					
0	17	17.9	19	20	0.096 <sup>a</sup>
1-3	69	72.6	71	74.7	
4-6	8	8.4	3	3.2	
>6	1	1.1	2	2.1	
<b>Emotional eating</b>					
Never	20	21.1	19	20	0.467 <sup>a</sup>
Seldom	27	28.4	27	28.4	
Sometimes	38	40	38	40	
Always	10	10.5	11	11.6	
<b>Sense of hunger</b>					
Before mealtime	34	35.8	32	33.7	0.190 <sup>a</sup>
Between mealtimes	37	38.9	36	37.9	
After dinner	24	25.3	27	28.4	
<b>Ways of obtaining food</b>					
Cooking	79	83.2	80	84.2	1.000 <sup>b</sup>
Purchasing	16	16.8	15	15.8	
<b>Paying attention to nutrition intake</b>					
Never	34	35.8	-	-	
Sometimes	48	50.5	-	-	
Always	13	13.7	-	-	
<b>Change in eating habits</b>					
No	-	-	53	55.8	
Yes, healthier	-	-	25	26.3	
Yes, unhealthy	-	-	17	17.9	
<b>Change in hunger/satiety perception</b>					
No	-	-	36	37.9	
Yes, more appetite	-	-	34	35.8	
Yes, less appetite	-	-	25	26.3	
<b>Portion size(s) in each meals</b>					
1 portion	78	82.1	72	75.8	
>1 portions	17	17.9	23	24.2	
<b>Eat late in the night</b>					
No	53	55.8	55	57.9	
Yes	42	44.2	40	42.1	

<sup>a</sup>Wilcoxon signed-ranks test <sup>b</sup>McNemar test; \*significant at p<0.05

**Table 3. Frequency Distribution and Bivariate Analysis of Physical Activity**

Variables	(n=95)		(n=95)		p
	n	%	n	%	
<b>Exercise</b>					
No	31	32.6	42	44.2	0.035 <sup>b*</sup>
Yes	64	67.4	53	55.8	
<b>Exercise type</b>					
Do not exercise	31	32.6	42	44.2	
Outdoor	42	44.2	6	6.3	
Indoor	22	23.2	47	49.5	
<b>Exercise duration per day</b>					
Do not exercise	31	32.6	42	44.2	
<60 minutes	39	41.1	41	43.2	0.004 <sup>a*</sup>
60 minutes	13	13.7	0	0	
>60 minutes	12	12.6	12	12.6	
<b>Exercise frequency per week</b>					
Do not exercise	31	32.6	42	44.2	
<3 times	49	51.6	40	42.1	0.030 <sup>a*</sup>
3 times	11	11.6	9	9.5	
>3 times	4	4.2	4	4.2	

<sup>a</sup>Wilcoxon signed-ranks test <sup>b</sup>McNemar test; \*significant at  $p < 0.05$

Results in Table 3, physical activity variables show an increase in the number of subjects who do not exercise by 11.6% during distance learning. All subjects who exercised for 60 minutes/day before distance learning do not exercise during distance learning. In addition, there is a decrease in the frequency of exercise <3 times/week by 9.5% during distance learning. Results of the analysis presented in Table 3. found that there are significant differences in the physical activity included exercise ( $p=0.035$ ), exercise duration ( $p=0.004$ ) and exercise frequency ( $p=0.030$ ) before and during distance learning with  $p < 0.05$ .

**Table 4. Distribution of Most Consumed Food and Beverages during Distance Learning**

Types of Food and Beverages	n	%
<b>Sweet food</b>		
Do not consume	17	17.9
Chocolate or confectionery	48	50.5
Baked products (e.g cake or cookie)	21	22.1
Other	9	9.5
<b>Sweetened beverages</b>		
Do not consume	9	9.5
Bubble tea	48	50.5
Soft drinks	6	6.3
Other	32	33.7
<b>Fried foods</b>		
Do not consume	9	9.5
French fries	42	44.2
Fritters	34	35.8
Other	10	10.5
<b>Processed foods</b>		
Do not consume	13	13.7
Sausages/meatballs	21	22.1
Nugget	41	43.2
Other	20	21.1
<b>Snacks</b>		
Do not consume	22	23.2
Chips	35	36.8
Extruded snacks	32	33.7
Other	6	6.3
<b>Junk food</b>		
Do not consume	19	20
Starchy meatballs (Bakso aci)	13	13.7
Crackers soup (Seblak)	41	43.2
Other	22	23.2

Table 4. presents certain types of most consumed food and beverages during distance learning. Table 4 showed the distribution of the most consumed of sweet food were chocolate or confectionery (50.5%) while the most consumed of sweet drinks were bubble tea (50.5%). The most consumed fried foods were

french fries (44.2%), the most consumed of processed foods were nuggets (43.2%), the most consumed of snacks were chips (36.8%) and the most consumed of junk food were crackers soup such as seblak (43.2%)

## DISCUSSION

Distance learning is a learning method from home carried out in a state of emergency COVID-19 pandemic. This method is meant to limit exposure to the spread of the virus that can occur in schools. Before distance learning, school hours ran for 8 hours/day.<sup>21</sup> Meanwhile, school hours are set at least 24 hours a week during distance learning.<sup>22</sup> This study indicates that most of the subjects study for >5 hours/day during distance learning. This happens because the online meeting schedule is tentative, and students are often given assignments outside of school hours so that students tend to study until the afternoon and even at night.

Based on the study results, there is an increase number of subjects with 2 times/day-meals and decrease number of subjects with 3 times/day-meals during distance learning Eating less than 3 times/day was included as a poor diet. Under normal conditions, each individual is advised to consume the main food 3 times a day. This study is in line with previous research which stated that the majority of students eat twice a day during the pandemic.<sup>23</sup> However, this research is in contrast with another study which found an increase in eating meals 5 times/day by 31.1% during social distancing, where previously it was 19.9%.<sup>24</sup>

The risk of overeating also corresponds to an increase in the frequency of 3 times/day-snacking during distance learning. The results of this study are compatible with other studies that stated that 18.9% of subjects snacking 3 times/day among the 21.1% of the subjects who are snacking more frequently during social restrictions.<sup>25</sup> Increased consumption of distractions can occur because of the tendency to feel hungry at dinner time. This is in line with the increase in subjects who feel hungry at dinner time during distance learning compared to before. Irregular snacking poses a risk to adolescent health, including cardiovascular, neurological, and metabolic complications, especially when done at a young age. Irregular snacking can affect the number of main meals and may increase snacking between meals.<sup>26,27</sup>

The recommended consumption of carbohydrates sources in a day is 3-4 servings.<sup>23</sup> This research showed there is a decrease number of subjects who consumed 3-4 servings of carbohydrates sources per day during distance learning and an increase number of subjects who consumed less than 3 of carbohydrates sources per day. In another study, a similar thing was found where there was a decrease in consumption of carbohydrates-based food to 13% of subjects during social restrictions compared to the previous 16.7% of subjects.<sup>28</sup> A decrease in consumption occurs because the subject feels less appetite during distance learning. Carbohydrates are the body's primary source of energy. The body requires adequate carbohydrates intake so as not to break down protein to meet energy needs. In addition, the body needs carbohydrates to break down fat and prevent the buildup of ketone bodies in the blood.<sup>29</sup>

There is a decrease in sweet food consumption of 4-6 servings/week during distance learning, where some subjects reduced their consumption to 1-3 servings/week, and several other subjects stopped consuming sweet food. This is due to subjects who try to change their eating habits to be healthier during distance learning. The addition of sugar to food aims to increase palatability and is used to preserve food. Although required in certain clinical conditions, additional sugar is not necessary for a healthy adolescent diet.<sup>30</sup> Excessive consumption of sweet food can cause cavities, weight gain, and increased blood glucose levels so that the consumption of sugar in sweet food is limited to 50 grams/day.<sup>31</sup> There is an increase in the number of subjects who do not eat snacks during distance learning. This result is different from other studies, which found an increase in the consumption of snacks during social distancing compared to before.<sup>24</sup> The increased number of subjects who do not eat snacks was due to the subjects changing their eating habits to be healthier during distance learning.

A study found acrylamide compounds, carcinogenic substances, in starchy snacks that have gone through the roasting and frying process.<sup>32,33</sup> In adults with normal weight and overweight, consumption of energy-dense snacks is associated with weight gain.<sup>34</sup> This also applies to children and adolescents where the total number of snacks consumed is associated with overweight status, but the risk of being overweight tends to be low.<sup>35</sup> There are no changes in animal and plant-based protein sources consumed during distance learning compared to before. On average, subjects consumed chicken and beef as sources of animal protein and consumed tofu and tempeh as sources of plant-based protein before and during distance learning. Based on research conducted in America, protein intake is more stable than carbohydrates intake. This shows that the body's biological mechanism strictly regulates protein intake to affect the elements of food and other macronutrient intakes.<sup>36</sup> During adolescent development, protein is needed to build new tissues and maintain existing tissues.<sup>37</sup> Animal protein has more complete amino acids, higher nutritional quality, and is more

easily absorbed by the body, while plant-based protein contains isoflavones which function as antioxidants and anti-cholesterol, so that they need to be consumed together every day to achieve balanced nutrition.

There are no differences in the intake of vegetables and fruits before and during distance learning. On average, spinach and water spinach are the most consumed vegetables. At the same time, mango, orange, and apple are the most consumed fruits before and during distance learning. These results confirm a previous study that found no difference in fruit and vegetable intake during restriction.<sup>38</sup>

Riskesdas 2018 data shows that 67.9% of Indonesian teenagers only consume 1-2 servings of fruit/vegetables/day. In addition, almost all Indonesian teenagers have not met their daily needs for vegetables and fruits (96.4%).<sup>39</sup> Vegetables and fruits are a high-fibre food group that is good for the body because they take longer to digest, thus providing a more prolonged feeling of fullness. In addition, the fibre contained in vegetables and fruits also serves to bind cholesterol and prevent constipation.<sup>29</sup>

There are no differences in the consumption of sweetened beverages and fried food before and during distance learning. During distance learning, the most consumed sweetened beverage is bubble tea, and fried food most often consumed is french fries. Fried food and sweetened beverages are fatty and high sugar drinks with a mood-boosting effect.<sup>40,41</sup> Physiologically, consuming fatty food and high-sugar drinks increases the production of serotonin and dopamine, which affect mood for the better.<sup>42</sup> However, excessive consumption can have adverse effects such as weight gain. No difference was found in the consumption of processed food and junk food before and during distance learning. Most of the subjects eat processed food because it is easy to be obtained, could be stored for a long time, and easy to serve. Although there is limited access to leave the house regarding the intake of junk food, some subjects choose to make their food at home or using a delivery service.

Processed food and junk food tend to be high in sodium, high in calories, and contain low nutritional value. Adolescents with normal weight should consume junk food in small amounts, while teenagers on a diet are recommended to limit their consumption of junk food. Regular consumption of junk food and processed food can increase the risk of chronic diseases such as cardiovascular, type 2 diabetes, liver disease, and cancer.<sup>43</sup> In addition, the sodium contained in processed food may cause water retention in the body, causing bloating, swelling, and weight gain.<sup>44</sup> Before and during distance learning, no significant differences in subjects who sometimes eat because of emotional eating were identified, possibly because the data were collected when some subjects already adapted to the pandemic conditions. Emotional eating is a tendency to overeat as a form of response to negative emotions that are felt.<sup>45</sup> Difficulty regulating emotions, feeling unhappy with body image, being on a diet, boredom, childhood habits, and social influences are some of the factors that may cause emotional eating.<sup>46</sup>

There are no significant differences in the self-reported sense of hunger before and during distance learning. However, there is an increase in subjects who declared to feel hungry after dinner during distance learning compared to before. Increased hunger after dinner occurred related to activities before bedtime, increased appetite, and the tendency to consume snacks at night.<sup>13</sup> In this study, it was found that 35.8% of subjects felt enhanced appetite during distance learning.

Leptin and ghrelin are part of the body's physiological mechanism to regulate food intake.<sup>47</sup> Leptin, sometimes referred to as satiety hormone, functions to inhibit appetite and stimulates increased energy expenditure. In contrast, a hunger hormone, ghrelin, stimulates hunger by increasing neuropeptide Y (NPY) release, an appetite stimulator.<sup>47-49</sup> Ghrelin levels tend to decrease in individuals who overeat and increase in individuals who eat less. In individuals with normal weight, increased leptin levels inhibit NPY and suppress appetite. Low-carbohydrates food can reduce leptin resistance, while food high in protein and fibre can inhibit ghrelin.<sup>50</sup>

There are no significant differences in the ways of obtaining food before and during distance learning. This contrasts with research conducted in America, where most parents who have children at school age (5-18 years) limit purchasing food from outside their houses and increase home-cooked meals for their families during the pandemic.<sup>51</sup> There is no difference in ways of obtaining food before and during distance learning because most family members have time to cook. Besides, cooking at home also tends to cost less than buying food.<sup>52</sup> Consumption of home-cooked meals has a significant relationship with indicators of a healthier diet.<sup>53</sup> Cooking their food will allow individuals to control the ingredients used and the portion served.<sup>54</sup> Research shows that individuals who cook at home consume lower calories than those who cook less.<sup>55</sup>

There is a decrease in the number of subjects, duration, and exercise frequency during distance learning. This result is consistent with another study in which there was a decrease in subjects who exercised

during social distancing.<sup>56</sup> Before distance learning, some subjects spent 60 minutes/day exercising, while no subjects exercised for 60 minutes/day during distance learning. Another study found a decrease in subjects who exercise >60 minutes/session by 11.9% during social distancing. The decrease of subjects who do not exercise was similar to other studies which found a decrease in exercise <3 times / week to 32.3% where before social restrictions was 35.4%.<sup>28</sup>

Social restrictions are reported to cause negative feelings, lack of personal space, and social pressure in adolescents, limiting their willingness and possibility to remain active.<sup>57</sup> Moreover, obstacles such as much schoolwork, lack of free time, limited space for movement, and the loss of opportunities to participate in sports at school may change the habits of teenagers, which is essential to form behaviour in current conditions.<sup>58,59</sup> Exercise can become a routine and a way to stay in touch with family and friends. Exercise is beneficial for improving bone and muscle strength, balance, flexibility, and fitness. In addition, exercise is also good for mental health, reduces the risk of depression and anxiety, and improves mood.<sup>60-62</sup>

Teenagers are advised to be able to eat food according to the recommendation of Tumpeng Gizi Seimbang. Besides, it might be good for teenagers to do physical activity with light intensity for 3-4 minutes, such as walking or stretching to relax the muscles and improve blood circulation during school hours.<sup>60</sup> This activity is sufficient to increase energy expenditure to improve the body's metabolic health by controlling the glycemic index.<sup>63</sup> Adolescents are expected to do 60 minutes/day of moderate-intensity physical activity such as aerobics or physical exercise outside of school hours.<sup>60</sup> In terms of research, it is recommended to conduct further research regarding the factors that influence eating habits before and during distance learning that were not examined in this study, such as nutritional status, socioeconomic status, stress level, and lifestyle.

The limitations of this study used categorical analysis to see the difference in the variables; however, it cannot show the magnitude of the decrease or increase numerically for each variable value. This research data was collected online using Microsoft Forms, so there are limitations in the validity of the data even though the researchers had tried to validate the data.

## CONCLUSIONS

There are significant differences in adolescents' eating habits and physical activity during distance learning. Significant differences were found in eating habits comprised of the number of main meals and snacking, intake of carbohydrates sources, sweet food, snack, and physical activity before and during distance learning with  $p < 0.05$ . However, there are no significant differences in eating habits comprised of intake of animal and plant-based protein sources, vegetable, fruit, sweetened beverages, fried food, processed food, junk food, and eating behaviour with  $p > 0.05$ .

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## Anthropometric Markers, Visceral Adipocyte Index, Inflammation Markers and Bone Density in Reproductive Obese Women

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### ABSTRACT

**Background:** Obesity has been associated with the risk of various diseases. The correlation between anthropometry and bone health is complex. Visceral adipocyte index (VAI) is one of the compositions of body fat compositions that mostly associated with proinflammatory cytokine, which can stimulate C-reactive protein (CRP) that affects bone density.

**Objectives:** This study aimed to prove the correlation between VAI, CRP and BMD in Asian reproductive obese women

**Materials and Methods:** A cross sectional study was conducted in November 2020 - February 2021 and a total of 134 women of reproductive age with obesity participated in this study. Weight, height, body mass index (BMI) and rate of visceral fat were measured by body composition analyzer. Waist (WC) and hip circumferences (HC) measured by using tape; lipid profile and CRP level were examined using a clinical chemistry automatic analyzer, and the examination of bone mineral density (BMD) using dual-energy x-ray absorptiometry. Waist to hip ratio (WHR) and VAI calculated manually. Pearson and Spearman test were used for statistical analysis.

**Results:** There were positive weak correlations between weight, height, BMI, WC, HC, rate of visceral fat, WHR and VAI. There were weak positive correlations between HC, WHR and CRP. There were positive moderate correlations between weight, height, BMI, waist, visceral fat, WHR and CRP.

**Conclusion:** Although there were correlations between anthropometric parameters and VAI and also CRP, but we did not found correlation between VAI and CRP to all BMD parameters.

**Keywords :** VAI, CRP, BMD, anthropometry, obesity, women

### BACKGROUND

Obesity is often associated with the risk of various diseases and encountered in the world as well as in Indonesia. The prevalence of obese women in Indonesia is 29.3% higher than in men, and 14.3% of most cases are at the age of 35-49 years.<sup>(1)</sup> The relationship between body composition and bone health is complex.<sup>(2)</sup> Cytokines and adipokines produced by fat mass can affect bone density. The C-Reactive Protein (CRP) is one of the acute phase proteins secreted by the liver in the presence of interleukin-6 stimulation<sup>(3,4)</sup>, and also with bone density.<sup>(5)</sup>

Previous study has shown that there is an anthropometric relationship including body mass index (BMI) and visceral fat with the risk of bone damage in obesity.<sup>(6)</sup> The bone mineral density is said to be positively correlated to subcutaneous fat, but negatively related to visceral fat.<sup>(7) (8,9)</sup> Adipocyte produces adipokines which can stimulating bone growth. In the other hand, adipocytes can also produce proinflammatory cytokines that will affect bone density.<sup>(10)</sup> Another parameter of body fat composition is the visceral adipocyte index (VAI). Previous studies linking bone density with body anthropometry are still contradicting each other. This study wanted to use VAI parameters involving several lipid profile parameters to find out more about the relationship between VAI and markers of inflammation with bone density. The parameters used in the VAI calculation can be modified and involve the blood lipid profile, so that if detected early, treatment or intervention can be carried out so that the situation does not become worse. This parameter indicates distribution and function of fat tissue, also, is widely associated with metabolic syndrome and cardiometabolic risk

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There are still few studies on women of reproductive age with obesity regarding the relationship between anthropometric parameters, VAI and CRP to BMD. This study aims to prove the correlation between VAI, CRP and BMD in Asian reproductive obese women.

## MATERIALS AND METHODS

A cross-sectional observational study was carried out at Diponegoro University academic community Semarang from November 2020 to February 2021. The subjects were 134 women at Diponegoro University aged 25-50 years and BMI >24 kg/m<sup>2</sup>. Participants had regular menstruation in the last 6 months, normal body temperature, normal liver and kidney functions, history of bone disorder/fractures during the past 6 months, breastfeeding, taking vitamin D, contraceptions or long-term corticosteroid were excluded from this study. Measurements of WC, hip circumference (HC), height and weight were carried out 2 times and the average results were obtained by 2 nutritionists and tested using the kappa test. Measurements of WC, hip circumference (HC), height and weight were carried out by 2 nutritionists and had been tested using kappa test. The index is calculated based on BMI, waist circumference (WC) and lipid profile in blood including triglyceride levels and high-density lipoprotein cholesterol (HDL) with the formula of  $\{[WC/36.58 + (1.89 \times BMI)] \times (\text{triglycerides}/0.81) \times (1.52/\text{HDL-cholesterol})\}$ .<sup>(11, 12)</sup> The examination of triglycerides was done using the principle of glycerol phosphate oxidase (GPO) while HDL was done by direct method and CRP by immunoturbidimetry using Indiko Thermo Fisher Scientific automatic clinical chemistry analyzer. The bone mineral density (BMD) examination was done using dual energy X-ray absorptiometry (GE-Lundar Prodigy-iDXA instrument) and interpretation was performed by a radiologist. Statistical correlation test with Pearson and Spearman Test. The value of significance if  $p < 0.05$ .

The study was conducted after obtaining permission from the Health Research Ethics Commission, Faculty of Medicine, Diponegoro University/Dr.Kariadi Semarang with number 242/EC/KPK/FK-UNDIP/X/2020. All subjects signed an informed consent prior to study.

## RESULTS

Total of 134 women were participated in the study The subject characteristics could be seen in table 1.

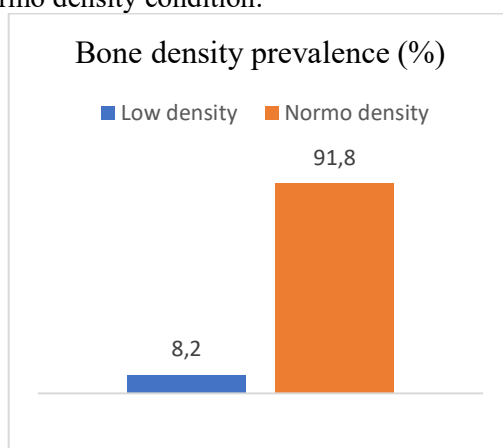
Table 1. Subject Characteristics

PARAMETER	Mean ± SD	Median (Min, max)
Age (years)	35.04 ± 6.12	34 (25 – 50)
Systole (mmHg)	115.15 ± 12.49	110 (90 – 170)
Diastole (mmHg)	73.43 ± 9.97	70 (60 – 110)
Height (cm)	155.18 ± 5.09	155.5 (145 – 169.5)
Weight (kg)	76.40 ± 13.99	72.6 (58.40 – 137.60)
BMI (kg/m <sup>2</sup> )	31.71 ± 5.05	30.50 (25.30 – 53.10)
Rate of visceral fat	9.62 ± 2.48	9 (6 – 19)
Waist circumference (cm)	93.39 ± 10.00	91(77 – 138)
Hip circumference (cm)	110.16 ± 9.86	110 (90 – 150)
WHR	0.86 ± 0.68	0.85 (0.68 – 1.04)
Total cholesterol (mg/dL)	186.49 ± 32.87	184 (98 – 257)
HDL cholesterol (mg/dL)	51.39 ± 12.05	51 (26 – 102)
LDL cholesterol(mg/dL)	113.49 ± 30.47	111 (56 – 188)
Triglyceride (mg/dL)	115.19 ± 54.26	101 (31 – 300)
VAI	4.57 ± 2.92	3.47 (0.81 – 12.53)
CRP (mg/L)	5.78 ± 5.05	4.25 (0.20 – 25)
SGOT (mg/dL)	24.57 ± 9.55	22 (14 – 78)
SGPT (mg/dL)	25.15 ± 14.37	21 (6 – 82)
Ureum (mg/dL)	23.34 ± 10.09	21 (5 – 81)
Creatinine (mg/dL)	0.78 ± 0.15	0.77 (0.49 – 1.28)
BMD lumbar	0.74 ± 1.34	0.7 (-7.2 – 3.60)
BMD femur neck	0.62 ± 0.97	0.50 (-1.70 – 4.60)
BMD femur total	0.76 ± 1.02	0.55 (-1.70 – 4.80)

Note : BMI = Body Mass Index; WHR = waist to hip ratio; VAI = Visceral Adipocyte Index; HDL = high-density lipoprotein; L low-density lipoprotein; CRP = C reactive protein; SGOT = serum glutamic oxaloacetic transaminase; SGPT = serum glutamic p transaminase; BMD = bone mineral density

Twenty out of 134 subjects (14.9%) had higher CRP levels (CRP levels > 10 mg/dL). A total of 10 out of 134 subjects (7.5%) had blood fasting glucose levels > 126 mg/dL, while the rest were within normal limits. None of the subjects were taking oral glucose and fat-lowering drugs. Bone mineral density examination

on all subjects is shown in picture 1. A total of 11 (8,2%) subjects had decreased bone density and the remaining 123 (91.8%) subjects were in normo density condition.



Picture 1. BMD result

Table 2 shows the statistical analysis of the correlation between VAI, CRP and the anthropometry.

**Table 2. The correlation between anthropometry marker, VAI, and CRP**

Parameter	VAI		CRP	
	r	p	r	p
Weight (kg)	0.250	0.004	0.448	0.0001
Height (cm)	-0.115	0.172*	-0.014	0.874*
BMI (kg/m <sup>2</sup> )	0.314	0.0001	0.491	0.0001
Waist circumference (cm)	0.334	0.0001	0.447	0.0001
Hip circumference (cm)	0.183	0.034	0.368	0.0001
Rate of visceral fat	0.312	0.0001	0.455	0.0001
WHR	0.234	0.006*	0.175	0.043*

Note : WHR =waist to hip ratio; BMD = bone mass density

\*Pearson correlation test

There were positive weak correlations between weight, height, BMI, WC, HC, rate of visceral fat, WHR and VAI. Increase in body weight, height, BMI, WC, HC, rate of visceral fat, there will be an increase in VAI. There were weak positive correlations between HC, WHR and CRP. There were positive moderate correlations between weight, height, BMI, waist, visceral fat, WHR and CRP. Which means, increase HC, WHR, weight, height, BMI, waist, rate of visceral fat and WHR, there will be an increase CRP levels.

**Table 3. The correlation between anthropometry parameters, VAI, CRP and BMD**

Parameter	BMD lumbar spine		BMD femur neck		BMD femur total	
	r	p	r	p	r	p
Weight (kg)	0.046	0.600	0.271	0.002	0.366	0.0001
Height (cm)	0.107	0.219*	0.122	0.159*	0.087	0.319*
BMI (kg/m <sup>2</sup> )	0.001	0.992	0.246	0.004	0.357	0.0001
Waist circumference (cm)	-0.028	0.749	0.212	0.014	0.319	0.0001
Hip circumference (cm)	-0.110	0.207	0.087	0.319	0.160	0.065
Rate of visceral fat	-0.023	0.792	0.245	0.004	0.353	0.0001
WHR	0.108	0.213*	0.204	0.018*	0.259	0.003*
VAI	-0.001	0.994	0.031	0.721	0.107	0.220
CRP (mg/L)	0.009	0.916	0.016	0.856	0.111	0.202

Note : BMI = Body Mass Index; WHR = waist to hip ratio; VAI = Visceral Adipocyte Index; CRP = C reactive protein

\*Pearson correlation test

Based on table 3, there were weak positive correlations between weight, BMI, waist, visceral fat, WHR and BMD neck and total femur. No correlations were found between VAI, CRP and all BMD parameters. However, in this study, there was positive weak correlation between VAI and CRP (r = 0.306; p = 0.0001; data was not shown).

## DISCUSSION

A moderately positive correlations between body anthropometry markers (HC, WHR, weight, height, BMI, waist, rate of visceral fat and WHR) HC, WHR, weight, height, BMI, waist, rate of visceral fat and WHR and CRP is supported by Aguirre's previous study which stated that increased CRP levels was accompanied by increased body fat mass.<sup>(6)</sup> Furthermore, Mulyamin (2021) concluded that there was a correlation between

BMI, WC, visceral fat and CRP. Meta-analysis studies have shown the same results between BMI, WC, WHR and CRP.<sup>(13)</sup> The increase in body fat mass examined from anthropometric parameters indicates the presence of chronic inflammation in an individual.<sup>(14)</sup> In this study, there was no relationship between CRP and BMD. This result is different from previous research by Sinya Ishii (2014) which showed that CRP levels > 3 mg/L increased the risk of fractures.<sup>(5)</sup> This different result may be due to population differences, namely, only obese-reproductive women without drinking-habit were analyzed in this study. However, the previous study was conducted on Caucasians and American-Africans with moderately high drinking-habit without taking BMI into account.

Another possible cause is the population in this study were productive-age women with regular menstrual cycles for the last 6 months. This condition allowed for the protection of the hormone estrogen. The estrogen plays an important role in bone homeostasis in longitudinal bone growth. During the early stages of puberty in women, low levels of estrogen stimulates the secretion of growth hormone/ insulin-like growth factor-1 which plays a significant role in bone growth at puberty. Towards the end of puberty, high estrogen levels cause the closure of bone growth.<sup>(15, 16)</sup>

Sex hormone receptors were detected in osteoblasts, osteoclasts, osteoblast progenitor cells and mesenchymal stromal cells. Estrogen and androgen hormones in bone tissue will work through estrogen and androgen receptors (ER $\alpha$ , ER $\beta$ , AR) which are mostly found in the cytoplasm and cell membranes.<sup>(17)</sup>

Achieving peak bone mass is crucial for bone health, and plays a key role in preventing osteoporosis and bone fracture risk. The risk of hip fracture can be reduced up to 30% with a 10% increase in peak bone mass. Estrogen deficiency during menopause will affect the normal bone turnover cycle due to the presence of estrogen receptors in osteoclasts, thus, osteoclast resorption activity is increased and osteoblastic activity is decreased. Enhanced overall bone resorption may weaken the inhibitory effect on osteoclastogenesis and osteoclast activity due to the decreased of estrogen levels.<sup>(18, 19)</sup>

An increase in CRP level without a decrease in BMD could be due to the role of adipokines (such as adiponectin) which have bone-protective properties but did not analyze in this study. The state of obesity with increased number of adipocytes stimulates the production of adipokines, including adiponectin and leptin which are protective against the bone. Adiponectin is secreted by adipocytes and plays role in osteogenesis, specifically the differentiation of mesenchymal stem cells into pro-osteoblasts and the proliferation and maturation of osteoblasts. Leptin is produced by white fat mass and has protective effect on bone by stimulating osteoblastic proliferation and differentiation.<sup>(20, 21)</sup>

Decrease of bone mineral content from BMD examination appears if there has been real damage to the bone. Osteoporosis is characterized by bone fragility which can be seen from the quality of micro-architecture, micro-damage and the level of bone remodeling that will affect the bone fracture. The reading of two-dimensional DXA technique still has intrinsic limitations to determine the changes of bone geometry. While measuring BMD with DXA is not sufficient enough to determine a diagnose, so bone biomarker examinations are needed for bone damage early screening.<sup>(22)</sup>

A meta-analysis study mentions several bone biomarkers such as osteocalcin (OC), procollagen type 1 propeptide and urine N-terminal crosslinking telopeptide of type 1 collagen (U-NTX) might have a role in evaluating long-term changes in BMD and predict future fracture risk.<sup>(23)</sup> There is weak positive correlation between VAI and CRP, in accordance with the study of Carbone (2019) which showed that there was a significant relationship between visceral fat and CRP.<sup>(24)</sup> Previous study stated that higher VAI was followed by increase CRP levels.<sup>(25)</sup> This study showed positive results between BMI, WC, rate of visceral fat with BMD of the femur and neck. This result is different from research by Zhang (2015) which shows the opposite relationship between visceral adiposity and bone density. This could be due to the population in this study was female subjects of reproductive age with obesity. The BMI of the subjects in this study was above the normal average, so there was an increase in subcutaneous and/or visceral fat that could affect the production of adipokines that are protective to bone.<sup>(9)</sup>

Visceral adipose tissue secretes inflammatory mediators, which stimulate liver and endothelial-cell acute-phase proteins. Adipocytes express and secrete TNF- $\alpha$ , which enhances the secretion of CRP by hepatocyte. This statement explains how body fat mass correlates with the inflammation. Increased abdominal fat mass which associated with increased CRP levels, and independent of BMI, is measurable for general adiposity detection. CRP levels were higher in individuals with abdominal adiposity than control group even though they had a similar BMI.<sup>(26)</sup>

In this study, VAI measurements based on WC, triglycerides and HDL were associated with CRP examination. The fat accumulation is identified by the balance of triglyceride synthesis and breakdown in the intestine or liver. Adipose tissue is the main source of pro-inflammatory cytokines, one of which is IL-6. This cytokine will induce liver lipogenesis and trigger systemic acute phase responses. <sup>(27)</sup> This study did not examine adipokines or proinflammatory cytokines levels produced by adipocytes. Further investigation is needed by measuring subcutaneous fat thickness, adipokines and proinflammatory cytokines levels to find out more about the relationship between anthropometric parameters and BMD especially in women of reproductive age with obesity.

## **CONCLUSION**

There were weak positive correlations between VAI and anthropometric parameters but CRP had moderate positive correlations with other anthropometric parameters. However, VAI and CRP had no correlation to all BMD parameters but weak correlations were found between some anthropometrics parameters and BMD neck and total femur

## **ACKNOWLEDGMENT**

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## Effect of Moringa (*Moringa oleifera*) Leaf Flour Supplementation on Total Antioxidant Content of Sprague Dawley Rat Serum Given High-Fat Diet

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### ABSTRACT

**Background:** Moringa oleifera leaf is high in quercetin which can be a source of exogenous antioxidants. Together with endogenous antioxidants, both the antioxidants will be able to counteract oxidative stress conditions.

**Objectives:** To analyze the effect of Moringa leaves flour supplementation on Total Antioxidants Content (TAC) of Sprague Dawley (SD) rat serum given a high-fat diet (HFD).

**Materials and Methods:** A randomized control group post-test design was used on 24 SD rats which were divided into 4 groups, namely healthy control (K<sub>1</sub>), HFD (K<sub>2</sub>), supplementation with Moringa leaf flour at a dose of 100 mg/100 g BW/day (K<sub>3</sub>), and a dose of 200 mg/100 g BW/day (K<sub>4</sub>). After 28 days of supplementation, serum TAC was analyzed using the ELISA method. Data analysis used Paired-T Test, One Way ANOVA, and Post-Hoc Bonferroni follow-up test.

**Results:** The results showed that the TAC of groups K<sub>1</sub>, K<sub>2</sub>, K<sub>3</sub>, and K<sub>4</sub> respectively were  $4.806 \pm 0.239$ ,  $1.323 \pm 0.292$ ,  $4.020 \pm 0.239$ , and  $5.123 \pm 0.695$ . There was a significant difference in serum TAC ( $p=0.000$ ) between supplementation groups. Significant differences in serum TAC were also found in the supplementation group compared to the HFD control group.

**Conclusion:** Moringa leaves flour supplementation for 28 days at a dose of 200 mg/100 g BW/day increases serum total antioxidant content higher than at a dose of 100 mg/100 g BW/day.

**Keywords:** High Fat Diet; Moringa Oleifera leaves Flour; TAC

### BACKGROUND

Reactive Oxidative Stress (ROS) has beneficial effects at moderate levels, and is involved in various physiological functions such as boosting the immune system. However, at higher levels, it produces oxidative stress, thereby damaging various molecules including lipids, proteins, and DNA. Oxidative stress develops when there is an increase in ROS production on one hand and a lack of antioxidants on the other<sup>1</sup>. A continuous increase in ROS causes the body to remain in a state of oxidative stress<sup>2-4</sup>. Meanwhile, the body has an effective defense mechanism boosted by endogenous antioxidants, thereby preventing excessive ROS formation<sup>5,6</sup>. Endogenous (synthesized by the body) and exogenous (obtained from food) antioxidants work synergistically to protect the body cells and organ systems from further damages due to excessive ROS<sup>7</sup>. Furthermore, less intake of exogenous antioxidants can decrease the endogenous<sup>8,9</sup>, which can also be increased by optimizing consuming foods containing antioxidants daily<sup>10</sup>. Good food intake pattern arrangements in supporting the availability of exogenous antioxidants was food that contains polyphenols, such as flavonoids<sup>11</sup>. Moreover, its daily consumption contributes to the production of exogenous antioxidants for the body<sup>12</sup>.

Flavonoids are one of the bioactive compounds with antioxidant properties<sup>13</sup> which are found in high content in Moringa (*Moringa oleifera*) leaf. Based on the type of flavonoid, quercetin in Moringa leaf is present in higher amounts than others and contain Provitamin A, Vitamin C, Vitamin E, and minerals, such as selenium and zinc that also act as antioxidants<sup>14-16</sup>. According to Ganatra (2017), Moringa leaf contains 8 times more polyphenols than red wine, 30 times more vitamin A than spinach and four times of carrots, and 7 times more vitamin C than oranges<sup>17</sup>. The antioxidant combination found is more effective compared to the single ones, due to the synergistic mechanism in suppressing ROS<sup>18</sup>. Following research conducted by

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Nilanjin (2012), the antioxidants contained in Moringa leaf had a beneficial effect on experimental animals fed on a high-fat diet by increasing Superoxide Dismutase (SOD), Catalase (CAT), and Glutathione Peroxidase (GPx) levels and reducing the free radicals, thereby inhibiting lipid peroxidation and tissue damage<sup>19</sup>.

Moringa leaf flour is one of the processed products that have experienced the initial drying and refining process. It is first ground and stored for months without refrigeration, also this does not reduce the nutritional content significantly<sup>20</sup>. Additionally, In the present study, two doses of Moringa leaf flour were selected as 200 mg/100 g BW/day and 100 mg/100 g BW/day. These doses were selected on the basis of previous reports of the acute toxicity study performed using the dose administered until 2000 mg/kg of dried leaf powder of Moringa which shows no signs of toxicity in rats and based on average daily flavonoid requirements<sup>21,22</sup>. Preliminary research has not been carried out on experimental animals and humans, therefore, this research aimed to prove the effect of Moringa (*Moringa oleifera*) leaf flour on increasing serum total antioxidant contents.

## MATERIALS AND METHODS

This experimental research was carried out with a post-test and randomized control design group. The production of Moringa leaf flour, rearing of experimental animals, and biochemical analysis of serum samples were carried out at the Nutrition Laboratory of the Inter-University Center for Food and Nutrition Studies (PSPGPAU), Gadjah Mada University, Yogyakarta, from March to April 2021.

The research subject is a male white rat Sprague Dawley (SD), and the number used was calculated based on the provisions of the World Health Organization (WHO), which postulates the need for a minimum of 5 experimental animals. To anticipate dropout, one experimental animal is added to each group, thereby amounting to a total of 24. Determination of the research subjects considered the inclusion criteria, namely experimental animals aged 8 to 11 weeks, body weight  $\pm$  150 g, healthy (active movement), and without defects. The independent variable used is the dosage variation of Moringa leaf flour dose I 100 mg/100 g and 200 mg/100 g BWs of experimental animals/day while the dependent is the TAC of the animal serum.

Research tools include basins, blenders, ovens, 80 mesh sieves, slicers, rat oral sonde, digital animal scales, hand gloves, and masks. The materials used include Moringa leaf, AD II standard feed, High Fat Diet (HFD), and water. High fat diet is a mixture of 10% lard and 2 ml of duck egg yolk in AD II standard feed. The process of making Moringa leaf flour is as follows: 1). The fresh, light, and dark green leaves that are not too dry are separated from the stems, 2). Washed, 3). Drained, 4). Then, dried in an oven at a temperature of 55°C for 60 minutes, 5). After which it is ground using a blender, and 6). Finally, it is sieved with an 80 mesh sieve. Moringa leaf flour used in this research was placed in an airtight container and stored in a refrigerator. Furthermore, primary data were collected from the measured body weight and examination of total serum antioxidant contents which is a comparison of the healthy, and HFD controls, including the treatment groups. Weight measurement data was recorded at the beginning of the research and this continued every week, besides, the total serum antioxidant examination data underwent a post-test.

Body weight was measured every 7 days using a digital animal scale, while examination of the total antioxidant contents was carried out using the ELISA method at the end of the research. In addition, blood samples were taken from the retroorbital plexus of the experimental animals. Subsequently, they were put in different cages and acclimatization lasted for 7 days with the provision of standard AD II feed and *ad libitum* drink daily.

Afterward, the animals were randomly grouped into 4 with 6 in each, namely K<sub>1</sub>, K<sub>2</sub>, K<sub>3</sub>, K<sub>4</sub>. Group K<sub>1</sub> was provided standard feed and *ad libitum* drink, while K<sub>2</sub>, K<sub>3</sub>, and K<sub>4</sub> were fed with HFD. The HFD administration period lasts for 2 weeks and the body weight of the animals was measured every week. This was followed by the intervention stage, which lasted for 28 days with all groups provided standard AD II feed and *ad libitum* drink whereas the intervention group was given additional Moringa leaf flour through an oral probe with a dose of 100 mg/100 g and 200 mg/100 g body weights of rats/day in groups K<sub>3</sub> and K<sub>4</sub> respectively. The animals' body weight was measured weekly during the intervention period and samples of their blood were collected from the retroorbital plexus to examine the total serum antioxidants after this stage.

The data were tested for normality using the Shapiro-Wilk test. The first statistical analysis determined the differences between the pre and post-test. The average weight of the experimental animals was normally distributed, with the Paired t-test and One way ANOVA used to examine changes and differences in the



groups. Furthermore, the Kruskal-Wallis test was also used to determine the same attribute among experimental animal groups. The second statistical analysis is the post-test carried out on serum TAC data, which proved that the serum TAC was normally distributed. Furthermore, the One Way ANOVA and Bonferroni Post-Hoc tests were used to examine the difference in the intervention effects in the groups. The significant difference with  $p$ -value  $<0.05$  shows the mean  $\pm$  SD and median (min  $\pm$  max) for data that were normally and abnormally distributed, respectively.

The analyzed data were computerized using SPSS. Meanwhile, this research was approved by the Health Research Ethics Commission (KEPK) of the Faculty of Medicine, Diponegoro University as stated in the Ethical Clearance NO.25/EC/H/FK-UNDIP/III/2021 dated March 17, 2021.

## RESULTS

The body weight characteristics of the experimental animals during the acclimatization period ranged from 182 to 187 g. Besides, none of the animals dropped out during the research and the consumption of HFD for 2 weeks led to a significant increase in weight. The results of statistical tests carried out after its administration (Table 1) showed an increase in body weight before and after being given standard feed AD II K<sub>1</sub> and HFD (K<sub>2</sub>, K<sub>3</sub>, K<sub>4</sub>), although a significant difference was observed in the groups ( $p = 0.000$ ).

**Table 1. Body Weight Value of Experimental Animals (g) Before and After HFD Administration**

Group	n	Before	After	<i>p</i>	$\Delta$	% $\Delta$
K <sub>1</sub>	6	185.00 $\pm$ 4.43	196.17 $\pm$ 5.12	0.00	11.00(10 $\pm$ 12)	6.03 $\pm$ 0.29
K <sub>2</sub>	6	187.00 $\pm$ 2.53	215.33 $\pm$ 2.16	0.00	28.00(27 $\pm$ 30)	15.16 $\pm$ 0.65
K <sub>3</sub>	6	185.17 $\pm$ 4.36	213.50 $\pm$ 4.42	0.00	28.00(28 $\pm$ 30)	15.31 $\pm$ 0.57
K <sub>4</sub>	6	182.83 $\pm$ 2.48	211.00 $\pm$ 2.61	0.00	28.00(27 $\pm$ 29)	15.41 $\pm$ 0.46

*p*=Paired T-Test; <sup>a</sup>=One Way ANOVA Test; <sup>b</sup>=Kruskal-Wallis Test

An insignificance difference ( $p = 0.282$ ) was observed in the average body weight of the experimental animals in all groups at the beginning of the research. After 2 weeks of being fed with HFD, a significant difference was observed among the groups ( $p = 0.000$ ). The results of the Kruskal-Wallis test showed that there was a significant difference in weight change among the 4 groups ( $p = 0.002$ ). Descriptively, the highest percentage of weight gain was exhibited by the group that was fed with HFD ( $\pm 15\%$ ) compared to the one that was only given standard feed ( $\pm 6\%$ ).

**Table 2. Body Weight Value of Experimental Animals (g) Before and After Moringa Leaf Flour Administration**

Group	Before	After	<i>p</i>	$\Delta$	% $\Delta$
K <sub>1</sub>	196.17 $\pm$ 5.12 <sup>a</sup>	221.83 $\pm$ 5.67	0.000	26.00(24 $\pm$ 27)	13.09 $\pm$ 0.48
K <sub>2</sub>	215.33 $\pm$ 2.16 <sup>a</sup>	266.50 $\pm$ 2.74	0.000	51.00(50 $\pm$ 53)	23.76 $\pm$ 0.52
K <sub>3</sub>	213.50 $\pm$ 4.42 <sup>a</sup>	245.50 $\pm$ 4.23	0.000	32.00(31 $\pm$ 33)	14.99 $\pm$ 0.60
K <sub>4</sub>	211.00 $\pm$ 2.61 <sup>a</sup>	236.83 $\pm$ 3.06	0.000	25.00(25 $\pm$ 28)	12.24 $\pm$ 0.63

*p*=Paired T-Test; <sup>a</sup>=One Way ANOVA Test; <sup>b</sup>=Kruskal-Wallis Test

The results of statistical tests on experimental animal body weight before and after the administration of Moringa leaf flour (Table 2) showed that all groups including the treatment group which was given standard feed, and HFD, experienced a significant increase in body weight ( $p = 0.000$ ). The average body weight after 4 weeks of treatment was significantly different ( $p = 0.000$ ). The average body weight between groups was observed after administering Moringa leaf flour for 28 days. Descriptively, the least percentage of weight gain was shown by the group with the highest dose ( $\pm 12.24\%$ ). Administration of Moringa leaf flour at a dose of 200 mg higher suppressed weight gain in the treatment group compared to 100 mg.

**Table 3. Total Antioxidant Contents of Experimental Animal Serum (mmol/L)**

Group	n	Serum Total Antioxidant Content	<i>p</i>
K <sub>1</sub>	6	4.806 $\pm$ 0.239 <sup>a</sup>	0.000
K <sub>2</sub>	6	1.323 $\pm$ 0.292 <sup>a</sup>	
K <sub>3</sub>	6	4.020 $\pm$ 0.239 <sup>a</sup>	
K <sub>4</sub>	6	5.123 $\pm$ 0.695 <sup>a</sup>	

*p*=One Way Anova Test, <sup>a</sup>=Post-Hoc Bonferroni Test

The results of the one-way ANOVA statistical test (Table 3) showed that serum total antioxidant contents were significantly different in the 4 groups ( $p = 0.000$ ). The Bonferroni Post-Hoc Statistical Test showed that the comparison of serum total antioxidant contents in the K<sub>3</sub> group to K<sub>4</sub> was significantly

different ( $p = 0.022$ ) after administration of Moringa leaf flour. Treatment with a dose of 200 mg/100 g BW and 100 mg/100 g BW indicated that the total serum antioxidant contents were significantly different to the  $K_2$  group fed with HFD ( $p = 0.000$ ,  $p = 0.000$ ). Meanwhile, it was discovered that  $K_3$  treated with a dose of 100 mg/100 g BW was significantly different to the  $K_1$  healthy control group ( $p=0.001$ ). The treatment of  $K_4$  with a dose of 200 mg/100 g BW showed a higher content compared to  $K_3$  treated with a dose of 100 mg/100 g BW, although it was not significantly different from the  $K_1$  healthy control group ( $p = 1.000$ ).

## DISCUSSION

These results indicate that the least total serum antioxidant contents were discovered in the group given HFD. The storage of excessive fat increases body weight thereby increasing the production of proinflammatory cytokines, such as Tumor Necrosis Factor- $\alpha$  (TNF- $\alpha$ ) and Interleukin-6 (IL-6)<sup>23</sup>. Furthermore, increased inflammation causes an increase in ROS production and depletion in endogenous antioxidants that exchanged oxidative stress<sup>24-26</sup>. Endogenous antioxidants depletion was caused by its increased consumption in suppression of ROS progression<sup>27</sup>, thus endogenous antioxidants are required in sufficient quantities. Intake deficiency of exogenous antioxidants may cause endogenous antioxidants to decrease continuously and the body remains in a state of oxidative stress<sup>28</sup>. Decreased endogenous antioxidants required exogenous antioxidants obtained from food<sup>29</sup>. Endogenous and exogenous antioxidants synergistically maintain or rebalance antioxidants and ROS due to the presence of ROS reducing compounds in exogenous antioxidants such as flavonoids, vitamins, and minerals through mechanism induced enzymes factor transcription, scavenging process by capturing ROS to donate one electron and hydrogen, metal chelating that helps ROS to become relatively stable and unreactive to induce further oxidative stress, and also act as a cofactor of antioxidants enzymes<sup>30,31</sup>.

Giving Moringa leaf flour to the treatment group significantly increased the total antioxidant content of serum, therefore, Moringa leaf flour can act as a source of antioxidants that restores or normalizes serum total antioxidant content efficiently. Mabrouki (2020) analyzed the effect of administering Moringa leaf extract on endogenous antioxidants in experimental animals. Endogenous antioxidants were significantly recovered by administration with Moringa leaf extract by mechanism to reduce and maintain ROS in a balanced concentration<sup>32</sup>. In this research, the increased contents are also due to reduced antioxidants used in the suppression of ROS progression. The previous research also showed an increase in the constituents after the extract intervention due to reduced antioxidants use in reducing ROS and the provision of hydrogen to make it more stable<sup>33</sup>.

Based on the content of Moringa Leaf flour, flavonoids as a source of exogenous antioxidants are present in high quantities<sup>34</sup>. Furthermore, Rodríguez-Pérez (2015), and Makita (2016), reported that methanol extract of Moringa leaf contained 26, and 14 flavonoids, respectively<sup>35,36</sup>. Compared to vegetables, previous research discovered that the flavonoid content in the dried Moringa leaf was 3 to 12 times more high than other types of vegetables consumed by families, namely 12 times more than cauliflower, 9 times of peas, 5 times of cabbage, 4 times of spinach, and 3 times of broccoli<sup>37</sup>. Another research showed that the experimental animals are given HFD, and dietary intervention containing flavonoids for 4 weeks increased endogenous antioxidants through the mechanism of interacts synergistically with exogenous antioxidant system, then captured free radicals, prevent further oxidative damage, thereby maintaining a balanced ROS system<sup>38,39</sup>. Additionally, quercetin, a flavonol bioactive compound, is a class of flavonoids that was found high in Moringa leaf<sup>40</sup>. In previous studies, it was discovered to have reached approximately 50% of the total flavonoids in Moringa leaf extract<sup>41</sup>. Subsequently, quercetin had an antioxidant function that affected the increase of endogenous antioxidant<sup>42</sup>. Quercetin increased endogenous antioxidant Glutathione Peroxidase (GPx), Catalase (CAT), and Superoxide Dismutase (SOD) by directly or indirectly induced the Nrf2-mediated transcription activity by increase Nrf2 expression of the antioxidants. These antioxidants are regulated by the transcriptional factor Nuclear Factor E2-Related Factor (Nrf2) which responds by binding to the Antioxidant Response Element (ARE) as a promoter of genes that code the antioxidant. Quercetin also regulates levels of endogenous antioxidant Glutathione (GSH). Superoxide Dismutase captures  $O_2^-$  of ROS and transforms it into  $H_2O_2$ . Catalase and Glutathione Peroxidase further catalyze the decomposition of  $H_2O_2$  to unreactive  $H_2O$ . This Reaction requires GSH as a hydrogen donor On the other hand, Quercetin has the ability to act directly as free radical scavengers or hydrogen donors, hydroxyl radical scavenging, and metal-chelating ability<sup>43,44</sup>.

Moringa leaf flour also has vitamins such as vitamin E, vitamin C, pro-vitamin A, and complete minerals such as Cu, Mn, Fe, and Zn<sup>45</sup>. These vitamins act as free radical scavengers and reduce free radicals, donating electrons and hydrogen to free radicals to prevent their oxidation and to generate a much less reactive species than most other free radicals<sup>44,45</sup> whereas minerals play an important role as cofactors of endogenous antioxidants that may increase the efficiency of endogenous antioxidant function. Endogenous antioxidants are metal ion cofactor-requiring enzymes that catalyze the dismutation of highly reactive superoxide radicals (O<sub>2</sub><sup>-</sup>) into unreactive and relatively stable molecular oxygen (O<sub>2</sub>) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>)<sup>48</sup>. However, through this mechanism, all bioactive compounds and micronutrients in Moringa leaf flour become extremely effective so that they may improve the efficiency of endogenous antioxidant function. After 28 days of treatment, the mean increase in serum total antioxidant contents was higher at dose II than dose I, and the increase at dose II was equivalent to the healthy group.

The average weight gain in the group given HFD ( $\pm 15\%$ ) was significantly different compared to the others. This is in line with previous research which proved HFD caused an increase of 9 to 23%<sup>49</sup>. There are two possible causes of weight gain due to the influence of HFD. First, fat as the main composition of HFD that contains high energy compared to other macronutrients<sup>50,51</sup>. Second, types of fat such as saturated fatty acids and cholesterol which are high in pork oil and duck egg yolk increase the HFD energy density and ease of absorption by the body, therefore, it is stored in excess which ultimately increases bodyweight<sup>52-54</sup>. Furthermore, administration of Moringa leaf flour at a dose of 100 mg and 200 mg was able to maintain and suppress the increase in body weight. This study is in accordance with previous studies which showed that administration of 200 mg and 400 mg of Moringa leaf extract were proven to be able to lose and maintain weight because of their high fiber content<sup>55</sup>. Moringa oleifera leaf can provide 41.20 g carbohydrate, 29.40 g protein, 5.20 g fat, and 12.50 g fiber by 100 g dry leaves whereas 100 g dried Moringa leaf powder contains approximately 38.20 g carbohydrate, 27.10 g protein, 2.30 g fat, and 19.20 g total fiber<sup>56</sup>. Due to high fiber content, Moringa can be used to suppress weight gain by mechanism increasing water-binding and swelling capacities. This slows gastric emptying, which in turn increases satiety, longer meal intervals and ultimately decreases food intake<sup>57</sup>.

However, there are some limitations associated with this research, such as difficulty in analyzing macronutrient and micronutrient content, especially specific polyphenols in Moringa oleifera leaf flour.

## CONCLUSION

In conclusion, the administration of Moringa leaf flour at a dose of 100 mg/100 g and 200 mg/100 g body weight/day increased the total antioxidant content of the serum in Sprague Dawley rats. Furthermore, the dosage of 200 mg/100 g body weight/day had a better effect.

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# The CIPP Model of Stunting Management Program During Covid-19 Pandemic in Semarang City

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## ABSTRACT

**Background:** Semarang City has successfully reduced in reducing the stunting rate by 2.7% in 2018 and 2.5% in 2019. With the Covid-19 pandemic, the stunting prevention program in Semarang City faces problems that have the potential to increase the prevalence risk of stunting. The problem are limited access of intervention and decline of the stunting program quality in work area of the Puskesmas in Semarang City. In addition, it is still unknown how the stunting program was implemented at the puskesmas during the Covid-19 pandemic.

**Objectives:** The purpose of this research was to identify and evaluate the implementation of the stunting prevention program in Semarang City during the Covid-19 pandemic by using the CIPP model.

**Materials and Methods:** This research used a survey research with a qualitative approach. This research was carried out from August to October 2021. The informants for this study consisted of 5 main informants: nutritionists at the puskesmas, 15 triangulation informants, the head of the puskesmas, posyandu cadres, and mothers who had stunted children in five health centers in Semarang City, namely Bandarharjo Health Center, Lamper Tengah Health Center, Tlogosari Wetan Health Center, Gunungpati Health Center, and Pegandan Health Center. Determination of informants using a purposive technique based on the geographic location of the Public Health Center. In-depth interviews used prepared guidelines. Data analysis used content analysis.

**Results:** The results showed that the in the context component, the nutritionists had understood goals and targets of the stunting program. The input component showed that Human Resources was not optimal because they helped in succeed in the Covid-19 program. Funding was disrupted because there were still no technical guidelines for funding during the Covid, infrastructures were not optimal due to a lack of training for posyandu cadres. The process components included: a monitoring program that was carried out door to door, no administration of PMT F100, ineffective online counseling, fewer mothers who were participated in nutrition consultations, no monitoring related to vitamin A administration.

**Conclusion:** The stunting prevention program in the work area of the puskesmas during the Covid-19 pandemic has not been able to be implemented well during the Covid-19 pandemic.

**Keywords :** Stunting; CIPP Model ; Program

## BACKGROUND

Toddler is an age group that is prone to nutrition and disease. Undernourished toddler can cause disruption of physical, mental and spiritual growth and development and resulting in low quality of human resources. Nutritional status is an important health indicator for toddlers because children under five years of age are a group that is prone to health and nutrition whose physical impact is measured anthropometry and categorized based on WHO standards with the index of WAZ (Weight for Age Score), HAZ (Height for Age Z-scores) and WHZ (Weight/Height Z-scores).<sup>1</sup>

Reducing the stunting prevalence is one of the national priority programs in health development. Reducing of the stunting prevalence is listed in the main target in 2020-2024 Medium-Term Development Plan, it is improving the health and nutrition status of the community with a target of stunting prevalence in 2024, which is 14%.<sup>2</sup> Stunting are toddlers with nutritional status based on length or height according to When compared to the WHO-MGRS (Multicentre Growth Reference Study) standard, the z-score is less than -2SD and is categorized as very short if the z-score is less than -3SD. Toddlers who experience stunting will have an impact on the level of intelligence that is not optimal, more susceptible to disease and can be at risk of decreasing productivity levels. The result of a low level of productivity will have an impact on stunting economic growth and increasing poverty.<sup>3</sup>

Although the Ministry of Health has determined that reducing stunting prevalence is one of the national priority programs in health development, nationally the reduction in stunting prevalence has not been going

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well. This is evidenced by the prevalence of stunting in Indonesia, namely in 2017 it was 22.7%, in 2018 it was 30.8% and in 2019 it was 27.67%.<sup>3</sup>

Meanwhile, Semarang City is a city that has succeeded in reducing the stunting rate for toddlers, namely in 2017 by 14%, in 2018 by 2.7%, and in 2019 by 2.5%.<sup>4</sup> This is an achievement that can be used as an achievement. a reference for stunting prevention systems in Indonesia and Central Java.

In 2020, the world community witnessed the emergence of a new type of corona virus that causes coronavirus disease or what is now known as Covid-19. to accelerate the handling of the corona virus outbreak (Covid-19) in an effort to control Covid-19.<sup>5</sup> This can increase the risk of increasing the prevalence of stunting in the world, including Indonesia.<sup>6</sup> five years will increase by 14.3% or equivalent to 6.7 million additional cases.<sup>7</sup>

The Large-Scale National Restriction Policy in the Context of Accelerating the Handling of Covid-19 is contrary to the Stunting Prevention Program, because the stunting prevention program requires direct contact with the program target. This has led to an increase in the risk of stunting prevalence in Indonesia during the Covid-19 pandemic due to the obstruction of access for mothers and children in obtaining optimal health services. It was noted that only 19.2 percent of Public Health Center continued to run posyandu (Integrated Healthcare Center) activities during the pandemic. Based on data from the Ministry of Health, the number of antenatal care visits and health services for infants, toddlers, and children has decreased so that immunization services, monitoring activities for the development and growth of infants and toddlers, as well as maternal and child health interventions cannot run optimally. This is in accordance with Efrizal's research which states that a decrease in children's nutritional status can have an impact on increasing the prevalence of children at risk of stunting.<sup>6</sup>

Although Semarang has succeeded in reducing stunting for three consecutive years, with the Covid-19 pandemic, the stunting prevention program in the city of Semarang has several problems that have the potential to increase the risk of increasing stunting prevalence rates caused by limited access to interventions from stunting prevention programs and quality stunting program in the work area of the Semarang City Health Center. Limited access to health services has an impact on increasing the prevalence of children at risk of stunting.<sup>6</sup> In addition, it is not yet known how stunting programs are implemented in Public Health Center during the Covid-19 pandemic.

Therefore, to get a qualified health program, evaluation activities are needed. The CIPP ((context, input, process, product) Evaluation Model is an evaluation method that can be implemented to obtain qualified health programs because the advantages of the CIPP model provide a comprehensive and complete evaluation format at each evaluation stage, they are context, input, process, and product stages. Advantages of CIPP evaluation concept that an important purpose of evaluation is not to prove, but also to improve. This is in accordance with the evaluation of the stunting prevention program during the Covid-19 pandemic which emphasized program improvement in order to obtain a complete program quality.

Therefore, the researcher intends to evaluate the stunting prevention program for nutritionists in Semarang City as a city that is able to reduce the incidence of stunting and how to implement the handling program during the Covid-19 pandemic using the CIPP Evaluation model.

The purpose of this study was to determine and evaluate the implementation of stunting prevention programs in Semarang City during the Covid-19 pandemic using the CIPP model covering context aspects, namely Identification of Program Objectives and Targets, input aspects namely human resources, funds, facilities and infrastructure, process aspects, namely planning. programs, implementation programs, monitoring and evaluation and outcome aspects.<sup>8</sup>

## **MATERIALS AND METHODS**

This research used a survey research with a qualitative approach. This research was carried out from August to October 2021. Sources of data in this study included primary data (in-depth interviews with informants and observations), and secondary data consisting of nutritional status health data processed by the relevant health agencies (Bandarharjo Public Health Center, Lamper Tengah Health Center, Tlogosari Wetan Health Center, Gunungpati Health Center, Public Health Center Pegandan, Semarang City Health Office, and the Indonesian Ministry of Health). The research has passed ethical approval in Health Research Ethics Commite Faculty of Public Health Diponegoro University with number 239/EA/KEPK-FKM/2021.

The informants of this study consisted of 5 main informants, namely nutritionists at the puskesmas and 15 triangulation informants, namely the head of the puskesmas, posyandu cadres and mothers who had

stunting toddlers. Determination of informants using a purposive technique based on the geographic location of the puskesmas. After identification, a representative sample was obtained: the northern part of Semarang was the Bandarharjo Health Center; the eastern part of the Semarang was the Central Lamper Health Center ; the eastern part of the Semarang area was the Tlogosari Wetan Health Center; the southern part of the Semarang Public Health Center the Gunungpati Health Center; the middle part of the Semarang was the Pegandan Health Center.

The main informants in the research were those who directly handled and understood the implementation process of the stunting program. The main informants of this research consisted of 5 nutritionists and in charge of the stunting program at the Puskesmas Bandarharjo, Puskesmas Lamper Tengah, Puskesmas Tlogosari Wetan, Puskesmas Gunungpati, Puskesmas Pegandan. The triangulation informants in this research were 15 people with details of 5 head of puskesmas, 5 posyandu cadres and 5 mothers who had stunted toddlers. In this research, the research will focused on 4 aspects of the CIPP evaluation model, they are Context, Input, Process, Product that can explained how the stunting program during the pandemic were implemented

In-depth interviews were using prepared guidelines. Validity tests in qualitative research were included credibility tests (internal validity), transferability (external validity), dependability (reliability), and confirmability (objectivity).<sup>9</sup>

The data analysis technique used in this research is to analyze all forms of communication, such as data derived from interview answers, manuscript documents, pictures, photos, and other information. The steps in the data analysis process are data reduction, data presentation, conclusion drawing, and verification.<sup>10</sup>

## RESULTS

### 1. Context Aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

Nutritionists as the person in charge for the stunting program were involved in policies making regarding to the stunting prevention programs at the puskesmas. Nutritionists understood and base program development based on the purpose of the stunting program at the Semarang city level during the COVID-19 pandemic, namely reducing the stunting prevalence rate.

*"tujuan program stunting saat pandemi ini, untuk menekan angka pandemi dengan keberjalanan program yang maksimal, sesuai arahan DKK " (IU 1)*

*"jelas to mas, tenaga gizi kan selaku koordinator program stunting, jadi kami terlibat dari awal sampe hasilnya gimana" (IU3)*

*"The purpose of the stunting program during this pandemic is to reduce the number of pandemics with maximum program implementation, according to the direction of the DKK" (IU 1)*

*"Obviously, sir, the nutritionist is the coordinator of the stunting program, so we are involved from the beginning until the results are there" (IU3)*

The informations were also supported by triangulation informations which stated that the main informant underlied the stunting program during the pandemic with the goal of the stunting program from the Semarang city level.

*"itu baru ya mas, iya mmm.. karena baru ya mungkin belum pernah ya disampaikan " (IT-KA 1)*

*"program di puskesmas, terutama stunting sudah sesuai dengan arahan kota, karena stunting merupakan program prioritas di kota semarang juga" (IT-KA 3) "That's new, sir, yes, mmm.. because it's new, maybe it's never been conveyed" (IT-KA 1)*

*"The program at the puskesmas, especially stunting, is in accordance with the direction of the city, because stunting is a priority program in the city of Semarang as well" (IT-KA 3)*

*"yang berbeda, tentu saja kegiatannya door to door mas, jadi dicek dari satu rumah ke rumah yang lain" (IU 1)*

*"untuk pelaksanaannya, nanti kader kan ada posyandu terus dicatat timbangan dan tinggi si anak. Nanti laporannya diserahkan ke kita lalu di cek di aplikasi buat lihat zscorenya. Semisal zscorenya termasuk kategori stunting, kita kesana buat ngecek bener ngga ini anaknya stunting. Kalau bener kita lakukan intervensi. Jadi sama mau pandemi atau tidak bedanya kita ngga di posyandu lagi tapi door to door" (IU 5)*

*"kalau bisa disebut kelebihan ya, lebih efektif mas karena bisa dapat semua data, tapi ya kasihan bu kadernya harus keliling keliling, nggih to bu? hehe (IU 1)*

"What's different, of course, is door to door, mas, so it's checked from one house to another" (IU 1)  
"For the implementation, there will be a posyandu for the cadres, and the scales and height of the child will be recorded. Later the report will be submitted to us and then checked in the application to see the zscore. For example, if the zscore is in the stunting category, we go there to check whether or not this child is stunted. If so, we will intervene. So whether it's a pandemic or not, the difference is that we're not at the posyandu anymore but door to door" (IU 5)  
"If you can call it an advantage, yes, it's more effective, bro, because you can get all the data, but it's a pity that the cadres have to go around, can't you, ma'am? hehe (IU 1)

Door to door monitoring is more effective than monitoring carried out at posyandu before the pandemic because it can reach all areas.

*"Kadang ke rumah lo anaknya tidur, kendalanya gitu mas lo mas, Ya to, kalau mau dibangunkan rewel, ya gitu to kendalanya disitu untuk pemantaunyanya (IU 5)*  
*"memang lebih capek daripada biasanya, tapi maug gimana lagi"(IU3)*  
"Sometimes when your child goes to your house to sleep, that's the problem, bro, yes, if you want to wake up fussy, yes, the problem is there for the monitoring (IU 5)  
"I'm more tired than usual, but what can I do"(IU3)

On the negative side, monitoring is difficult because some toddlers are sleeping when visited, in addition to the energy and energy expended by posyandu cadres.

## 2. Input aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

The input for the stunting prevention program during the pandemic at the puskesmas in the Semarang City consisted of human resources, funds, facilities and infrastructures.

Based on research conducted by Rustam, the efficiency and effectiveness of an implementation of a program depends on human resources.<sup>11</sup> Based on the results of in-depth interviews with key informants, it is known that the personnel who play role in the malnutrition prevention program at the Health Center are nutritionists, KIA officers, all Puskesmas employees, regional responsible persons, cadres in posyandu.

*"intinya, dari gizi, kader posyandu, dan kepala puskesmas sebagai pengawas"(IU 3)*  
*"Itu dari petugas puskesmas, kader posyandu ya" (IU 5)*  
"Essentially, from nutrition, posyandu cadres, and the head of the puskesmas as supervisors" (IU 3)  
"That's from puskesmas officers, posyandu cadres, yes" (IU 5)

In carrying out the stunting program the adequacy of officers is an important component in the implementation of a program.<sup>12</sup> The program can run well if the program has sufficient resources, but the program cannot run well if the resources are not sufficient.

*Kekurangannya yaa, otomatis kita belum bisa maksimal... karena kita tenaganya Cuma 2, yang satunya sering dilibatkan ke vaksin jadi otomatis susah gitu" (IU 1)*  
*"ya dimasa pandemi ini, beban kerja menjadi tambah" (IU 5)*  
The drawback is, we can't automatically maximize... because we only have 2 staff, the other one is often involved in vaccines, so it's automatically difficult." (IU 1)  
"Yes, during this pandemic, the workload has increased" (IU 5)

One component of the resources needed in implementing a health program is the health financing budget. The Health Budget aims to provide health financing in sufficient amounts, utilized and allocated equitably. During the Covid-19 pandemic, stunting funding was sourced from the BOK and BLUD Puskesmas. BOK is Health Operational Assistance from the State Budget and Expenditure Revenue (APBN)

Although there is a budget from the BOK, in its implementation during the pandemic, there was a temporary suspension of the flow of aid and BOK at the beginning of the year, because there was no technical guidance that regulates the funding of the BOK nutrition program during the Covid-19 pandemic.

*"untuk pendaan saat awal juga belum ada juknisnya jadi pas awal tahun agak mandeg" (IU 1)*  
*"iya dana BOK belum cair pada awal tahun" (IT-KA 1)*

"There is no technical guideline for funding at the beginning, so at the beginning of the year it stagnates a bit" (IU 1)

"Yes, BOK funds have not been disbursed at the beginning of the year" (IT-KA 1)

All key informants stated that the availability of infrastructure at all puskesmas was complete including body scales (stepping scales for adults and baby scales), measuring instrument for infant body length, microtoise to measure height, measuring tape/metline to measure head circumference, arm circumference, waist and hip circumference.

"Kalau sarpras di puskesmas sudah menunjang ya, kita punya peralatannya, tapi ya yang masih belum terealisasi itu yang di beberapa wilayah di posyandu" (IU 1)

"beberapa alat perlu dicek kembali karena ada yang kemungkinan sudah tidak layak pakai" (IU 3)

"ada mas di posyandu sebelah belum dapat bantuan, kadang pinjam alat dikita" (IT-KP 1)

"seperti timbangan badan bayi mas, sudah ngga bisa dipake, jadi biasanya kita pake timbangan biasa" (IT-KP 3)

"If the infrastructure at the puskesmas is already supporting, yes, we have the equipment, but yes, what has not been realized is in several areas at the posyandu" (IU 1)

"several tools need to be re-checked because some may not be suitable for use" (IU 3)

"There's a man at the posyandu next door who hasn't gotten help yet, sometimes he borrows tools from us" (IT-KP 1)

"It's like a baby's scale, you can't use it anymore, so we usually use a regular scale" (IT-KP 3)

Regarding the availability of infrastructure facilities in the posyandu area (Integrated Healthcare Center), two of the five main informants stated that the availability of infrastructure facilities in posyandu (Integrated Healthcare Center), was not evenly distributed, especially anthropometric tools between one region and another. Meanwhile, the two main informants confirmed by triangulation informants stated that some anthropometric tools were damaged and unfit for use. This, of course, must be given more attention because the implementation of the nutrition program is determined by the nutritional infrastructure, especially the anthropometric tool used as a measuring tool for the growth and development of toddlers.<sup>13</sup>

### 3. Process aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

Stunting prevention programs at the Puskesmas during the Covid-19 pandemic during the Covid-19 Pandemic were Monitoring toddlers, Providing PMT, Health Counseling, Nutrition Counseling at the Puskesmas and Giving Vitamins and Minerals. This is in line with Syahputra's research which states that the nutrition program at the puskesmas is in the form of monitoring, providing education, providing complementary foods and vitamins. Stunting prevention programs at the Puskesmas during the Covid-19 pandemic during the Covid-19 Pandemic were Monitoring toddlers, Providing PMT, Health Counseling, Nutrition Counseling at the Puskesmas and Providing Vitamins and Minerals. This was in line with Syahputra's research which states that the nutrition program at the puskesmas is in the form of monitoring, providing education, providing complementary foods and vitamins.<sup>8</sup>

"pertama pemantauan pertumbuhan, kemudian makanan tambahan, penyuluhan sama eee ada konseling di puskesmas mas" (IU 1)

"... dalam programnya untuk stunting ada pemberian PMT, promosi kesehatan, pemberian vitamin, zink dan ada pemantauan balita apakah dai stunting atau tidak" (IU 4)

"kita melaksanakan pemantauan, pemberian pmt, berupa kemarin itu saya kasih mpasi sama susu, dikasih vitamin juga, lalu pembinaan" (IU 5).

"First is growth monitoring, then additional food, counseling is the same as there is counseling at the Mas Health Center" (IU 1)

"... in the program for stunting there is provision of PMT, health promotion, provision of vitamins, zinc and there is monitoring of toddlers whether they are stunted or not" (IU 4)

"We carry out monitoring, giving PMT, in the form of yesterday I gave complementary milk, given vitamins too, then coaching" (IU 5).

### 4. Product aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

After monitoring and evaluating each activity carried out to see the quality of services from the stunting prevention program. Then a product evaluation was carried out, whether the stunting program during the current pandemic will be continued, modified or discontinued. Product indicators are

assessments carried out to measure the success of stunting prevention programs during the pandemic in achieving the goals that have been set. The data generated will greatly determine whether the activity will be continued, modified or discontinued in the stunting control program at the puskesmas during the pandemic. Evaluation of each activity of the stunting prevention program is presented to the head of the puskesmas which contains the implementation of activities, obstacles and performance achievements of the stunting prevention program during the pandemic. Covid-19.

*“lapornya kita paparkan ya mas, setahun sekali kalo pemaparan ke kapus. Tapi tiap bulan juga ada laporan rutin juga.”*

*(IU 5)*

*“minimal setaun sekali kita kumpul bersama membahas program” (IT-KA 5)*

*“We will explain the report, sir, once a year for the exposure to the head office. But every month there are also regular reports as well.”*

*(IU 5)*

*“at least once a year we gather together to discuss the program” (IT-KA 5)*

## DISCUSSION

### 1. Context Aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

To create a stunting program that is in accordance with the program's objectives, the Puskesmas as a health service organization as well as the holder of the stunting program is obliged to improve the quality of organizations and programs at the Puskesmas. Improving the quality of organizations and programs, especially the stunting program at Puskesmas during the Covid-19 pandemic, can be done by identifying the strengths and weaknesses of the organization.<sup>14</sup> By identifying the strengths and weaknesses of the organization, it is expected to improve the quality of policy making, especially policies related to stunting prevention program.

Based on the results of interviews regarding the objectives of the stunting prevention program during the Covid-19 pandemic, it was found that all informants understood that the purpose of the stunting program was primarily to reduce stunting during the Covid-19 pandemic, in addition, several key informants used various terms such as zero stunting, reducing stunting, stunting prevalence and maximize stunting programs.

All informants stated that the purpose of the stunting prevention program during the Covid-19 pandemic was based on directions from the Semarang City Health Office. Some of the main informants stated that the stunting program objectives directed by the Semarang City Health Office were adjusted to the vision and mission of each puskesmas.

Nutrition workers understand the advantages and disadvantages of organizations that are used as references in making stunting programs, namely: Government support, Posyandu Cadre activity, Limited access, lack of coordination with cross-sectors during the Pandemic, Negative public stigma towards health services during the Covid-19 pandemic. Understanding of the organization affects the effectiveness and efficiency of a program. In addition, identifying the strengths and weaknesses of the organization can increase the capabilities, independence, and resources owned.<sup>15,16</sup>

All key informants stated that the targets for stunting in the city of Semarang were stunted toddlers, pregnant women, mothers who had stunting toddlers and non-stunted toddlers. Two of the five main informants also explained the target for stunting under five, namely toddlers with a body length of less than 48 cm for boys and 47 cm for girls. This is in accordance with the target of the stunting program at the puskesmas that has been set by the Semarang City Health Office. Determining program targets is one of the important tools in formulating a program because program objectives act as the point we want to achieve.<sup>17</sup>

### 2. Input aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

The input desc<sup>12</sup>ription result of the three indicators have not implemented well during the pandemic. The quality component of nutrition officers can be said to be competent and qualified, this is evidenced by direct exposure from the head of the puskesmas and posyandu cadres as triangulation informants, in addition to support for educational competence, namely all nutrition officers with a minimum education of D3 nutrition science, and supported by training carried out by the DKK . The qualifications of nutritionists as coordinators of nutrition programs are in accordance with the Regulation of the Minister of

Health Number 26 of 2013 concerning the implementation of work and practice of nutrition workers. Qualified nutrition workers or officers affect the quality of the nutritional program quality.<sup>18,19,20</sup>

Meanwhile, the lack of skills of posyandu cadres, especially in monitoring children under five, is caused by the lack of training provided. Training is an effort to invest in human resources to improve work abilities and skills so that employee performance increases.<sup>21</sup> The effects of the Covid-19 pandemic, namely restrictions on mobility and budget changes during this pandemic, have resulted in the implementation of training not being able to be carried out properly. In carrying out the stunting program the adequacy of officers is an important component in the implementation of a program.<sup>12</sup> The program can run well if the program has sufficient resources, but the program cannot run well if the available resources are not sufficient.

From the results of the interview, it can be seen that the workforce is sufficient in the implementation of the nutrition program, namely at least one, this is in accordance with the minimum requirements for nutritionists in puskesmas in the Regulation of the Minister of Health of the Republic of Indonesia Number 75 of 2014. Although the adequacy of nutrition workers is in accordance with the Regulation The Minister of Health of the Republic of Indonesia Number 75 of 2014 but in its implementation during the pandemic there was an additional responsibility in each unit for the success of the vaccine program at the puskesmas which made the workload increase so that the nutrition program, especially stunting, was not optimal. This is in accordance with Permatasari's research which states that a heavy workload affects the quality of work, which has an impact on the organization.<sup>22</sup>

From the results of the interview, From the results of the interview above, it is known that the source of funds in the implementation of the stunting program during the Covid-19 pandemic is from the BOK and BLUD Puskesmas. BOK is Health Operational Assistance from the State Budget and Expenditure Revenue (APBN), the Ministry of Health and is central government assistance to regional governments which is channeled through the co-administration task mechanism to accelerate the achievement of priority health program targets.<sup>23</sup>

Funding that is hampered due to the absence of technical guidelines for funding during the Covid-19 period is a problem in the implementation of stunting prevention programs because funds have a very important role in stunting prevention programs, so that health costs must be available in sufficient quantities in the sense that they can finance the implementation of all health efforts. needed.<sup>24</sup>

Facilities and infrastructure is one of the supporting factors in addition to human resources and funding. In the stunting prevention program, of course, the availability of adequate facilities and infrastructure along with optimal management and utilization can help achieve the success of a program. This study uses two components in describing the indicators of facilities and infrastructure in the stunting prevention program during the Covid-19 pandemic. The two components are availability and constraints.<sup>25</sup>

All key informants stated that the availability of infrastructure at all puskesmas was complete including body scales (stepping scales for adults and baby scales), measuring instrument for infant body length, microtoise to measure height, measuring tape/metline to measure head circumference, arm circumference, waist and hip circumference. Regarding the availability of infrastructure facilities in the posyandu area, two of the five main informants stated that the availability of infrastructure facilities at the posyandu was not evenly distributed, especially anthropometric tools between one region and another. Meanwhile, the two main informants confirmed by triangulation informants stated that some anthropometric tools were damaged and unfit for use.<sup>13</sup>

This, of course, must be given more attention because the implementation of the nutrition program is determined by the nutritional infrastructure, especially the anthropometric tool used as a measuring tool for the growth and development of children under five.

From the results of the interview, the reason for not being able to check and collect data related to damaged anthropometric tools is due to limited access during the pandemic, especially in August where the city of Semarang carried out PPKM. Checking and calibrating nutritional measuring instruments at the posyandu can minimize calculation errors that have an impact on achieving the objectives of monitoring activities for children under five.<sup>101</sup>

In addition, the use of tools that are not appropriate or according to procedures can cause errors in weighing data that affect the stunting program. This is in accordance with Rusdiarti's research that errors in the use of nutritional measuring tools at the posyandu that are not appropriate, result in incorrect data, which has an impact on errors in making programs and policies related to nutrition programs.<sup>26</sup>

3. Input aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

The implementation of each activity was as follows:

a. Monitoring and tracking activities.

The purposes of monitoring and tracking toddlers were to obtain fast and accurate information on stunting cases, found and treated all stunted toddlers and all stunted toddlers received treatment according to stunting management so that they can suppressed and reduced the stunting prevalence. The target of tracking stunting toddlers was for 100 percent of toddlers in the working area of the puskesmas to track stunted toddlers.

During the Covid-19 pandemic, monitoring and tracking activities are carried out door to door. During the Covid-19 pandemic, tracking of toddlers was carried out by door to door or house-to-house visits of mothers and toddlers by posyandu cadres. Tracking activities are carried out once a week or 3 times a month. After tracking in the form of anthropometric measurements, namely WAZ (Weight for Age Score), HAZ (Height for Age Z-scores), and WHZ (weight for height Z-scores). After monitoring by posyandu cadres, the data is submitted to nutrition workers for checking. If a stunting toddler is found with a z score of less than -2SD, direct monitoring by nutrition workers and posyandu cadres is carried out door to door. If the area is a stunting locus area, then monitoring activities are also assisted by DKK through the Nutrimas program.

While the drawback is that some toddlers are sleeping when visited, so monitoring is difficult to carry out, in addition to the effort and energy spent by posyandu cadres, which has the potential to decrease performance which has an impact on the quality of monitoring and tracking activities.

This was in accordance with Didah's research which states that the heavy workload of posyandu cadres can reduced the achievement result of a program implementation in posyandu.<sup>27</sup>

b. PMT giving activities.

The provision of supplementary food (PMT) for stunted toddlers at the puskesmas used the Recovery PMT and the F100 package with the aim of improving the nutritional status of these toddlers.

The target in giving PMT is the distribution of PMT to all toddlers, especially toddlers with stunting and to have an impact on the community to have the habit of giving toddlers a healthy diet. During the Covid-19 pandemic, only PMT recovery without PMT F100 was given to toddlers who were stunted.

During the Covid-19 pandemic, the provision of PMT for stunting toddlers in the form of recovery PMT and F100 packages was given from the puskesmas, namely nutrition workers to posyandu cadres, to be handed over to mothers with stunting toddlers.

The administration of PMT during the Covid-19 pandemic was the absence of the F100 package for stunted toddlers. According to Kholidah's research, the F100 administration program regularly can reduce.<sup>28</sup>

c. Stunting Counseling

The purpose of health education about stunting was to achieve changes in the behavior of individuals, families and communities related to awareness of stunting prevention, to played an active role in realizing optimal health for infants and toddlers according to healthy living.

During the Covid-19 pandemic, due to the prohibition on access to posyandu, stunting counseling was carried out online. Online stunting counseling is carried out through the WA group with participants from pregnant women, mothers who have toddlers, both stunted and non-stunted. Online counseling is held at least once a month, with nutritionists, health promotion personnel and MCH conducted through group chats or group video calls.

Obstacle in stunting counseling program regularly via online was : participants who do not have quotas and cellphones that meet the minimum specifications cannot participate in counseling activities. This was in line with Fakhriyah's research which states that the problem with online health lectures in WA is that mothers of toddlers do not have quotas and do not have the WA application.<sup>29</sup>

Extension activities are not flexible because one group is filled by several puskesmas officers and have different interests, so that there is the potential that the messages conveyed are conflicting and ineffective.

d. Counseling

The purpose of counseling services was to alleviate the problems experienced by clients. In this case, the client meant pregnant women, mothers who have toddlers, especially mothers who have stunted toddlers. The target to be achieved in nutritional counseling was for mothers to know their nutritional needs and adequacy according to age so that the pattern of giving food was appropriate.

Nutrition counseling is the only activity that has not undergone major changes in the stunting prevention program during the Covid-19 pandemic. This is because the activity is carried out at the puskesmas. A different change from the period before the pandemic was the absence of gifts from posyandu cadres for those who came for consultations.

Although there is no difference before the pandemic and after the pandemic in the stunting program, there are various obstacles that are experienced only during the pandemic, namely the decrease in consultation visits to the puskesmas. One of the causes of the decline in visits to puskesmas is public perception of health services during the Covid-19 period. Public perception affects visits to health care facilities.<sup>30</sup> The Covid-19 pandemic has made the public's negative perception of health services increase.<sup>31</sup> In addition, the absence of a stimulus in the form of PMT made by posyandu cadres makes mothers who have toddlers not visit the puskesmas.

e. Giving Vitamin A

The purpose of vitamin supplementation administration was to make the child's body to be healthy. In particular, the consumption of vitamin A for toddlers has benefits such as: Increasing the body's resistance to diseases and infections such as measles and diarrhea. Assisted the process of vision in adapting light to dark places. Prevented abnormalities in epithelial cells, including the mucous membranes of the eyes.<sup>32</sup>

The target for the provision of vitamins and minerals is that all toddlers get 100 percent at least vitamin A.

During the Covid-19 pandemic, the vitamin and mineral provision which was usually carried out at the posyandu turned into a door-to-door provision of vitamins and minerals due to the prohibition of access to posyandu.

The obstacle experienced during the pandemic was that the administration of vitamin A directly to toddlers was not monitored because it was different from the administration of vitamin A at the posyandu which could be monitored in taking it, the administration of vitamin A during the pandemic was carried out door to door so that it was not possible to carry out further monitoring.

4. Output aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

So it can be concluded that the nutritionist as the coordinator of the stunting prevention program conducts regular evaluations once a year. In addition to evaluating, nutrition workers also conduct assessments. Assessment is a process to determine the value or level of success of a program in achieving the goals that have been set or an orderly and systematic process in comparing the results achieved with the benchmark criteria set, followed by drawing conclusions and providing suggestions and input that can be done at each stage. stage of program implementation. Without an evaluation it will be difficult to know how far the planned goals will be achieved.<sup>33</sup>

The main objective of the stunting prevention program during the Covid-19 pandemic was to reduce the stunting rate during the Covid-19 pandemic, which during the current COVID-19 pandemic had the potential for a spike in cases due to limited access and quality of the stunting program itself.<sup>6</sup> Therefore, to find out about the success of the stunting program objectives in general, it can be seen from the status of stunting prevalence in the city of Semarang.

Based on data from the Semarang City Health Office, the prevalence of stunting in the pre-pandemic period was 2.5% in 2018 and 2.57% in 2019 while the prevalence of stunting during the pandemic taken from 2020 data was 3.13% or as many as 3143 infants and toddlers were stunted. It can be concluded that the stunting program during the pandemic has not met the expected target where there is an increase in stunting cases from 2.57% to 3.13% with the total number of toddlers experiencing stunting during the pandemic, an increase of 384 toddlers compared to before the pandemic. This certainly needs special attention, especially in improving the quality of the quality of a program. The success of the stunting prevention program during a pandemic must be in line with the declining prevalence rate during the pandemic.

## CONCLUSION



The stunting prevention program in the work area of the puskesmas during the Covid-19 pandemic has not been able to be implemented well during the Covid-19 pandemic. The input aspect proved this; the process has not run well, thus increasing the stunting prevalence rate from 2.57% to 3.13%. The number of toddlers experiencing stunting during the pandemic increased by 384 toddlers. The suggestion in this study is to increase the innovation of stunting prevention programs by using digital technology during the pandemic.

This research is cannot be separated from the limitations and weaknesses in the data collection process. Limitations and weaknesses in this research include: The limited time of the informants to conduct in-depth interviews due to the busyness of the informants at work, so that the information obtained was not maximized, The limitations of researchers to make observations through observing the available infrastructure at the posyandu (Integrated Healthcare Center) due to restrictions during the pandemic Covid-19.

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## Differences in Development and Diet of Stunting and Non-Stunting Children in the Rowosari Health Center Work Area, Semarang, Indonesia

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### ABSTRACT

**Background:** Stunting in children aged 36-59 months is caused by the intake of energy and protein below the average RDA recommendation. This low consumption has an impact on different growth and development disorders.

**Objectives:** This study aimed to determine the differences in the development and diet of stunted and non-stunted children aged 36-59 months.

**Materials and Methods:** This was an observational study with a cross-sectional approach, which was carried out at the work area of the Rowosari Health Center. The sample population consisted of 67 children aged 36-59 months, which were selected using the simple random sampling technique. The characteristics of the subjects and mothers were then collected using a questionnaire. Meanwhile, data on the diet and child development were obtained with the 24-hour recall method and Developmental Pre-Screening Questionnaire (KPSP), respectively.

**Results:** The results showed that there were differences in the development as well as energy and protein adequacy level of stunted and non-stunted children with a p-value <0.05.

**Conclusion:** There were several deviant developments in non-stunted toddlers due to the lack of nutritional intake, stimulation, interaction with the environment as well as the low knowledge of mothers about child care patterns.

**Keywords:** Stunting, diet, development, Semarang

### BACKGROUND

Stunting is caused by various child development disorders<sup>1</sup> and it has affected 21.3% of children under the age of five years globally with a total of 144 million cases. Several studies showed that the condition is more prevalent in Asian and African countries<sup>2</sup>. The 2018 Basic Health Research (Riskesdas) and the 2019 Indonesian Toddler Nutritional Status Survey (SSGBI) reported that there was a decrease in the stunting rate from 30.8% to 27.7%<sup>3,4</sup>. However, it is still a health problem because its prevalence is above the WHO standard of 20 %<sup>4</sup>.

Adequate nutrition, health conditions, protection, and safety factors play an important role in children's development, especially at an early age<sup>5</sup>. The occurrence of stunting during this period can affect the structure and function of the brain where a reduced number of cells causes growth delays. A survey by the Health Ministry of Indonesia revealed that 16% of children under five years experienced fine and gross motor development disorders, hearing loss, decreased intelligence as well as speech delays with a total of 0.4 million cases<sup>6</sup>. At the age of 36-59 months, only 6-7 toddlers have reached the appropriate growth stage<sup>5</sup>. Furthermore, a previous study showed that faltering growth before birth and 18 months after gestation is associated with poor language and motor development<sup>7</sup>. Stunting children aged 2, 5, and 9 years have lower verbal scores and IQ of 4.6 points compared to others<sup>8</sup>. Several studies also revealed that they have lower scores in all aspects of development<sup>9</sup>. A study in Kalasan showed that stunting children are 3.9 times more at risk of developing suspect than others with normal growth<sup>10</sup>.

Nutrient intake plays an important role in supporting the development of children<sup>11</sup>, hence, low consumption of energy and protein causes growth failure<sup>12</sup>. This was evident in 45.7% of the sample population having an energy intake <70% AKE, while 36.1% were <80% RDA<sup>13</sup>. Furthermore, a previous study revealed that toddlers with low consumption are 7.5 times more at risk of experiencing stunting<sup>14</sup>. A study in Brazil also reported that the intake of protein must meet the nutritional needs of children. Toddlers are 1.59 times at risk of experiencing stunting when their protein intake is below the nutritional adequacy level<sup>15</sup>.

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Semarang is one of the cities in Central Java with the lowest stunting prevalence of 21.0%<sup>16</sup>, but the rate was reduced by 2.7% in 2018 and 2.5% in 2019. However, due to the pandemic, there was a 3.13% increase in the rate with a total of 384 children under the age of five in 2020<sup>17</sup>. Tembalang is one of the affected districts in Semarang City, which had the highest prevalence of 10.11%<sup>18</sup>. During the pandemic, the intervention administered was ineffective<sup>17</sup> and it had a negative impact on the monitoring of children's growth<sup>19</sup>. The diversity of food for stunting children is still lacking, especially during prenatal feeding and exclusive breastfeeding<sup>20</sup>. Therefore, this study aims to determine the differences in the development as well as the diet of stunted and non-stunted toddlers aged 36-59 months in Tembalang District, Semarang City.

## MATERIALS AND METHODS

This was an observational study with a cross-sectional design, which was carried out in December 2021. The sample population consisted of toddlers aged 36-59 months living in the working area of the Rowisari Health Center, Tembalang District, Semarang City, and the size was calculated using the Lemeshow formula. Furthermore, the study location was in Meteseh Village 3, 4, and 16 where a total number of 67 children was selected using the simple random sampling technique.

The subjects who entered the stunting group as many as 12 children, while those who entered the non-stunting group as many as 55 children. We included children aged 36-59 months living in the working area of the Rowosari health center, living with parents / caregivers, born enough months, agreeing to be respondents by signing *informed consent*. We exclude those who had not in place during the study and had congenital abnormalities.

The free variables in this study were development and diet, while the bound variables were stunting and not stunting. Stunting is determined through the results of measurements of height compared to age in the  $\geq -2$  elementary school assessment standards WHO<sup>3</sup>. The samples' nutritional status was obtained using a stadiometer Seca 213 with TB/U indicators, which were then interpreted according to anthropometric standards<sup>21</sup>. Meanwhile, their development was assessed using the Child Development Pre-screening Questionnaire (KPSP)<sup>22</sup>. The dietary data were collected using the Recall method for 3x24 hours, after which the food ingredient composition was calculated with a nutrisurvey to determine the number of macronutrients consumed<sup>23</sup>. It was then compared with the RDA and all the data were analyzed using Chi-Square statistical test.

## RESULTS

**Table 1. Distribution of Respondents' Characteristics**

Variable	Stunting		Non-stunting		Total	
	N	%	N	%	N	%
Gender						
Male	6	9.0	40	59.7	46	68.7
Female	6	9.0	15	22.4	21	31.3
Children Age						
36-46 months	6	9.0	22	32.8	28	41.8
47-59 months	6	9.0	33	49.3	39	58.2
Mother's Age						
25-35 years	12	17.9	47	70.1	59	88.1
>36 years	0	0	8	11.9	8	11.9
Mother's Job						
Working	1	1.5	23	34.3	24	35.8
Housewife	11	16.4	32	47.8	43	64.2
Mother's Education Level						
Junior and Senior High School	10	14.9	45	67.2	55	82.1
S1 and Equal	2	3.0	10	14.9	12	17.9

Table 1 shows that 59.2% of the samples were male, and 49.3% were between 47-59 months, which was the most aged group. Furthermore, 70.10% had mothers aged 25-35 years, while 55.2% had housewife mothers. 67.1% of the parent have a junior high and high school education background, and they were all in the non-stunting group.

**Table 2. Differences in the development of stunting and non-stunting children**

Nutritional status	Child development	P-Value*
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	Deviant		Normal		n	%	
	n	%	n	%			
Stunting	11	16.4	1	1.5	12	17.9	0.008
Non-stunting	26	38.8	29	43.3	55	82.1	

A high deviant child development occurred in the non-stunting group where 38.8% of the samples were affected compared to the stunting category with 16.4%, as shown in Table 2. The chi-square test result showed that there were differences in the development in the two groups with  $p < 0.05$ .

**Table 3. Differences in the energy adequacy level of stunting and non-stunting children**

Energy Adequacy Level	Nutritional status						P-Value*
	Stunting		Non-stunting		n	%	
	n	%	n	%			
Lack	12	17.9	33	49.3	45	67.2	0.006
Adequate (appropriate with AKG)	0	0	22	32.8	22	32.8	

Table 3 shows that 46.3% of the children in the non-stunting group had a good energy adequacy level compared to the stunting category with 17.9%. Furthermore, the fisher's exact test results revealed that there were differences in the levels recorded in the two groups ( $p < 0.05$ ).

**Table 4. Differences in protein adequacy levels for stunting and non-stunting children**

Protein Adequacy Level	Nutritional status						P-Value*
	Stunting		Non-stunting		N	%	
	N	%	N	%			
Lack	11	16.4	17	25.4	28	41.8	0.000
Adequate (appropriate with AKG)	1	1.5	38	56.7	39	58.2	

Table 4 revealed that 25.4% of the children in the non-stunted group had good protein adequacy compared to the stunting category with 16.4%. The results of the chi-square test showed that there were differences in the level of energy adequacy in the two groups ( $p < 0.05$ ).

## DISCUSSION

### Subject characteristics

The sample population consists of 59% male and 49.3% were aged 47-59 months. Furthermore, 55.2% of the children had a housewife mother of which 67.1% had junior and senior high school education background. A previous cross-sectional study in Ethiopia identified 410 toddlers in a critical growth and development period between 6-59 months. The results showed that the factors affecting stunting include gender, birth weight  $< 2.5$  kg, low active visits of mothers to integrated service posts, and inappropriate complementary feeding.<sup>24</sup> Mugianti (2018) reported that the growth and development of boys are more influenced by the environment, hence, they can easily experience the condition due to psychological conditions. The growth process is primarily dependent on the ability of the caregivers to meet their nutritional needs.<sup>25</sup> Meanwhile, a study in Ghana showed that stunting was more common in girls than boys aged  $>2-5$  years.<sup>26</sup> This was because the child received an adequate amount of breast milk, but the feeding was improper. Although growth can be achieved after the conditions change, malnourished children never reach optimal level.<sup>26</sup>

The results showed that the mothers' nutritional education and knowledge is one of the factors related to child outcomes. Children with an educated parent are often healthier and well-groomed compared to others. Therefore, the low level of mother's education has an impact on the prevalence of malnutrition among toddlers apart from other factors, such as income.<sup>26</sup> These findings are in line with a study in Laos and Thailand where stunting children have mothers and caregivers without formal education.<sup>27,28</sup>

### Children development

Table 2 shows that abnormal development is prevalent in non-stunted children where 38.8% were affected compared to stunted toddlers with 16.4%. The chi-square test indicated that there were differences in the development based on the incidence of stunting ( $p < 0.05$ ). This finding is in line with Nahar (2020) that there were developmental variations in the cognitive, motor, language, and socio-emotional function of both groups.<sup>9</sup> Putri (2018) also revealed that there were significant differences in the growth of stunted and non-

stunted children in Semarang Regency<sup>29</sup>. Stunting toddlers experience slow and short skeletal growth, hence, good nutrition is needed at an early age. Based on the level of energy and protein adequacy, nutritional intake in this study was still lacking. These nutrients are greatly needed from birth to the age of 2 or 3 years, and the fastest period is the first 6 months of life<sup>30</sup>.

The meta-analysis revealed that stunting children aged 36-59 months in various developing countries experience poor development<sup>31</sup>. This difference causes growth inhibition of the brain cells, fibers, and connectors, thereby leading to overall developmental delays<sup>32</sup>. A previous study reported that the functional connectivity of the brain can function as a neural pathway, where biological difficulties have an impact on cognitive development. These findings provide an understanding of the pathways, which serves as a link between impaired growth and poor cognitive outcomes. Furthermore, this reveals the widespread adverse effects of malnutrition on children's brain development, consequently, more efficient intervention can be developed<sup>33</sup>.

### **Energy Adequacy Level**

Based on energy adequacy levels, the majority of the toddlers were included in the low category, as shown in Table 3. Furthermore, most of the children with deficiency were in the non-stunted group, accounting for 49.3% of the total population. The fisher's exact test showed that there were differences in the energy adequacy level of the stunted and non-stunted groups with a p-value <0.05. This finding is in line with Adani and Nidya (2017) as well as Damayanti that there are variations in the consumption of energy, protein, zinc, iron, exclusive breastfeeding history as well as the development of stunted and non-stunted children<sup>34</sup>. This study is also consistent with Mahfouz et al (2021), which obtained similar results where there were differences between the consumption level of both groups<sup>35</sup>. Three-quarters of the sample population lack energy and the daily intake of stunted toddlers was lower than that of others<sup>36</sup>. Mugianti (2021) reported that children with low consumption are 0.146 times more at risk of experiencing stunting compared to others with sufficient adequacy level<sup>25</sup>. At an early age, sufficient energy and nutrients intake lead to healthy growth and development of the brain, bones, and immune system<sup>37</sup>. Differences in nutritional intake of stunted and non-stunted children are caused by the type of food consumed and irregular eating patterns with fewer portions, which can contribute to growth failure<sup>38,39</sup>.

### **Protein Adequacy Level**

Table 4 shows that 56.7% of the toddlers were included in the category of protein adequacy levels, but the non-stunted group had higher levels compared to the stunting category. The chi-square test results revealed that there were differences in the development of both groups with a p-value <0.05. Furthermore, this finding is in line with Yuristi et al (2019) that there are variations in the protein intake of stunted and non-stunted children<sup>40</sup>. This is also consistent with Sharm S et al (2020) that approximately 85% of children under 5 years have more than 70% of the recommended protein intake<sup>41</sup>. Solihin R et al (2013) reported that every 1% increase in toddlers' protein adequacy level elevates the z-score of BH/A by 0.0024 units<sup>12</sup>.

Protein plays an essential role in the building of new tissues as well as maintaining, repairing, and replacing damaged parts. The intake of nutrients that helps in brain growth and development includes energy, protein, certain types of fat, and iron. Children with long-lasting protein deficiency often experience stunting in height despite the presence of adequate energy<sup>42,36</sup>. However, there are some short children with a good intake of the nutrient. Protein consumption is not directly related to height, but it can serve as an indicator of previous food intake<sup>43</sup>.

### **LIMITATION**

This study was only carried out at Rowosari Health Center, hence, it did not describe the stunting state of Semarang City. Furthermore, some respondents did not understand the child's intake because they were not the main caregiver or the food were not provided by them.

### **CONCLUSION**

The result showed that there were differences in the development as well as the energy and protein adequacy levels of stunted and non-stunted children aged 36-59 months in the Rowosari Health Center's working area. Furthermore, more deviant developments were observed in the non-stunted toddlers due to the

lack of nutritional intake, stimulation, interaction with the environment as well as the mother's low knowledge of parenting patterns.

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# The Association between Sleep Duration, Breakfast Routine and Nutritional Status in Indonesian Adolescents during COVID-19 Pandemic

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## ABSTRACT

**Background:** Adolescents are susceptible to nutritional status issues, both undernutrition, and over-nutrition, becoming a public health concern promptly. There were 912 junior and high-school adolescents who were obese and 249 high-school adolescents who had low body mass index (BMI) in Samarinda City. During the COVID-19 pandemic, adolescents experienced changes in sleep duration, and many adolescents were skipping breakfast. Sleep duration and breakfast can affect the nutritional condition of adolescents.

**Objectives:** The purpose of this study was to determine the association between sleep duration, breakfast routine and BMI in Samarinda, Indonesian adolescents during COVID-19 pandemic.

**Materials and Methods:** A total of 340 adolescents was sampled and assessed using a cross-sectional technique to ascertain their sleep duration, breakfast routine, and nutritional status. Nutritional status was classified based on BMI-for-age and z-value BMI. The amount of sleep duration was calculated by the average wake time and sleep time. Breakfast routine was obtained from seven days of breakfast before 9 am. Then, using multivariate analyses were tested for sleep duration, BMI z-value, breakfast routine, and nutritional status.

**Results:** This study revealed that 68.5% had good nutrition, with an average sleep duration of 8 hours (65.9%) and irregular breakfast (59.1%). Nutritional status was significantly influenced by breakfast routine ( $p=0.044$ ), gender ( $p<0.001$ ), and mother's employment ( $p<0.001$ ). A cubic association was found between sleep duration and BMI ( $p=0.045$ ); and a significant association between breakfast routines and BMI, independent from age, gender, ethnicity, school.

**Conclusion:** Adolescents must consider their sleep duration and the frequency and composition of their breakfast. Future study in the longitudinal study is needed to explore in more detail.

**Keywords :** Sleep Duration; Breakfast; Nutritional Status; Adolescent

## BACKGROUND

Adolescence is a vulnerable period with nutritional status problems, such as malnutrition, including low body weight, overweight, stunting, and micronutrient deficiencies [1, 2]. Overweight and obesity in adolescents can increase the risk of heart disease, atherosclerosis, diabetes mellitus, orthopedic disorders, mental health disorders, and cognitive function [2].

Globally, the prevalence of overweight in adolescents aged 15-19 is 10%, and 2-3% of them are obese. Meanwhile, 88% are underweight in which 29% are girls and 59% are boys [3]. Over 340 million children aged 5-19 years were overweight and obese in 2016 [4]. Overweight or obesity adolescents are public health problems that require immediate attention and it may worsen their health, causing infectious disease [5-7].

According to Basic Health Research in 2018, the proportion of overweight and obese people aged 18 years and over in Indonesia has increased. East Kalimantan, Borneo is in the top three proportions of obese adults aged 18 years and over. Meanwhile, the prevalence of obesity and overweight in the Samarinda area in adolescents aged 13-15 years is 9.03% and 10.42%, respectively. Additionally, the prevalence of obesity and overweight for 16-18 years is 5.50% and 8.17%, respectively. Meanwhile, the prevalence of underweight and fragile nutritional status in Samarinda is 8.34% and 4.66% in 13-15 years and 10.98% and 3.36% in 16-18 years [8].

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Sleep duration, sleep quality, and sleep problems can lead to obesity and overweight. Sleep duration can increase the risk of cardiovascular disease, type 2 diabetes, mental health, hypertension and affect academic performance [9–12]. In addition, adolescent nutritional status is related to short sleep duration, which has the highest risk of obesity or overweight, increased fasting glucose levels, and an unhealthy immune profile [13].

Several studies state an association between short sleep duration and the nutritional status of high school adolescents, which stated that during a pandemic period, adolescents sleep only 4-6 hours in one day [13–15]. The amount of sleep duration is not aligned with the suggestion of the Ministry of Health of the Republic of Indonesia in 2018, which stated that the total sleep duration for adolescents should be 8-9 hours a day.

Another research on the sleep duration in high school students discover that more female students (75.6%) are having a shorter sleep duration compared to male students (69.6%) [16]. The same result is also found in high school students in Brazil, as well as with a sense of sleepiness was excessive [17]. Nonetheless, short sleep duration has a relationship with obesity in adolescents [18].

Apart from sleep duration, meta-analytical studies confirm that skipping breakfast also increases the risk of obesity or overweight [19]. Health behaviors such as the duration of sleep and breakfast consumption in adolescents are associated with chronic disease [13]. Breakfast plays a role in fulfilling nutritional intakes. However, adolescents still skip breakfast [20]. Adolescents who skip breakfast tend to have a poor quality diet and have a higher BMI or have more weight than adolescents who do not skip breakfast. [21, 22]. Another study suggests a positive correlation between skipping breakfast and obesity [23].

In Samarinda, 912 junior high and high school students are obese [24], and 249 high school adolescents have a low BMI [25]. There was also an increase in body weight during the COVID-19 pandemic [26]. In addition, changes in sleep duration in adolescents during the COVID-19 pandemic and their breakfast behavior affect their nutritional status [27, 28]. If those problems do not get enough attention, it will lead to an increasing number of adolescents with high BMI during the COVID-19 pandemic. The result from this study are expected to be used as a reference for further study about the problems and can be another source of knowledge for society. The aim of this study was to identify and predict the relationship between adolescent nutritional status and sleep duration and breakfast routines during the COVID-19 pandemic. This study conducted during COVID-19 pandemic at Samarinda, West Kalimantan, Borneo, Indonesia.

## **MATERIALS AND METHODS**

This study was an observational study with a cross-sectional survey conducted in Samarinda in West Kalimantan in March 2021. The population for this study was 2,943 high school students. Schools were selected based on the ease of access for researchers to reach. The sample was calculated using the Lemeshow formula [29]. The randomized and stratified random sampling technique was used based on geographic location, age, and socio-economic status [30]. The independent variables were sleep duration and breakfast routine, and the dependent variable was nutritional status. Based on self-reports, data on nutritional status, sleep duration, and breakfast routines were collected. Sleep duration was obtained from calculating bed and wake up time during the week. Meanwhile, the breakfast routine is obtained by calculating the time of breakfast during the week and the number of days of breakfast. BMI was calculated by age to determine nutritional status. The instrument used was an online questionnaire that was previously tested for its reliability. The sleep duration question was used to determine the average amount of sleep duration for teenagers in one week, breakfast routine questions were used to see what breakfast time teenagers had breakfast. However, the nutritional status question was asked to see the nutritional status of adolescents based on the z value of BMI. Informed consent was obtained by providing a descriptive at the beginning of the questionnaire and providing questions regarding willingness to fill out the online questionnaire. The study protocol was approved by the ethics committee in Mulawarman University, Samarinda, Indonesia.

Univariate data analysis was used to see the distribution and frequency. The bivariate analysis used was the Spearman test and the chi-square test to find confounding variables. Multivariate analysis was conducted to see whether there was a relationship between sleep duration and breakfast routine on nutritional status. Data analysis using quantitative analysis, namely linear, quadratic, cubic, and logistic regression analysis. If Sig (2-sided) < 0.05 then H<sub>0</sub> is rejected and Sig (2-sided) > 0.05 then H<sub>0</sub> is accepted. This analysis predicted sleep duration and breakfast routine based on nutritional status. A logistic regression test was used to predict the relationship between breakfast routine variables and nutritional status variables by adjusting the four models. The linear test was used to see a straight-line relationship between sleep duration and the z value of BMI as seen from the significant fixed coefficient. Meanwhile, quadratic and cubic tests were used to see the

relationship between sleep duration and the z value of BMI, which was seen from the significant fixed effects results. Linear, quadratic, and cubic tests were adapted to the four models. For all tests, a two-tailed p-value < 0.05 was considered statistically significant.

**RESULTS**

**Table 1. Characteristic of Adolescents**

Variables	Nutritional Status				N (%)	p-value
	Poor (%)	Good (%)	Over (%)	Obese (%)		
<b>Sleep Duration</b>						
<8 Hours	28 (12,5)	158 (70,5)	27 (12,1)	11 (4,9)	224 (100)	0,459
8-9 Hours	8 (12,5)	43 (68,3)	9 (14,3)	3 (4,8)	63 (100)	
>9 hours	5 (9,4)	32 (60,4)	13 (24,5)	3 (5,7)	53 (100)	
<b>Breakfast Routine</b>						
Not Routine	26 (12,9)	131 (65,2)	32 (15,9)	12 (6)	201 (100)	0,420
Routine	15 (10,8)	102 (73,4)	17 (12,2)	5 (3,6)	139 (100)	
<b>Age</b>						
15	1 (6,3)	9 (56,3)	6 (37,5)	0	16 (100)	0,586
16	19 (11,5)	122 (73,9)	18 (10,9)	6 (3,6)	165 (100)	
17	12 (9,6)	85 (68)	20 (16)	8 (6,4)	125 (100)	
18	7 (22,6)	16 (51,6)	5 (16,1)	3 (9,7)	31 (100)	
19	2 (66,7)	1 (33,3)	0	0	3 (100)	
<b>Sex</b>						
Female	20 (9,3)	165 (76,7)	22 (10,2)	8 (3,7)	215 (100)	<b>&lt;0,001</b>
Male	21 (16,8)	68 (54,4)	27 (21,6)	9 (7,2)	125 (100)	
<b>School</b>						
PUBLIC HS 11	14 (11,8)	81 (68,1)	19 (16)	5 (4,2)	119 (100)	0,146
PUBLIC HS 1	5 (5,2)	75 (78,1)	12 (12,5)	4 (4,2)	96 (100)	
<b>Nutritional Status</b>						
Variables	Poor (%)	Good (%)	Over (%)	Obese (%)	N (%)	p-value
PRIVATE HS Setia Marga	9 (16,1)	35 (62,5)	7 (12,5)	5 (8,9)	56 (100)	0,146
PRIVATE HS Islam	3 (11,5)	17 (65,4)	6 (23,1)	0	26 (100)	
ISLAMIC HS Granada	10 (23,3)	25 (58,1)	5 (11,6)	3 (7)	43 (100)	
<b>Grade</b>						
X (Ten)	20 (11)	129 (71,3)	25 (13,8)	7 (3,9)	181 (100)	0,498
XI (Eleven)	16 (11,6)	92 (66,7)	22 (15,9)	8 (5,8)	138 (100)	
XII (Twelve)	5 (23,8)	12 (57,1)	2 (9,5)	2 (9,5)	21 (100)	
<b>Tribe</b>						
Kutai	3 (13)	15 (65,2)	4 (17,4)	1 (4,3)	23 (100)	0,197
Banjar	13 (13)	70 (70)	14 (14)	3 (3)	100 (100)	
Dayak	0	2 (40)	2 (40)	1 (20)	5 (100)	
Jawa	13 (11,9)	66 (60,6)	22 (20,2)	8 (7,3)	109 (100)	
Bugis/ Makassar	8 (15,1)	39 (73,6)	3 (5,7)	3 (5,7)	53 (100)	
Others	4 (8)	41 (82)	4 (8)	1 (2)	50 (100)	
<b>Fathers' Occupation</b>						
Government/ private employees	17 (11)	105 (68,2)	23 (14,9)	9 (5,8)	154 (100)	0,565
Army/ Police	0	4 (80)	0	1 (20)	5 (100)	
Laborer	4 (18,2)	17 (77,3)	0	1 (4,5)	22 (100)	
Unemployment	5 (13,5)	21 (56,8)	8 (21,6)	3 (8,1)	37 (100)	
Others	2 (16,7)	9 (75)	1 (8,3)	0	12 (100)	
<b>Mothers' Occupation</b>						
Government/ private employees	9 (12,3)	43 (58,9)	16 (21,9)	5 (6,8)	73 (100)	<b>&lt;0,001</b>
Entrepreneur /trader	6 (19,4)	21 (67,7)	4 (12,9)	0	31 (100)	
Army/ Police	0	0	0	1 (100)	1 (100)	
Laborer	1 (100)	0	0	0	1 (100)	
Housemakers/ Unemployment	24 (10,4)	168 (73)	28 (12,2)	10 (4,3)	230 (100)	
Others	1 (25)	1 (25)	1 (25)	1 (25)	4 (100)	

The p-value of the nutritional status and age variables was based on the Spearman test.

In addition to the Spearman test, the value was obtained from the chi-square test.

The comparison results were obtained from the p-value > 0.05.

Values in bold are significant values.

A total of 340 respondents were obtained from the four public and one private high school in Samarinda. The demographic characteristics of the respondents are depicted in Table 1. The majority of respondents were 16 and 17 years (48.5% and 36.8%, respectively) and predominantly female (63.2%). More than half of the respondents were in class X (ten), as many as 181 (53.2%). Of 340 participants, 63.2% attended public school, and 109 of the respondents (32.1%) were Javanese. Meanwhile, as of parents' occupations, a government/private employee (45.3%) and housewife (67.6%) were the most common for father and mother, respectively.

The group with the highest number of good nutritional status was 16 years. In addition, the number of poor nutrition (undernutrition, overnutrition, and obesity) was only 43 respondents. There are 28 respondents aged 17 years who have more nutritional status and obesity, which makes this age has the highest number compared to other ages. The good nutritional status was predominantly female, while the malnutrition was predominantly male. In addition, respondents whose father is a government/private employee have the best nutritional status, amounting to 105 respondents. At the same time, they also have the highest number of over nutritional status compared to other fathers' occupations, which are 23. Based on the mother's occupation, respondents with a housewife mother have the best nutritional status compared to working mothers.

Based on table 1, the most respondents slept for <8 hours, which amounted to 224 (65.8%). The results of the cross-tabulation showed as many as 158 adolescents had good nutritional status and sleep duration < 8 hours. In addition, respondents with sleep duration < 8 hours had the highest good nutritional status compared to other sleep durations. And, most respondents (59.1%) did not have breakfast regularly. In addition, as many as 131 respondents who do not routinely have breakfast have good nutritional status, while only 26 respondents have poor nutritional status and do not routinely eat breakfast.

**Table 2. Sleep Duration and Body Mass Index**

	BMI Z Score		
	Linear	Quadratic	Cubic
Model 1	0,701	0,135	<b>0,045</b>
Model 2	0,655	0,134	<b>0,042</b>
Model 3	0,553	0,124	0,053
Model 4	0,966	0,355	<b>0,020</b>

Model 1: Age, gender, occupation of mother

Model 2: Age, gender, occupation of father

Model 3: Age, gender, father's occupation, mother's occupation

Model 4: Age, gender, ethnic, school

The value of each model is obtained from linear, quadratic, and cubic tests. The comparison is obtained from the p-value < 0.05. Values in bold are significant values.

**Table 3. Breakfast Routine and BMI-for-age**

Breakfast Routine	BMI-for-age
	p-value
Model 1	<b>0,044</b>
Model 2	0,061
Model 3	<b>0,047</b>
Model 4	<b>0,024</b>

Model 1: Age, gender, occupation of mother

Model 2: Age, gender, occupation of father

Model 3: Age, gender, father's occupation, mother's occupation

Model 4: Age, gender, ethnic, school

The value of each model is obtained from linear, quadratic, and cubic tests. The comparison is obtained from the p-value < 0.05. Values in bold are significant values.

Results of the chi-square test showed that gender (<0,001) and mother's occupation (<0,001) were significant. Meanwhile, other variables were not significant. For the cubic test results displayed in table 2, the significance values obtained in model 1, model 2, and model 4 were 0.045, 0.042, and 0.020, which showed significant results with the Z score BMI. However, for model 3, the results were insignificant with the Z BMI value because the significance value obtained was 0.052. The logistic regression statistical test results in table 3 showed the significance value (p-value) in each model of 0.044, 0.061, 0.047, and 0.024. Because  $p < 0.05$ , this means that model 1, model 3, and model 4 showed a significant value, while model 2 did not show a significant value.

The results of the cubic test were presented in the figure 1 where it can be seen that the line begins to rise at a sleep duration of fewer than 8 hours, then falls back to 8 to 9 hours of sleep duration and again experiences a high increase when sleep duration was 10 hours. These results showed an increase in the Z score BMI when sleep duration was less than 8 hours and a significant increase was more than 10 hours.

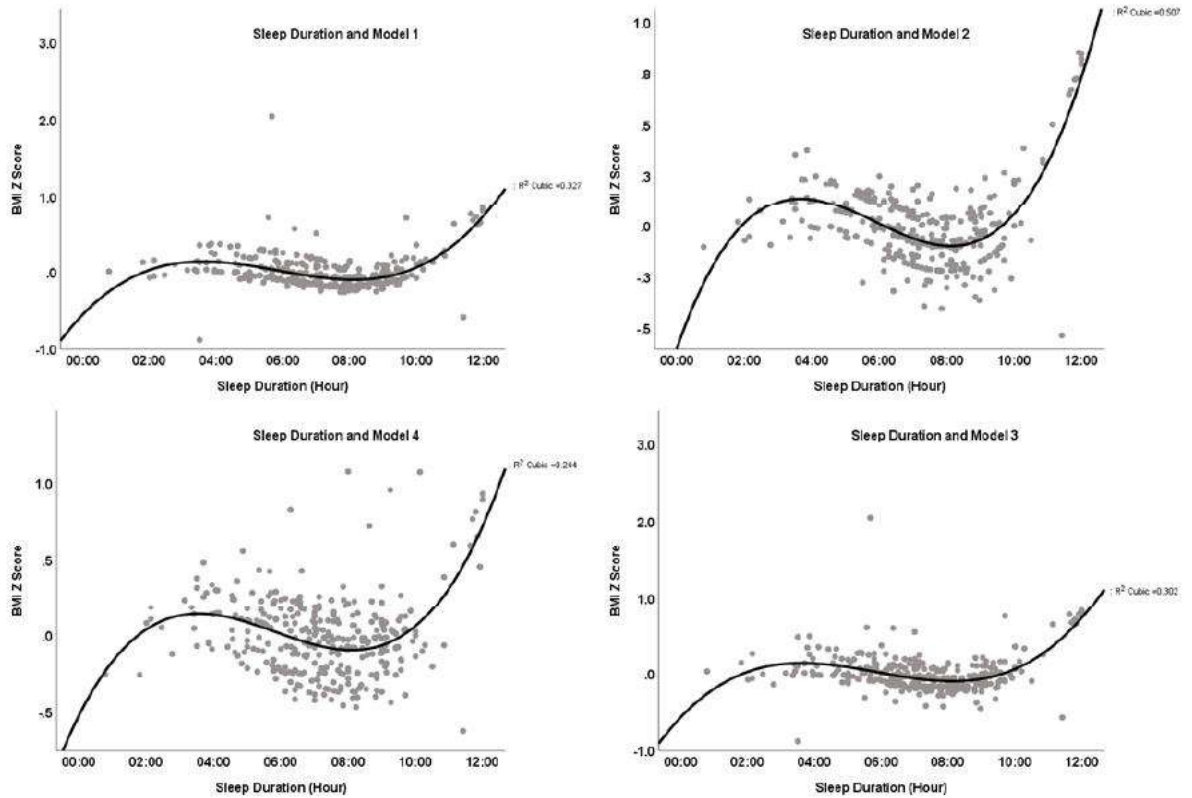


Figure 1. Sleep Duration and Z-Score BMI Each Model

## DISCUSSION

This study's main results indicate a relationship between sleep duration and breakfast routine on the nutritional status of adolescents during the COVID-19 pandemic. However, the relationship found between sleep duration and BMI Z value based on the Multicentre Growth Reference Study (MGRS) for sleep duration [31]. In addition, there is also a relationship between gender and mother's occupation with the nutritional status of adolescents.

In term of age, Salmela-Aro (2011) categorized adolescents into three, namely, early adolescents (11-13 years), middle adolescents (14-17 years), and late adolescents (17-19 years) [32]. Therefore, based on the results of this study, 90% of adolescents were included in the category of middle adolescents, and 10% were late adolescents. Drastic growth and development occur at that age, so the need for energy, vitamins, protein, and minerals increase significantly [20]

In the current study, the prevalence of overweight and obesity was 22.6% in adolescents aged 17-19 years. These results are very high compared to the results of previous studies, which found the prevalence of overweight and obesity in adolescents is 2.3% [33]. In the same age group, the prevalence of malnutrition was 13.2%, while the study by Roba et al. (2016) reports that 29.5% of adolescents have poor nutritional status [34]. These different results may be caused by different socio-economic backgrounds or ethnic differences in dietary behaviour [34, 35]. Strict diet patterns and over snack consumption can also make their nutritional intake unfulfilled and result in malnutrition [36]. While the reason why adolescents with overweight or obesity caused too much consuming fat and carbohydrate food and lack in physical activity [36].

Nutritional issues in adolescents might started during infant period and they also suffer from malnutrition during infant periods. Furthermore, the adolescent environment influences their nutritional status [37]. Nutritional issues in adolescents, such as undernutrition or obesity, can also be induced by an imbalanced adolescent nutritional intake [38]. Food consumption and weight gain in the 10 - 19 years age group are rising during the COVID-19 pandemic, potentially affecting their nutritional condition [39]. One can assume that this might be caused by a shift in behavior related to weight increase in the school-age group during the ongoing pandemic [40].

The respondents in this study were predominantly female, with the sex ratio between female and male being 2:1. Adolescents experience different sexual maturity between girls and boys, influencing their

nutritional needs [20]. Adolescent sexual maturity is related to hormonal changes, body composition, weight, and linear growth [20]. Gender determines a person's nutritional needs, where male adolescents have higher nutritional needs due to their higher physical activity than female adolescents [41]. Nutritional status in adolescents was found to have an association with gender on this study. This finding is in line with the results of a study conducted by Darling et al. (2020), which found a relationship between adolescent girls with a reduced risk of being underweight, but a high risk of being overweight [42]. Meanwhile, adolescent boys are associated with low body weight [42]. The difference between girls and boys is because girls have about twice as much fat as boys. After all, girls are prone to fat accumulation [43]. Research conducted by Maltoni et al. (2021) stated weight gain in adolescent boys during the COVID-19 pandemic [44].

Women from young to old, married or unmarried, have children or do not have children at this time have the ambition to work, so it is not uncommon to find a mother who has a dual role in a family [45]. However, during the COVID-19 pandemic, many mothers between the ages of 25 and 44 lost their jobs due to demands to care for their families [46]. This study found a relationship between a mother's work and adolescent nutritional status. However, the results of this study were different from previous studies, which reported no relationship between the mother's work and the nutritional status of students [47]. Adolescents with mothers who have employment status as homemakers are the most likely to have good adolescent nutritional status based on this study. Because homemakers have time to meet their children more often, mothers can pay more attention to their children's health [47].

This study found no significant association between father's occupation and adolescent nutritional status. This may be due to the status of mothers who are mostly housewives and the finding of a relationship between mother's occupation status and adolescent nutritional status, so that father's occupation does not show significant results. Meanwhile, a previous study states a significant relationship between fathers' work and adolescent nutritional status [48]. The type of father's occupation affects his income in which will affect the amount and food selection at home [48]. Income that only comes from one parent can hinder overweight in adolescents [49]. Family with low income might have some difficulties to provide and choose nutritious and diverse foods [50].

Sleep duration usually refers to the total amount of sleep gained, either during episodes of nocturnal sleep or over 24 hours [51]. Sleep is defined as a behavioral state characterized by rest, reduced environmental awareness, and immobility [52]. Different sleep times result from different lifestyles and jobs for each individual [52]. When sleep is of insufficient duration, it can disturb consciousness during the day and cause excessive experience sleepiness [52]. Adolescents often experience insufficient sleep duration can be caused by the adolescents deliberately reducing the duration of their sleep for other activities, such as attending parties, working, studying at night for exams [53]. Lack of sleep duration can cause individuals to experience hallucinations, mood swings, fatigue, irritability, impaired perception & orientation, and declining attention [52].

Based on this study, most adolescents had a total sleep duration of less than 8 hours, so this finding was in line with the results of the study by Sinha et al. (2020), which reported that the amount of sleep duration for adolescents during the COVID-19 pandemic is only 4-6 hours in a day [54]. It can be caused by adolescents who deliberately reduce their sleep duration, such as doing activities at night, studying, partying, or working [53]. These results did not meet the sleep needs of adolescents recommended by the Indonesian Ministry of Health in 2018, which is 8-9 hours of sleep duration in one day.

Previous research on sleep duration during the COVID-19 pandemic conducted in five cities (Seoul, Stockholm, London, Los Angeles, and New York) found that the average sleep duration of respondents is less than 8 hours [55]. This short sleep duration is due to increased stress during the COVID-19 pandemic [56]. During the COVID-19 pandemic, many adolescents experienced stress, making it hard for them to sleep at night. Stress and sleep quantity can also reduce sleep duration because during the COVID-19 pandemic, they rarely sleep at night, even though their sleep duration is only about 6 to 8 hours [57].

In addition, poor health can cause adolescents to sleep less than eight hours. Evidence by Panel et al. (2015) states that adolescent sleep duration of fewer than seven hours tends to have poor and low health and low physical and mental quality [58]. Likewise, Guo et al. (2021) state that an unhealthy lifestyle occurred during the COVID-19 pandemic among students at a high level of education [59]. Health problems such as obesity in adolescents, hypertension, diabetes, and cardiovascular disease can cause sleep duration shorter than eight hours [60]. Individuals who lack sleep can affect their long and medium-term performance (58). Short sleep duration can affect changes in sleep quality during the COVID-19 pandemic [61].

Research on sleep duration in America states that, on average, an adolescent sleep for 7.3 hours in one day [62]. This result is similar to the studies conducted in European and North American states, where the average adolescent sleep duration ranges from 7 to 9 hours on school days [63]. In addition, these results are also supported by research conducted in Africa, Asia, Central and South America, the Middle East, the Caribbean, and Oceania, which found that the sleep duration in 16-year-old adolescents is 7 hours [64].

This study found that 15.6% of adolescents had a sleep duration of more than 9 hours, while research conducted by AL-Haifi (2016) found that 24.85% of adolescents have more than 9 hours sleep duration, others found that almost 90% of adolescents have more than 7 hours sleep duration in one day [65, 66]. Adolescents with longer sleep duration can increase the risk of coronary heart disease and affect their mental health [67, 68].

This study showed that only 18.5% of adolescents met the adequacy of sleep duration, namely for 8-9 hours, while the majority (81.5%) did not meet the adequacy of sleep duration. As a comparison, previous research showed that 82.7% of adolescents met the adequacy of their sleep duration, while 17.2% did not meet the adequacy of their sleep duration [69]. Because other study were conducted before the COVID-19 pandemic while this study was conducted during the pandemic, so that makes results are different. Another reason is adolescents having a tough time maintaining and initiating sleep [70].

The bivariate analysis results showed no significant relationship between sleep duration and adolescent nutritional status during the COVID-19 pandemic. It is in line with the results of a previous study, which stated that there was no association between BMI and sleep duration in adolescence [71]. A study by Schneider et al. (2020) also found that there is no association between BMI and sleep duration in adolescent boys [72]. These results show that short sleep duration does not affect their nutritional status [73].

Sleep duration and nutritional status are not related because when adolescents stay up late, they do not always consume food or drink; it could also be that they are busy doing school assignments [73]. In addition, factors that directly affect nutritional status are food intake and infection, while sleep duration is an indirect factor affecting nutritional status [74]. The absence of this relationship can also be explained that sleep duration is not an independent factor. It can also be caused by other factors such as genetic factors and environmental factors [75].

The results of the cubic test analysis in this study found that adolescents whose sleep duration was more than 9 hours experienced a high increase in their BMI Z value, which was inversely proportional to the findings of Grandner et al. (2015) [76]. They found that a short sleep duration of less or equal to four hours is associated with high BMI Z values. This difference is because a non-linear relationship was found in the current study, while Grandner et al. (2015) found a linear relationship [76]. Lack of sleep duration is associated with unhealthy eating habits, such as more significant portions, increased hunger, increased appetite in high-calorie foods, and increased intake of sugary foods and drinks [77]. Children who experience sleep deprivation and lack healthy food have a high BMI z value [77].

Research from Italy states that adolescents with low or average weight tend to have longer sleep durations compared to adolescents who are overweight and obese [78]. The results of this study are in line with the results of this study, in which 70% of adolescents with low or normal nutritional status had a total sleep duration of more than nine hours compared to adolescents with overweight and obese status. Covariates effect such as lifestyle, diet, and physical activity on BMI can influence these outcomes, as can sample size, age group differences, and geographic and ethnic variations [79].

For breakfast, can be characterised as the first meal before or starting the activity two hours after waking up, usually, less than 10 am, with a calorie content of about 20% to 35% of the total daily energy adequacy [19]. This study found that 59.1% of adolescents did not regularly eat breakfast. These results align with Hermanto et al.'s (2020) research, which found that 70.4% of adolescents rarely eat breakfast [70]. Skipping breakfast is often done by adolescents and can reduce their nutrient intake [20].

Adolescents skip breakfast because there is no food available in their homes [22]. Husain & Ashkanani (2020) reported that during the COVID-19 pandemic, breakfast is often missed. Staying up late makes someone snack in the middle of the night, and excessive sleep is the reason for skipping breakfast [80]. Other reasons adolescents skip breakfast are lack of appetite, no time, difficult to make a food, and religious reasons [81]. These results are inversely proportional to the research conducted by Sidor & Rzymiski (2020), who stated that 65.5% of respondents had breakfast every day [82].

A total of 131 adolescents who did not regularly take breakfast has good nutritional status, while adolescents who regularly eat breakfast with good nutritional status are 102 respondents. Based on this study,



adolescents who did not regularly eat breakfast tend to have good nutritional status during the COVID-19 pandemic. It can be due to other factors related to good nutritional status, such as physical activity. Adolescents who are physically active during the COVID-19 pandemic tend to have normal nutritional status [83]. In addition, the intake of energy, carbohydrates, and protein also affects the nutritional status of adolescents [84]. Therefore, there is a possibility that adolescents have good nutritional status but do not regularly eat breakfast.

The bivariate analysis results in this study showed no correlation between breakfast routine and nutritional status. A previous study by Kurniawan (2020) show no relationship between breakfast routines and nutritional status [85]. A typical breakfast cannot determine a person's nutritional status because the total energy requirement obtained from breakfast food is only 25% [38]. So, a balance breakfast menu is needed to fulfill the daily nutritional intake [86]. Previous studies demonstrated that there is no association between breakfast habits and the nutritional status in high school students [85, 87]. Food quality and quantity such as large portions, nutritional value, and food varieties affect a person's nutritional status rather than solely breakfast behavior [88].

This study found a linear relationship between breakfast routine and nutritional status in adolescents. Nutritional status is a balance between nutrient intake from food and the nutritional needs needed for body metabolism [2]. Data analysis using logistic regression tests found an association between breakfast routines and nutritional status in adolescents. This finding aligns with Amalia & Adriani (2019), which found an association between breakfast routines and nutritional status [89]. Research conducted on European and Brazilian adolescents found that skipping breakfast leads to obesity in adolescents [90]. Similarly, a study in Bangladesh and India demonstrated that skipping breakfast significantly correlates with being overweight [91]. However, research from Zagreb, Croatia, states that adolescent girls who eat breakfast have a higher incidence of obesity [92].

Adolescents who skip breakfast tend to have increased blood sugar levels, fatigue, declined concentration, and experience a decrease in physical and mental conditions [93]. Breakfast can improve cognitive performance, as the adolescents will not be disturbed by hunger and affect memory [94]. A previous study have reported that skipping breakfast is associated with an increased risk of obesity by 1.75 times than eating breakfast regularly [19].

During the COVID-19 pandemic, adolescents increase their breakfast and unhealthy food/drinks consumption, resulting in weight gain that affects their nutritional status [95]. Beside excessive breakfast, skipping breakfast can also increase the energy intake obtained when adolescents consume snacks to replace breakfast [96]. Another explanation is that adolescents who skip breakfast during the COVID-19 pandemic are caused by waking up at night, leading to snacking in the middle of the night and also excessive sleep the next day, which can lead to overweight and obesity [80]. Another study conducted in South Korea stated that in general breakfast consumption in adolescent during the pandemic COVID-19 is higher than before the pandemic. During the pandemic period, adolescents have a lot of free time to eat at home, the ban on going out causes adolescents to have a lot of time to eating or snacking at home [97]. Also, a study showed that during a pandemic there are some people who skip breakfast, which can affect their quality of life [98].

## **CONCLUSION**

In a nutshell, there was an association between sleep duration and breakfast routine with adolescent nutritional status. The findings indicated that many adolescents had less than 8 hours of sleep duration and a lack of breakfast routines. However, more than half of adolescents had good nutritional status. Adolescents are advised to get enough sleep duration as recommended and to have breakfast every day and maintain it during the COVID-19 pandemic.

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## Effects of Sorghum Cookies (*Sorghum Bicolor L. Moench*) on Fasting Glucose, Triglyceride, High-Density Lipoprotein level, and Body Fat Percentage in Adolescent Obesity

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### ABSTRACT

**Background:** Adolescent obesity is related to the risk of metabolic syndrome. Several studies have proven the effect of dietary interventions on metabolic parameters in obese individuals. A source of complex carbohydrates that is still rarely developed in the obese diet is sorghum which contains resistant starch.

**Objective:** The study was to reveal the effect of sorghum cookies on Fasting Glucose (FG), Triglycerides (TG), High-Density Lipoprotein (HDL), and Body Fat Percentage (BFP) in obese adolescents.

**Materials and Methods:** This quasi-experiment with the pre-post control-group design was conducted on 20 boys and 20 girls (divided into 10-boy control group, 10-girl control group, 10-girl intervention group, and 10-girls intervention group) with the age range of 13–15 years who attended Junior High School 14 Semarang chosen by consecutive sampling. Weight, Height, and BFP were measured directly by BIA. Metabolic parameters (FG, TG, and HDL levels) were taken through venous and 10-hour fasting. Energy intake and physical activity were taken by interview using the food recall questionnaire for 6 days randomly and IPAQ. The intervention of sorghum cookies was given in 90 grams/day with 473 kcal/day for 28 days. The analysis of the effect of the intervention was conducted by a paired t-test and independent t-test.

**Results:** At 28-days sorghum cookies intervention resulted in lower levels of FG, TG, and BFP in the intervention boy group ( $p < 0.05$ ) and BFP in the girl group ( $p < 0.05$ ). The intervention of sorghum cookies showed no effect on HDL levels in boys, and it did not affect FG, TG, or HDL levels of the girl subjects ( $p > 0.05$ ).

**Conclusion:** Obese adolescents who had been receiving intervention of 90 grams of sorghum cookies for 28 days appeared to have lower levels of fasting glucose, triglycerides, and body fat percentage.

**Keywords:** Sorghum, Fasting Glucose, Triglycerides, HDL, Body Fat Percentage

### BACKGROUND

Adolescents are particularly susceptible to obesity due to various factors. The body's rapid growth and development necessitates more energy and nutrients. Changes in lifestyle and eating habits will have an impact on nutritional intakes, such as lack of fruits and vegetable intake and frequent intake of fatty and high sugar foods<sup>1</sup>. According to the data of Riskesdas 2018, the prevalence of obese adolescents in Indonesia has reached 16%. Central Java Province has a prevalence of obese adolescents of 11.19%, and Semarang City has a prevalence of obese adolescents of 11.09%.<sup>2</sup>

One type of Cerealia in intervention therapy for obesity is sorghum. Furthermore, sorghum is an alternative local food as it has a low glycemic index of 43 which is much lower than that of white rice of 82.<sup>3</sup> The low glycemic index is due to the contribution of high fiber content. Fiber can slow down the rate of food in the gastrointestinal tract and inhibit the activity of digestive enzymes so that it can control blood glucose.<sup>4</sup> Meanwhile, the mechanism of fiber in reducing fat absorption is by binding to fatty acids, cholesterol, and bile salt in the gastrointestinal tract. Fatty acids and cholesterol that are bound to fibers cannot form micelle which is needed for fat absorption to pass through unstirred water layers into enterocytes. As a result, the fat that binds to the fiber cannot be absorbed and will go to the large intestine to be removed with faeces or degraded

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by intestinal bacteria. In addition, fiber is also able to slow down gastric emptying and change gastric peristalsis, causing longer satiety so that appetite can be controlled.<sup>5</sup>

The food product that was administrated is sorghum cookies. The main ingredient of cookies is 60 g of sorghum flour processed with egg yolks, palm oil, glucose, flour, and skim milk. After it was baked, the total weight of the cookies was 90 g. Cookies were distributed in the morning, afternoon, and evening (3 times a day). Daily serving could replace 473 calories per day or 25% of total calories for boy adolescents and 30.5% for girl adolescents.<sup>6</sup>

Polysaccharides in sorghum are resistant starches that function as prebiotics. In 90 g of sorghum cookies, there is 2.43% of resistant starch. Processing cookies with heating and cooling can enhance resistant starch levels by up to 9%.<sup>7</sup> This starch is difficult to digest in the small intestine and to be fermented by bacteria in the large intestine. The fermentation results in the form of SCFA (Short-Chain Fatty Acid) act as a key regulator to modulate intestinal integrity, energy homeostasis, anti-inflammatory, control glycemc and insulin response, and improve blood lipid profile.<sup>8</sup> In the previous study, Olawole *et al.* showed that giving sorghum flour concentration to a cake could inhibit the activity of  $\alpha$ -amylase and  $\alpha$ -glucosidase which could reduce glucose levels.<sup>9</sup> According to Shen *et al.*, Sorghum resistant starch can inhibit the increase in triglycerides, cholesterol, LDL, and increase HDL levels in someone with metabolic fat disorders. This resistant starch cannot be digested in the small intestine and then fermented by bacteria in the large intestine. The fermentation product in the form of SCFA (Short Chain Fatty Acid) plays a role in reducing blood cholesterol and increasing the volume of faeces and changing the number of bacterial microbiota populations.<sup>10</sup> Therefore, the researchers examined the effect of sorghum cookies on fasting glucose, TG, HDL, and body fat percentage in obese adolescents.

## MATERIALS AND METHODS

The design of this study is a quasi-experiment with a pre-post control-group design. The study was conducted in October 2021 in Semarang City and has received ethical clearance from the Semarang State University (UNNES) Health Research Ethics Committee No. 153/EC/KEPK/2021. Sampling was carried out by non-probability sampling with a purposive sampling technique.<sup>11</sup> The minimum sample size was calculated by  $X1-X2 = 10.5$ ;  $Z\alpha + Z\beta = 2.92$ ;  $\alpha = 0.05$ , so the total subject in a group was 10, and the total in 4 groups was 40. The groups were divided into a 10-boy control group, 10-girl control group, 10-girl intervention group, and 10-girls intervention group. Inclusion criteria included adolescents aged 13–15 years, having Z-score BMI/Age  $\geq 2SD$ , not consuming diet supplements or drugs, having no history of degenerative diseases, and being willing to fill in informed consent. Exclusion criteria included quitting during the study.

Data retrieval was conducted during the Covid-19 pandemic so that it obeyed the health protocol. The researchers and enumerators in charge of data retrieval wore masks and always washed their hands with soap before and after collecting the data from each subject. The subjects were also required to wear masks and use hand sanitisers. Anthropometry tools were cleaned using 70% alcohol at each subject change. Height data were measured using GEA microtoice with 0.1 cm accuracy, body weight was measured using Omron digital scale with 0.01 kg accuracy, and per cent body fat was measured using Bioimpedance Analysis (BIA, *Omron Karada HBF-375*) with 0.1% accuracy. The independent variable in this study was the intervention of sorghum cookies as much as 90 grams per day given as morning, afternoon, and evening snacks. The nutrient contents of sorghum cookies are listed in Table 1.

Table 1. Nutrient Content of Sorghum Cookies

Ingredient	Total (gr)	Energy (ca	Protein (gr	Fat (gr)	Carbohydrate (g	Fiber (gr)
Sorghum flour	60	199.2	6.2	1.8	44.2	7.6
Wheat flour	10	36.4	1.0	0.1	7.6	0.3
Palm oil	12	103.4	0	12	0	0
Egg yolk	10	27.8	1.9	2.1	0.2	0
Skimmed milk powe	10	36.8	3.6	0.2	5.2	0
Sugar	18	69.7	0	0	18	0
Total		<b>473</b>	12.7	16.2	75.2	7.9

Source: Center for Food and Nutrition Laboratory Gajah Mada University

Metabolic parameters were taken through vein blood vessels with 10-hour fasting. The blood specimen analysis was conducted at Diponegoro National Hospital Laboratory. FG levels are high if they are  $\geq 110$  mg/dl.<sup>12</sup> Triglyceride levels are high when they are  $\geq 150$  mg/dl, and HDL levels are low for boys when they



are < 45mg/dl; whereas, HDL levels are low for girls if they are < 50 mg/dl.<sup>12</sup> Percent of body fat was measured by the position of the subject rising to the top of the foot unit (without any footwear) attached to the leg electrodes. The hands were stretched forward to form an angle of 90° standing upright holding the hand electrode using the BIA Omron Karada HBF-375. The high BFP category for boys is ≥ 25%, for girls ≥ 30%.<sup>12</sup> The confounding variables in this study included gender, energy intake, and physical activity. Gender is a biological difference between boys and girls. Energy intake is the number of calories consumed from all types of food and drinks. Intake data were taken through 6-time interviews in 6 intermittent days with a food recall questionnaire and processed with Nutrisurvey using Windows software. Physical activity is a body movement that results in energy expenditure. The intervention of physical activity was jogging and skipping 5 times a week. Data on physical activity were taken through interviews on physical activity during the last 7 days using the International Physical Activity Questionnaire (IPAQ) instrument. IPAQ consists of 7 questions including the type, frequency, and duration.<sup>13</sup>

The data analysis using SPSS 23.0 computer software included univariate analysis, paired test (paired t-test), and unpaired different test (independent t-test). The univariate analysis looked at the distribution and normality of the data using the Shapiro Wilk test. Paired difference test aims to see the difference before and after intervention in each group on FG, TG, HDL, and BFP using paired t-test if the data are normally distributed, and the Wilcoxon test is used if the data are not normally distributed. Unpaired difference test aims to see differences in the results of FG, TG, HDL, and BFP between groups using the independent t-test if the data are normally distributed, and the Mann Whitney test is used if the data are not normally distributed.<sup>14</sup>

## RESULTS

### Subject Characteristics

A total of 40 subjects who met the inclusion criteria in the age range of 13–15 years were evenly divided into 4 groups, namely the boy and girl in the control group, boy and girl in the intervention group. The mean values (±SD) of the subjects was shown in Table 2.

Table 2. The Baseline Characteristics of Subjects

Variables	Boys		Girls	
	Control (n=10)	Intervention (n=10)	Control (n=10)	Intervention (n=10)
Body Weight (kg)	85.21±12.87	85.83±13.76	75.86±8.87	76.15±9.12
Z-score (SD)	2.96±0.44	2.98±0.47	2.45±0.29	2.48±0.24
Energy Intake (kcal)	2,454.50±39.90	2,460.50±35.31	2,092±308.58	2,147.50±27,40
Physical Activity (METs)	367.60±80.64	362.40±91.50	435.20±52.53	443.20±61.66
Fasting Glucose (mg/dl)	87.30±6.21	88.40±7.47	86.70±9.60	89.50±10.90
Triglyceride (mg/dl)	133.60±33.96	130.50±38.75	151.30±26.83	148.00±27.83
HDL (mg/dl)	38.20±7.44	38.60±10.07	39.90±4.36	42.10±5.94
Body Fat Percentage (%)	33.43±2.92	32.96±3.09	33.43±1.86	32.90±3.00

Table 2 showed the overall characteristics of the subjects by gender. Body weights in the boy group were higher than in the girl group. Z-Score increased simultaneously with energy intake. Low physical activity was found in both groups. Although the participants were mildly obese, they did not have impaired fasting glucose and TG but were low in HDL levels. A high body fat percentage was found in boys and girls.

### Differences in Body Weight (BW) between Pre- and Post-Interventions

Based on the Wilcoxon test, the boy control group showed no difference in the results of pre- and post-interventions (p = 0.443). In the boy intervention group, there was a significant difference (p= 0.005) with a decrease in BW (Δ) of 2.47±1.03 kg. Mann-Whitney test in the boy control and intervention groups showed no differences (p = 0.450) as shown in Table 3.

Table 3. Body Weights of Boy and Girl Groups

Groups	Boys			Girls		
	Pre(Mean±SD)	Post(Mean±SD)	p	Pre (Mean±SD)	Post(Mean±SD)	p
Control	80.05±13.57	80.05±13.23	0.443	75.86±9.35	75.71±9.17	0.288
Intervention	80.60±14.50	77.70±14.01	0.005*	76.15±9.61	73.68±9.82	0.001*
p <sup>1</sup>		0.450			0.639	

$p$  = Analyzed by Wilcoxon test

$p^1$  = Analyzed by Mann-Whitney test

\* =  $p < 0.05$  (significant)

Changes in body weight in the girl control group based on the paired test showed no different results between pre- and post-interventions ( $p = 0.288$ ). Meanwhile, the intervention group showed a significant difference ( $p = 0.001$ ) with a decrease in BW ( $\Delta$ ) of  $2.47 \pm 0.77$  kg. The Mann-Whitney test showed no significant BW difference between the girl control and intervention groups ( $p = 0.639$ ).

### Differences in Z-scores of BMI/Ages between Pre- and Post-Interventions

The Wilcoxon test results for the Z-score BMI/Age value in the boy control group showed no difference between pre- and post-intervention ( $p = 0.234$ ). Meanwhile, the intervention group showed a significant difference ( $p = 0.005$ ) with a decrease of ( $\Delta$ ) Z-Score BMI/Age of  $0.13 \text{ SD} \pm 0.04 \text{ kg/m}^2$ . According to the Mann-Whitney test, there was no difference in the BMI/Age Z-scores between the boy control and intervention groups ( $p = 0.496$ ) as shown in Table 4.

**Table 4. Changes of Z-Score in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre(Mean $\pm$ SD)	Post(Mean $\pm$ SD)	$p$	Pre (Mean $\pm$ SD)	Post(Mean $\pm$ SD)	$p$
Control	2,845 $\pm$ 0.46	2.840 $\pm$ 0.45	0.234	2.45 $\pm$ 0.30	2.44 $\pm$ 0.31	0.247
Intervention	2.76 $\pm$ 0.49	2.65 $\pm$ 0.48	0.005*	2.48 $\pm$ 0.25	2.36 $\pm$ 0.27	0.001*
$p^1$		0.496			0.546	

$p$  = Analyzed by Wilcoxon test

$p^1$  = Analyzed by Mann-Whitney test

\* =  $p$  value  $< 0.05$  (significant)

The results of the Wilcoxon test in the girl control group showed no difference between pre- and post-interventions ( $p = 0.247$ ). The girl intervention group showed a significant difference ( $p = 0.001$ ) with a decrease in Z-Score of BMI/Age of  $0.12 \pm 0.05 \text{ kg/m}^2$ . Based on the Mann-Whitney test, there was no difference in the Z-scores between the girl control and intervention groups ( $p = 0.546$ ) as shown in Table 4.

### Differences in Energy Intakes (EI) between Pre- and Post-Interventions

Wilcoxon test results in the boy control group showed significant differences between pre- and post-interventions ( $p = 0.007$ ). For the intervention group, there was a significant difference ( $p = 0.005$ ) with a decrease ( $\Delta$ ) of per day energy of  $558 \pm 76.41$  kcal. According to the Mann-Whitney test, there were significant differences between the boy control and intervention groups ( $p = 0.001$ ) as contained in Table 5.

**Table 5. Changes in Energy Intake in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre(Mean $\pm$ SD)	Post(Mean $\pm$ SD)	$p$	Pre(Mean $\pm$ SD)	Post (Mean $\pm$ SD)	$p$
Control	2450,00 $\pm$ 42,00	2325,00 $\pm$ 100.50	0.007*	2167.50 $\pm$ 325,00	2150,00 $\pm$ 127.64	0.332
Intervention	2460,00 $\pm$ 37.22	1910,00 $\pm$ 79.38	0.005*	2150,00 $\pm$ 28.89	1562.50 $\pm$ 35.74	0.005*
$p^1$		0.001*			0,001*	

$p$  = Analyzed by Wilcoxon test

$p^1$  = Analyzed by Mann-Whitney test

\* =  $p$  value  $< 0.05$  (significant)

The girl group, based on the results of the control group's Wilcoxon test, showed no difference between pre- and post-interventions ( $p = 0.332$ ). The intervention group showed a significant difference ( $p = 0.005$ ) with a decrease ( $\Delta$ ) of per day energy of  $587.5 \pm 52.45$  kcal. Based on the Mann-Whitney test, there were significant differences between the girl control and intervention groups ( $p = 0.001$ ) as contained in Table 5.

### Differences in Physical Activities (PA) between Pre- and Post-Interventions

Wilcoxon test results in the boy control group showed no difference between pre- and post-interventions ( $p = 0.284$ ). The boy intervention group showed a significant difference ( $p = 0.005$ ) with an increase in IPAQ scores ( $\Delta$ ) of  $271.1 \pm 81.63$  METs. Based on the Mann-Whitney test, there were significant differences between the boy control and intervention groups ( $p = 0.001$ ) contained in Table 6.

**Table 6. Changes in Physical Activity in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean $\pm$ SD)	Post (Mean $\pm$ SD)	$p$	Pre (Mean $\pm$ SD)	Post (Mean $\pm$ SD)	$p$
Control	372.50 $\pm$ 85.00	390,00 $\pm$ 87.36	0.284	420,00 $\pm$ 55.36	457.50 $\pm$ 70.31	0.066
Intervention	360.50 $\pm$ 96.45	631.50 $\pm$ 25.17	0.005*	446.50 $\pm$ 65.00	651.50 $\pm$ 25.92	0.005*
$p^1$		0.001*			0,001*	

$p$  = Analyzed by Wilcoxon test

$p^l$  = Analyzed by Mann-Whitney test  
 \* =  $p$  value < 0.05 (significant)

The results of the Wilcoxon test in the girl control group showed no difference between pre- and post-interventions ( $p = 0.066$ ). The girl intervention group showed a significant difference ( $p = 0.005$ ) with an increase in AF ( $\Delta$ ) scores of  $203.7 \pm 44.46$  METs. Based on the Mann-Whitney test, there was a significant difference in the AF values between the girl control and intervention groups ( $p = 0.001$ ) as shown in Table 6.

**Differences in Fasting Glucose (FG) between Pre- and Post-Interventions**

The results of the paired t-test test in the boy control group showed no difference between pre- and post-interventions ( $p = 0.84$ ). This is in contrast with the intervention group that had a significant difference ( $p = 0.004$ ). Based on the independent t-test, there were significant differences in FG levels between the boy control and intervention groups ( $p = 0.045$ ) as shown in Table 7.

**Table 7. Changes in Fasting Glucose (FG) in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SD)	$p$	Pre (Mean±SD)	Post (Mean±SD)	$p$
Control	87.30±6.54	87.10±5.52	0.840	86.70±10.13	85.90±8.19	0.380
Intervention	88.40±7.87	82.40±4.03	0.004*	89.50±11.49	81.70±5.01	0.008*
$p^l$		0.045*			0.187	

$p$  = Analyzed by Paired T-Test  
 $p^l$  = Analyzed by Independent T-Test  
 \* =  $p$  value < 0.05 (significant)

The results of the paired t-test test on the girl control group showed no difference between pre- and post-interventions ( $p = 0.38$ ). It is different from the girl intervention group which showed a significant difference ( $p = 0.008$ ). Based on the independent t-test analysis, there was no significant difference in FG levels between the girl control and intervention groups ( $p = 0.187$ ) as shown in Table 7.

**Differences in TG Levels between Pre- and Post-Interventions**

The results of the paired t-test test in the boy control group showed no difference between pre- and post-interventions ( $p = 0.052$ ). This is in contrast with the intervention group that had a significant difference ( $p = 0.005$ ). Based on the independent t-test, there were significant differences in TG levels between the boy control and intervention groups ( $p = 0.013$ ) as shown in Table 8.

**Table 8. Changes in Triglyceride Levels in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SD)	$p$	Pre (Mean±SD)	Post (Mean±SD)	$p$
Control	121.50±35.79	127.50±30.37	0.052	151.30±28.28	150.20±22.99	0.682
Intervention	114.50±40.85	91.00±41.90	0.005*	148.00±29.33	126.20±30.78	0.001*
$p^l$		0.013*			0.064	

$p$  = Analyzed by Wilcoxon test  
 $p^l$  = Analyzed by Mann-Whitney test  
 \* =  $p$  value < 0.05 (significant)

Based on the paired t-test analysis, the girl control group showed no difference between pre- and post-interventions ( $p = 0.682$ ). It is different from the girl intervention group which showed a significant difference ( $p = 0.001$ ). Based on the independent t-test, there was no significant difference in TG levels between the girl control and intervention groups ( $p = 0.064$ ) as shown in Table 8.

**Differences in HDL Levels of Pre- and Post-Intervention**

The results of the paired t-test analysis on the boy control and intervention groups showed no difference between pre- and post-interventions ( $p = 0.664$ ;  $p = 0.089$ ). Based on the independent t-test, there was no difference between the two boy groups ( $p = 0.505$ ) as shown in Table 9.

**Table 9. Changes in HDL Levels in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SD)	$p$	Pre (Mean±SD)	Post (Mean±SD)	$p$
Control	38.20±7.84	37.90±6.50	0.664	39.90±4.60	37.90±4.09	0.060
Intervention	38.60±10.61	35.90±6.64	0.089	42.10±6.26	38.40±3.34	0.012*
$p^l$		0.505			0.768	

$p$  = Analyzed by Paired T-Test  
 $p^l$  = Analyzed by Independent T-Test  
 \* =  $p$  value < 0.05 (significant)

The girl control group, based on the paired t-test analysis, showed no difference between pre- and post-interventions ( $p = 0.060$ ). Meanwhile, the girl intervention group showed a significant difference ( $p = 0.012$ ). Based on the independent t-test analysis, there was no difference in HDL levels between the girl control and intervention groups ( $p = 0.768$ ) as shown in Table 9.

### Differences in Body Fat Percentage (BFP) between Pre- and Post-Interventions

Paired t-test analysis results in the boy control group showed no difference between pre- and post-interventions ( $p = 0.882$ ). The intervention group showed a significant difference ( $p = 0.001$ ). Based on the independent t-test analysis, there were significant differences in BFP between the boy control and intervention groups after the intervention of sorghum cookies ( $p = 0.001$ ) as shown in Table 10.

**Table 10. Changes in Body Fat Percentage (BFP) in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SI)	<i>p</i>	Pre (Mean±SD)	Post (Mean±SD)	<i>p</i>
Control	33.43±3.08	33.37±2.41	0.882	33.43±1.96	33.17±1.96	0.166
Intervention	32.96±3.26	27.31±3.19	0.001*	32.90±3.17	28.52±2.70	0.001*
<i>p</i> <sup>1</sup>		0.001*			0.001*	

*p* = Analyzed by Paired T-Test

*p*<sup>1</sup> = Analyzed by Independent T-Test

\* = *p* value < 0.05 (significant)

The girl control group, based on the paired t-test analysis, had no difference between pre- and post-interventions ( $p = 0.166$ ). It is different from the girl intervention group which showed a significant difference ( $p = 0.001$ ). The independent t-test analysis showed a significant difference in the values of BFP between the girl control and intervention groups ( $p = 0.001$ ) as shown in Table 10.

## DISCUSSION

This study observed the effect of the difference in the intervention of 90 grams of sorghum cookies for consecutive 28 days on fasting glucose (FG), Triglyceride (TG), HDL, and Body Fat Percentage (BFP) on obese adolescents. It was found that the intervention of sorghum cookies could reduce FG, TG, and BFP in the boy group, and it reduced BFP in the girl group ( $p < 0.05$ ). Before the treatment, both groups were homogeneous, so the change in all parameters values was due to the sorghum intervention.

The intervention of sorghum cookies could decrease the bodyweight of both intervention groups because sorghum cookies contain 7.9 g of fiber and 2.43 g of resistant starch. They are used as a snack with low calories but contain soluble and insoluble fibers with a longer satiety effect so that weight loss can slowly be achieved. Fiber cannot be absorbed in the small intestine and would absorb water and form a gel in the stomach. Fiber could prolong transit time in the stomach and felt full longer.<sup>10</sup> In addition, the influencing factor was the addition of physical activity with jogging and skipping.

Z-scores of BMI/age parameter decreased after intervention in the treatment group. It was because the Z-scores decreased simultaneously with weight loss. It caused decreasing body fat and more energy expenditure. There were significant differences in energy intakes in both boy and girl groups ( $p = 0.001$ ;  $p = 0.001$ ) to reduce energy in the intervention group by 500 calories/day. This is under the recommendation of a maximum weight loss of 2 kg/month or 500 g/week by reducing energy intake to 500 kcal/day.<sup>15</sup>

Differences were observed in the physical activity of the intervention group derived from the physical activity program for 150 minutes/week. Jogging for 25 minutes and skipping for 5 minutes were done regularly 5 times a week. The physical activity aims to create a balance between the energy obtained and the energy released by the body. For obese adolescents, this creates a negative energy balance that can lose weight.<sup>16</sup> Physical activity that could increase energy export meets the criteria of frequency, intensity, type, and duration. Physical activity has a frequency in how often the activity is conducted. Usually, the frequency of training in the week ranges from 3 to 5 times and depends on the individual condition. The intensity was how hard an activity was conducted. It was usually classified into low, medium, and high intensity. In the initial stages, it should be done with moderate intensity (64–76% of the maximal heart rate) and increased as time goes by. Time refers to how long activity was conducted in one meeting. Usually, the intensity was 30–60 minutes for each exercise. Types of activities refer to the types of physical activities carried out such as walking, jogging, biking, swimming, and so on.<sup>17</sup>

Differences in FG levels after intervention in the boy group were influenced by the content of sorghum including soluble fiber and resistant starch. Resistance starch makes a lower sorghum glycemic index than

rice. Resistant starch cannot be absorbed by digestive enzymes, and resistant starch metabolic processes occur 5–7 hours after consumption. Hence, the water-soluble fiber contained in sorghum will absorb water and form a gel in the stomach that can extend gastric emptying.<sup>7</sup> Fermentation occurs in the large intestine that produces Short-Chain Fatty Acid (SCFA). As a result, these fatty acids will return to the bloodstream and could inhibit the use of glucose by body tissues for a long time, thereby increasing peripheral insulin sensitivity. It causes a decrease in blood glucose levels and improvement of insulin resistance. This finding is in line with previous research that sorghum flour can reduce fasting glucose and improve insulin sensitivity ( $p \leq 0.05$ ).<sup>4</sup>

There was a difference in TG levels between the boy control and intervention groups after the intervention ( $p = 0.013$ ), but there was no difference in the girl groups ( $p = 0.064$ ). The decrement in TG levels due to the presence of starch content in sorghum acts as a prebiotic that induces changes in intestinal microbiota. Resistant starch that cannot be digested in the colon will be fermented to produce SCFA. SCFA production will encourage the expression of pro-glucagon and increase the production of Glucagon Like Peptide-1 (GLP 1). GLP 1 was known as an intestinal hormone secreted by L ileum cells and suppresses hepatic lipogenesis through activation of the Adenosine Monophosphate Protein Kinase (AMPK) pathway.<sup>18</sup> AMPK is an energy metabolism regulatory enzyme that works by inhibiting the pathway of anabolism and stimulating the path of catabolism (metabolic homeostasis). Activation of the AMPK pathway that can reduce hepatic lipogenesis can reduce serum triglyceride levels. Based on previous studies, sorghum flour can reduce the number of adipose cells that express Peroxisome Proliferators-Activated Receptors (PPAR- $\gamma$ ). PPAR- $\gamma$  plays a role in the storage of fatty acids in adipose cells.<sup>19</sup>

There are no differences in HDL levels between the control and intervention groups in boys and girls after the intervention ( $p = 0.505$ ;  $p = 0.768$ ). This is estimated because the effects of dietary foods can affect HDL levels requiring 6–8 weeks.<sup>20</sup> The importance of increasing HDL-c cholesterol in a person with obesity is because HDL-c cholesterol functions to bring excess cholesterol into blood vessels and transport it to the liver for further metabolism. Improved HDL-c can be done by increasing physical exercise with the principle of FITT (frequency, intensity, type, time). Improved HDL-c by increasing physical exercise with the FITT principle requires 3 to 6 months.<sup>20</sup>

Differences in BFP changes based on the independent t-test between the control and intervention groups of boy and girl adolescents ( $p = 0.001$ ). A decrease in BFP caused by the consumption of sorghum cookies for 28 days can increase the intake of complex carbohydrates and fibers and reduce body fat in someone with obesity. This is similar to previous studies of the correlation of intervention of 40 grams of sorghum per day in 8 weeks to decrease body fat ( $p \leq 0.05$ ).<sup>21</sup> Another study found that a low-calorie diet in the second week could decrease fat by 50–70% due to fatty acid oxidation.<sup>22</sup>

## CONCLUSION

The intervention of 90 g/day of sorghum cookies for 28 days reduces fasting blood glucose, triglycerides, and percent body fat in the boy group, and it reduces percent body fat in the girl group ( $p < 0.05$ ).

## SUGGESTION

Additional duration of dietary intervention and physical activity is needed as it will affect HDL level changes which need 3–6 months.

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## Improvement of Students and Snack Vendors Behavior After Received Health Promotion Program from UKS's Cadres

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### ABSTRACT

**Background:** School Health Program or UKS aims to improve students learning achievement by improving their health status including the fulfillment of nutrition so that they can grow and develop optimally. The nutritional problems of school-age children in Indonesia, according to Riskesdas 2018 data, are children with the short/stunting category reaching 30.7%, while those who are obese are 8% and anemic 26%. Nutritional problems in school children will affect the quality of human resources in the future.

**Objectives:** This study examined the effect of promoting healthy and safe snacks by UKS's cadres on increasing knowledge, attitudes, behavior of students and snack sellers.

**Materials and Methods:** The first stage of research was training elementary school students UKS's cadres who will become educators on promoting healthy and safe food consumption behavior. The second stage was assessed to 360 randomly selected students and 94 school vendors in 12 different schools. The intervention schools received a package of promotions delivered by UKS's cadres while the comparison group received the poster. Data on knowledge, attitudes, behavior of students and food sellers were collected using a questionnaire instrument. The data were collected by the researchers assisted by 12 enumerators, 6 research field assistants and 12 teachers in charge of the research field. Bivariate analysis using t-test, Wilcoxon test, and Mann Whitney test were used to assess the differences between the groups.

**Results:** After intervention by UKS's cadres, there was a change in students' knowledge of 51.1% for knowledge of healthy snacks, 52.8% about safe snacks, 82.8% about formalin, 62.8% about borax, and 75.6% about Rhodamine B. Changes in the behavior of snack sellers, the highest percentage of changes in holding food with tools is 62.5% and not holding food after holding money is 54.2%. Increased change were significantly higher in the intervention groups than the comparison group ( $p < 0.05$ ).

**Conclusion:** The UKS's cadres as trained peer-educators could significantly improve safe and healthy food behavior of students as well as knowledge of snack school vendors. UKS's cadres as promoters of healthy and safe snacks can be used as a mandatory UKS program in school to achieve food safety for school children

**Keywords:** School health program; elementary school; trained students; street vendors; food safety; peer educators

### BACKGROUND

The nutritional problems of school-age children in Indonesia, according to Riskesdas 2018 data, are children with the short/stunting category reaching 30.7%, while those who are obese are 8% and anemic 26%. Nutritional problems in school children will affect the quality of human resources in the future [1]. Quality human resources in the school environment can be realized by providing food that will be consumed by the school community in safe, quality, and nutritious conditions. The food consumed by the school community can be in the form of snack food available in the school environment or snack food outside the school environment. The food currently circulating, including food sold in school canteens and/or in the school environment, is food produced by the food industry, including the food home industry and food produced by catering services which are called ready-to-eat food. The safety and quality of food products circulating in the

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school environment are determined by school policies, the level of knowledge and concern of school canteen managers and food vendors around the school environment [2].

Law No. 36 of 2009 concerning health has mandated efforts to improve nutrition to improve the nutritional quality of individuals and communities. Fulfilling the nutritional adequacy of children can be through breakfast and snacks for children who have not had breakfast. In 2017 there were 53 extraordinary incidents of food poisoning reported by BPOM throughout Indonesia. The use of hazardous food additives (BTP) that is often used is the use of preservatives, dyes, and sweeteners [3].

The provision of energy and other nutrients for school-aged children is partially supplied by snacks. Snack consumption, and is beneficial for the growth of children [4]–[8]. The family environment exercises a strong influence on the child's diet. On reaching school-age, however, the child's diet may change because of the increased time spent by children in school and away from parental supervision. Many children acquire new habits of 'what to eat' and 'how to eat' from outside the home [9]–[12].

Among all age groups and social classes, including school-age children and adolescents, snacking is part of daily life [13], [14]. Many school-age children buy snacks in accordance with their preferences, without any knowledge or understanding of the ingredients contained in the snacks, which may adversely affect their health [15]–[18]. Many snacks still sold in schools have not met the basic health requirements, such as hygiene and use of harmful chemical additives, increasing the risk for students to consume unhealthy snacks [19].

The Food & Drug Control National Agency (BPOM) has found many cases from the research on street food snacks for school children. But ironically, until now there are still many dangerous school snacks sold in the school environment. These unhealthy snacks contain at least one or more the harmful substances, namely formalin, borax, rhodamine B, and methanyl yellow. All four are carcinogenic or trigger cancer. Borax and formalin are commonly used as preservatives, while Rhodamine B and methanyl yellow are used as dyes. Napitupulu and Abadi, 2018 examined roasted meatballs sold by vendors in several elementary schools in Medan and found that three samples of roasted meatballs contained Borax and four samples of sauces on roasted meatballs that were examined contained Rhodamine B [20]. These problems indicated the low level of awareness concerning the food safety of the community, including both sellers and buyers.

School health programmes are an important component of public health. Children spend more time at school than anywhere else, except at home. Schools can play a significant role in influencing school-age children by, teaching them, for instance, healthy behaviours for children. Without education, children are not prepared to get the correct information, proper knowledge, and skills about nutrition. Some studies have showed that a peer-based model of nutritional education has a positive impact on students' nutritional behaviour. Peers can positively influence students' knowledge, awareness and self-reliance [14], [21]–[23]. A study on the efficacy of training students as peer educators to provide information on healthy and safe consumption behaviour in schools is necessary. We aimed to assess the changes in knowledge, attitude and behaviour of UKS's cadres after being trained; students' knowledge, attitudes and behaviour during the intervention and compare it after the student group had received the promotion from UKS's cadres and snack vendors' knowledge during the intervention and compare it after the group had received the promotion from UKS's cadres.

## MATERIALS AND METHODS

The quasi-experimental approach using a pre–post-test control group was assigned in this study. The study conducted in Deli Serdang District, Sumatera Utara Province, Indonesia. The selection of research locations in Deli Serdang Regency was carried out purposively. Researchers chose two sub-districts based on geographical location and based on the number of primary schools that were most abundant in the sub-district. The selected sub-districts are Pantai Labu District representing the coastal area and Tanjung Morawa. District representing the mainland area based on purposive. The selection of schools in the district was also chosen purposively, namely schools that had UKS activities and many food vendors around the school.

Researchers set six primary schools as controls and six primary schools as intervention sites for UKS's cadres selected in each sub-district of Pantai Labuh and sub-district of Tanjung Morawa so that the total number of primary schools used as research locations was 12 elementary schools. Pantai Labu sub-district, three primary schools were selected as intervention and three primary schools as controls. In the Tanjung Morawa sub-district, three primary schools were intervention and three primary schools were controls. The selection of schools in the district was also chosen purposively.



The population in this study was all 3rd grade, 4th grade, 5th-grade elementary school students, and all school children snack sellers in the school environment. The population in this study was to assess the effect of giving promotions by trained *UKS's* cadres to elementary school students in the intervention group and the effect of pasting posters on the control group. Using a level of significance of 5%, and a test power of 90%, we anticipated the proportion of the population in the twelve selected schools to be 0.44 (P1) and 0.25 (P2) while the drop-out rate to be 30%. We enrolled 360 students in two groups. The sample of students in the intervention group of *UKS's* cadres was 180 and the sample in the control was 180. The sample selection was carried out by systematic sampling for the student sample by considering the number of students in each class. Sample for snack sellers, all snack sellers around the school were used as respondents in this study (48 for intervention and 46 for control).

Data analysis was carried out univariate and bivariate. Univariate analysis was conducted to determine the frequency distribution of the data. Bivariate analysis to analyze the effect of treatment on the intervention group by *UKS's* cadres and the control group. Before the bivariate analysis was carried out, the data normality test was carried out using the Kolmogorov Smirnov test. In this study, all data were not normally distributed, so the Wilcoxon statistical test and the Mann-Whitney test were carried out to analyze the effect of treatment between groups. The paired-sample t-test statistical test was used to analyze the effect of *UKS's* cadre training on the knowledge, attitudes, and behavior of *UKS's* cadres because after the normality test the data with Kolmogorov-Smirnov showed a normal data distribution ( $p > 0.05$ ).

### **Study instrument**

We assessed the knowledge, attitudes and behaviours of the students using structured questionnaires. We asked questions relating to 22 items of knowledge, 15 items of attitude and 15 items of behaviour to identify the students' understanding concerning the healthy snacks, potential bacteria, chemical and physical hazards in snacks, characteristics of foods containing chemical hazards, as well as the impact of the consumption of contaminated food on health. We also asked the vendors questions concerning 24 items of knowledge using structured questionnaires while we observed their behaviours using a structured check list. We kept the sentence structure and format of the questionnaires for an easier understanding. An expert panel of nutritionists determined the validity of the content while we used a group of students ( $n = 30$ ) and a group of vendors ( $n = 10$ ) to assess the content validity prior to data collection. We tested the internal consistency (Cronbach's alpha) for the students' knowledge, attitude and behaviour sections, with results of 0.666, 0.654 and 0.632, respectively. Cronbach's alpha for the snacks vendors' knowledge question was 0.714.

We scored each positive or correct response to the students and vendors questionnaires as 1 point. The maximum score obtained for a student's knowledge was 22, that for a student's attitude was 15, and that for a student's behaviour was 15. The maximum score for a snacks vendor's knowledge was 24. We evaluated the differences in the scores for knowledge, attitude and behaviour of students before and after intervention, as well as between intervention and comparison groups using the Mann Whitney test with a significance level of 5%.

### **Data Collection**

The data was collected by 12 enumerators, namely nutrition students from the Health Polytechnic of the Medan Ministry of Health who have passed the food safety and nutritional status assessment courses. This data collection was also accompanied by researchers and 6 field research officers. The field officers are three nutrition laboratory officers from the Health Ministry of Health Medan and three nutrition workers at the *puskesmas* or community health center. In addition to researchers and field assistants, this data collection was also accompanied by one teacher from each school who became the research locus as the person in charge of the field. Data were collected using questionnaire instruments and observation sheets.

### **Intervention**

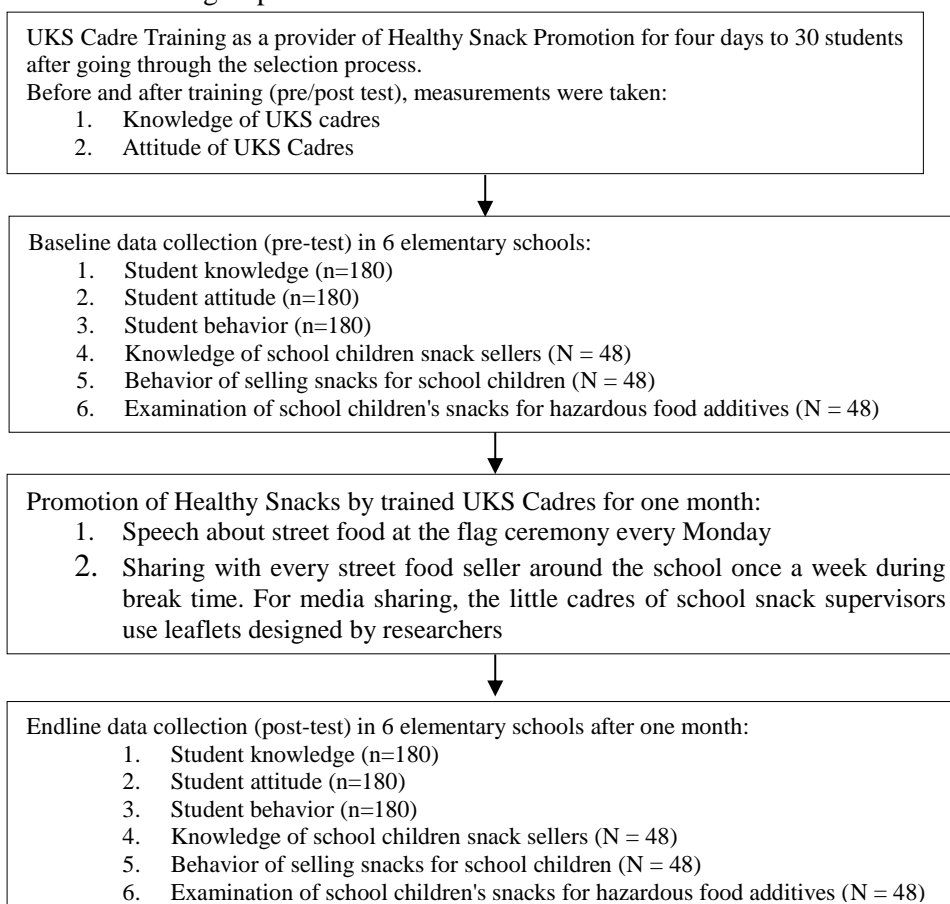
The initial phase of the research involved the training of the students as *UKS's* cadres, to act as educators in the selected schools. We selected and trained five students from each of 12 different elementary schools located in selected districts using the inclusion criteria of students in grades 3, 4 and 5, academically ranked from 1<sup>st</sup> to 5<sup>th</sup> in their class, and with good public speaking skills. The cadres were trained for four days, after which they were recruited based on the results of the test. For the first day, we provided training material involving snacks that contain chemicals harmful to human health. The material for the second day included

promotion methods to the vendor (speech). In the third day, we trained the students on the borax, formalin and rhodamine B assessments while in the fourth day, we focused on speech and sharing information practices.

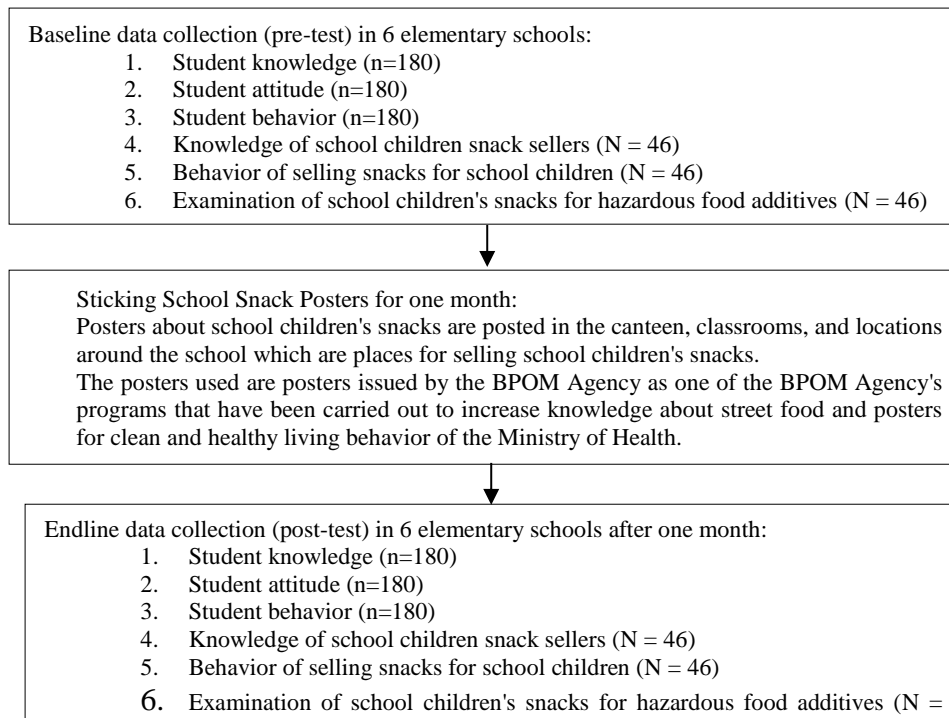
In the second phase of our research, we assessed 360 randomly selected students and 94 school vendors in 12 different schools. We performed this phase after the intervention of the UKS's cadres every Monday and the sharing of information with street food vendors once a week for one month. We provided the intervention schools with packaged activities, such as a speech to peers, interpersonal communication with snack vendors and poster distribution. We displayed posters promoting the consumption of healthy and safe snacks, developed by the National Agency of Food and Drug Control (BPOM) in comparison schools. The posters distributed to both groups included information about healthy snacks, potential bacteria, chemical and physical hazards in snacks, characteristics of foods containing chemical hazards, as well as the impact of the consumption of contaminated food on health. Prior to the intervention activities, we conducted a baseline survey to assess the knowledge, attitudes and behaviours of students, the knowledge of snacks vendors and an assessment of the foods potentially containing dangerous additives, such as formalin, borax and rhodamine B. Then, the UKS's cadres and laboratory research staff subjected the foods suspected of contamination with harmful additives to laboratory tests using touch formalin tests, touch borax tests and touch rhodamine B tests.

## Research Scheme

### Treatment in the intervention group



### Comparison group



We obtained permission and administrative approvals from the Education Office of Deli Serdang District to conduct this study. The ethical clearance was obtained from the Nursing Faculty of the University Sumatera Utara, with number: 1206/V/SP/2018. We informed all respondents about the purpose of the study and obtained their consent prior to data collection.

### RESULTS

This research was started by training UKS students as a provider of snack promotions to students and snack sellers for school children. To assess the success of the training, researchers measured the knowledge, attitudes, and behaviour of students about school children's snacks, with the following results:

**Table 1. Change In Knowledge, Attitudes and Behaviour Scores of UKS's Cadres Before and After Training (N = 30)**

Variables	Average ± SD	Average change ± SD	<i>p value</i> *
knowledge before training	12.77 ± 3.58		
knowledge after training	19.77 ± 2.11	7.00 ± 2.98	0.001
attitude before training	8.20 ± 2.16		
attitude after training	13.37 ± 1.88	5.17 ± 1.91	0.001
behaviour before training	7.93 ± 1.89		
behaviour after training	13.0 ± 1.88	5.07 ± 1.64	0.001

\*difference within the group (before and after) using paired t-test, at significant level of 5%

Table 1 summarises the scores for knowledge, attitude and behaviour. An increase of these scores, with significant average differences of  $7.00 \pm 2.98$ ,  $5.17 \pm 1.91$  and  $5.07 \pm 1.64$ , respectively can be observed. After being analyzed with the paired t-test statistical test, it showed that there were differences in the mean knowledge, attitudes, and behavior of UKS cadres before and after the training. UKS cadre training as a promotion provider for school children snacks affects increasing the knowledge, attitudes, and behavior of UKS's cadres.

### The effect of intervention to student and snack school vendors

The method of promoting healthy and safe snacks for school children carried out by trained UKS cadres is a speech every Monday during the flag ceremony and sharing with school children snack sellers. Respondents in this study were all students in grades 3, 4, and 5 from each school that became the research location which was randomly selected, and all street vendors selling snacks for school children around the school. The characteristics of the respondents can be seen in table 2 and table 3 below.

**Table 2. Characteristics of Student Respondents**

Variabels	Control		Intervention	
	n	%	n	%
Age				
8 - 9	57	31.7	52	28.9
10 - 11	115	63.9	120	66.7
12 - 13	8	4.4	8	4.4
<b>Kelas</b>				
Grade 3	60	33.3	62	34.4
Grade 4	61	33.9	66	36.7
Grade 5	59	32.8	52	28.9
Total	180	100	180	100

**Table 3 Characteristics of Snack Sellers Around School**

Variabels	Control		Intervention	
	n	%	n	%
Age				
25 - 35	9	19.57	11	22.92
36 - 46	19	41.30	17	35.42
47 - 57	13	28.26	16	33.33
57 - 70	5	10.87	4	8.33
<b>Jenis Kelamin</b>				
Male	17	36.96	21	43.75
Female	29	63.04	27	56.25
Total	46	100	48	100

**Table 4. Knowledge, Attitude and Behaviour Scores Before and After the Interventions**

Variables	Comparison (N1 = 180) (N2 = 46)*	Intervention (N1 = 180) (N2 = 48)*	p value <sup>b)</sup> between groups
<b>Student's knowledge</b>			
before	12.00 (10.00–16.00)	12.00 (9.00–15.00)	0.096
after	13.00 (11.00–16.00)	19.00 (16.00–21.00)	0.001
change	1.00 (0–1.00)	6.00 (4.00–9.00)	0.001
p value <sup>a)</sup> within group	0.001 <sup>a)</sup>	0.001 <sup>a)</sup>	
<b>Student's attitude</b>			
before	8.00 (7.00–10.00)	8.00 (7.00–10.00)	0.758
after	9.00 (8.00–11.00)	13.00 (11.00–14.00)	0.001
change	1.00 (0–3.00)	4.00 (2.00–6.00)	0.001
p value <sup>a)</sup> within group	0.001 <sup>a)</sup>	0.001 <sup>a)</sup>	
<b>Student's behaviour</b>			
before	7.00 (7.00–10.00)	7.00 (6.00–9.00)	0.287
after	9.00 (7.00–11.00)	12.00 (10.00–14.00)	0.001
change	2.00 (0–3.00)	4.00 (2.00–5.00)	0.001
p value <sup>a)</sup> within group	0.001 <sup>a)</sup>	0.001 <sup>a)</sup>	
<b>Vendor's knowledge</b>			
before	17.00 (13.75–19.00)	17.00 (14.25–18.75)	0.854
after	16.50 (14.00–19.00)	21.00 (19.00–22.00)	0.001
change	0.50 (0–2.00)	4.00 (2.00–5.75)	0.001
p value <sup>a)</sup> within group	0.042 <sup>a)</sup>	0.001 <sup>a)</sup>	

<sup>a)</sup> difference within groups (before and after) using Wilcoxon test, at significance level of 5%

<sup>b)</sup> difference between groups (intervention and comparison) using Mann Whitney test, at significant level of 5%

<sup>1)</sup> expressed as average (25<sup>th</sup>–75<sup>th</sup> percentile)

\* N1: number of students

N2: number of snacks vendors

Table 4 shows that the condition of both groups of students and vendors in the baseline were similar in term of knowledge, attitude and behaviour. However, after the given intervention, there was an increase

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change in the score of knowledge, attitudes and behaviour of students as well as vendor's knowledge. It is seen that the increase in the intervention groups were significantly higher than that for the comparison group. The average values of knowledge, attitude and behaviour of students before and after intervention showed significant differences ( $p < 0.05$ ).

It can be seen in Table 5 that the increasing percentage of students who gained knowledge is the highest for the topic 'characteristics, form and function of formalin' (43.9%) and the lowest for the topic 'healthy snack' (17.8%).

**Table 5. Student's Knowledge About the Specific Topics Related on Healthy and Safe Snacks Before and After the Interventions**

Topics	Comparison (N=180)				Intervention (N = 180)				Difference <sup>b)</sup>	
	Before		After		Before		After		n	%
	n	%	n	%	n	%	n	%		
1. Healthy snack change <sup>a)</sup>	92	51.1	152	84.4	88	48.9	180	100	32	17.8
2. Snack safety (bacteria, chemical, and physical) change <sup>a)</sup>	70	38.9	122	67.8	82	45.6	177	98.3	43	23.9
3. The characteristics, form, and function of formalin change <sup>a)</sup>	18	10.0	88	48.9	14	07.8	163	90.6	79	43.9
4. The characteristics, form, and function of borax change <sup>a)</sup>	24	13.3	79	43.9	21	11.7	134	74.4	58	32.2
5. The characteristics, form, and function of rhodamine B change <sup>a)</sup>	22	12.3	86	47.8	25	23.9	161	89.4	72	40

<sup>a)</sup> change within groups

<sup>b)</sup> change between groups

**Table 6. Behaviour of Snack Vendors Based on Cadres' Observations**

Behaviour	Comparison (N=46)				Intervention (N = 48)				Differences <sup>b)</sup>	
	before		After		before		after		N	%
	N	%	N	%	N	%	N	%		
1. Holding food without tools change <sup>a)</sup>	46	100	46	100	48	100	18	37.5	3	31.9
2. Holding snacks after holding money change <sup>a)</sup>	46	100	46	100	48	100	22	60.4	2	27.7
3. Long nails, dirty clothes change <sup>a)</sup>	30	65.2	21	45.7	31	64.6	10	20.8	1	12.7
4. Dirty tools change <sup>a)</sup>	35	76.1	32	69.6	36	75	19	39.6	1	14.9
5. Opened snacks change <sup>a)</sup>	39	84.8	35	76.1	37	77.1	6	12.5	2	28.7
6. Waste disposal unavailable change <sup>a)</sup>	44	95.7	43	93.5	41	85.4	2	4.2	3	40.4

<sup>a)</sup> change within groups

<sup>b)</sup> change between groups

Table 6 shows the behaviour of snack vendors based on cadres' observations. The lowest percentage of change belongs to vendors' behaviour in the topic of personal hygiene, such as long nails and dirty clothes (12.7%). Snack vendors find it difficult to change their behavior in terms of personal hygiene, especially cleanliness of nails and cleanliness of clothes used when selling.

Table 7 summarises the results of the vendor inspections conducted by cadres and supervised by laboratory workers. It was found that both the control and the intervention groups used unsafe food ingredients.

**Table 7. Snacks Containing Harmful Chemical Additives Before and After the Interventions**

Comparison (N=6)				Intervention (N=6)			
Location	Snacks	before contains	after contains	Location	Snacks	before contains	after contains
SD A, public school	noodles	formalin	formalin	SD I.1, Islamic private school	rice cake	borax	-
SD B, Islamic private school	nugget	borax	borax	SD I.2, public school	chicken nugget	borax, rhodamine B	food not sold anymore
SD C, public school	meat ball	borax	borax	SD I.2, private school	jam	rhodamine B	food not sold anymore
SD D, private school	noodles	formalin	formalin	SD I.3, public school	noodles	formalin	formalin
SD E, public school	ice candle	rhodamine B	rhodamine B	SD I.4, public school	ice candle	rhodamine B	-

## DISCUSSION

Our study shows that prior to the intervention, most of the students had poor knowledge about healthy and safe snacks, as reflected in the score before intervention. In the comparison group, we considered the average score of knowledge to be low even after the intervention. In general, respondents were ignorant about the harmful ingredients found in snacks. Neither students nor snack vendors knew the characteristics of snacks that may contain formalin, borax and rhodamine B, nor their impact on human health. This lack of knowledge is reflected in the low scores of the respondents in terms of attitudes and behaviour. Because the information about safe and healthy snacks is not yet available in the school curriculum, it is very difficult for students to get the correct information about healthy and safe snacks for school children, with severely limited access for students. The only source of information for students is often their parents while every day at school, the children are exposed to various types of snacks without any form of supervision regarding food quality and safety.

We found that vendors were aware of the need for students to consume safe and healthy snacks. However, our research showed that the vendors mostly had poor practices and sold unsafe and unhealthy snacks to school children. We also noted their poor personal hygiene, such as not using tools when holding snacks, not washing hands after holding money and leaving the snacks they sold uncovered and consequently, in contact with flies. The results of the chemical tests showed that some snacks contained harmful chemical additives.

After the intervention, we observed an increase in the average scores for knowledge, attitudes and behaviour of students and vendors, both in the intervention and the comparison groups. This increase in mean score was evident in the group given interventions which received a combination of poster distribution and promotion activities implemented by UKS's cadres ( $p < 0.05$ ). Posters and promotions conducted by school health programme cadres provided a stimulus in the form of healthy and safe vendor's information, prompting the change in knowledge, attitudes and behaviour of respondents. Poster distribution and speech are both methods of mass health education.

Our study showed that a combination of both methods namely, poster distribution and monthly speeches by trained students to their fellow students during gathering events, such as the flag raising ceremony, proved to be more effective than poster distribution alone to improve the knowledge, attitude and behaviour of respondents ( $p < 0.05$ ). Educational media in the form of posters requires a high reading interest from the target audience. Attractively designed posters are more likely to rouse curiosity and attract interest in reading and thereby to achieve the goals for which they were designed. In this study, we used posters that had been designed and used by the BPOM. In this field, however, when conducting in-depth interviews with students at the comparison site, the researchers found the interest of school children in reading this poster is lacking. Generally, the children read posters only when they were attached due to the curiosity.

The change in knowledge, attitude and behaviour of students who received the combination of the poster and group speech by UKS's cadre was greater. This was because the frequency at which the students received the stimulus in the form of information about healthy and safe snacks was more intensive and regular than that in the comparison group, when generally, the students read posters only once while some of them never even read the poster. Judging by the observations of the research team, the students who attended the

ceremony carefully listened the cadres' speeches, which they found compelling. During their speeches, the cadres wore white uniforms, which gave them a sense of pride and confidence to give speeches in front of their friends and teachers.

The pride of each school health programme cadre motivated them to always be passionate about promoting healthy and safe snacks. We observed this from the changes in speech and sharing skills, which improved every week. The growing interest among students to emulate the cadres motivated them to pay attention to the speeches delivered by their friends. Children need nutritional education to access the right nutritional knowledge and skills. Peer-based nutritional education models have a positive impact on students' nutritional behaviour. Peers can influence the knowledge and awareness of their fellow students and improve student self-reliance [24], [25].

The ideal and common places to provide health promotional interventions for children aged 6 to 12 years are educational institutions. Food marketing impacts children's food knowledge, behaviour and health. Understanding food marketing in children's everyday settings is necessary to protect children [26], [27]. Children's nutritional knowledge has shown an improvement with the increase of nutritional education programmes in schools [16], [28]. As previously shown, the nutritional education using the peer education model influences children's behaviour [22], [23], [29] and how they will select the food [30]. Nutritional education will increase the children's knowledge. Therefore, the children with higher knowledge scores are more likely to choose healthy snacks [11], [30].

Our research also found that pasting posters affected increasing the knowledge of street food vendors. However, when compared with the sharing and lecture methods given by *UKS's* cadres, the average change in knowledge of street food vendors who were intervened by *UKS's* cadres was higher than the knowledge of street food vendors given by posters. In our study, the promotion of healthy and safe snacks by *UKS's* cadres was more effective than the affixing of posters. From interviews with several school snack vendors who were given posters, they stated that they did not have time to read the posters because they were busy selling. Several sellers stated that they were not interested in reading the poster.

Sharing the information with the vendors has proved to be the most effective way of increasing their knowledge and skills. Apparently, the vendors took the information provided by the cadres of the school health programme about the personal hygiene and snacks. The vendors would have been embarrassed if they were caught by the school health programme cadres and in consequence, they always paid attention to cleanliness when engaged in selling. Vendors who sold snacks that are harmful to health were also approached by the school, but only after they were reported to the counsellor and principal by the school health programme cadres.

As most children attend school regularly and consume at least one meal and a number of snacks at school each day, the school-based programmes represent an ideal setting to enhance healthy eating. However, the current research suggests that the elementary school teachers often display low levels of nutritional knowledge, self-reliance and necessary skills to deliver effective nutritional education [31], [32]. By empowering the school health programme's cadres, the school-based programmes are effectively used as nutritional education programmes in schools.

Several studies showed that a peer approach to school-based health promotion is very effective in changing the healthy life behaviour of children. These improvements were achieved in parallel with progresses in diet quality, self-reliance and knowledge concerning healthy living [33]–[35]. The use of peer-to-peer approaches in health promotion interventions targeting youth seems to be a strategy with great potential. Peer leadership initiatives can increase physical activity for youth and children [36]. Darise, Deby Sinta (2021) in their research suggest that peer education can be used as an approach by schools for students to reduce the number of snack consumption habits in adolescents. In their research, they found that the peer education method affected increasing knowledge and attitudes related to snack consumption [37].

## **CONCLUSIONS**

*UKS's* cadres as promotion providers of healthy and safe snacks are more effective when compared to the method of providing posters on the knowledge, attitudes, and behavior of students and snack sellers at school. *UKS's* cadres as promoters of healthy and safe snacks can be used as a mandatory *UKS* program in every school to achieve food safety for school children. This study did not analyze other factors that may also influence changes in the knowledge, attitudes, and behavior of respondents such as age, gender, parental education level, and other factors.

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## CONFLICT OF INTEREST

The authors have no conflict of interests to declare.

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## The Evaluation Study of Nutritional Knowledge from Sports Practitioners in The Quadrennial National Sports Competition 2021

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### ABSTRACT

**Background:** Nutritional program is another influencing factor of athletic performance after the physical training program, and psychological training program. However, Indonesian sports practitioners somehow still neglect the important role of sports nutrition to achieve the best athletic performance.

**Objectives:** To examine the level of basic nutritional and sports nutritional knowledge among the sport's practitioners who participated in the quadrennial national sports competition 2021.

**Materials and Methods:** This evaluation study has conducted with a descriptive quantitative approach. Thirty-eight sports practitioners (24 males and 14 females), were represented from five provinces such as Central Java, Western Java, Eastern Java, Southern Sumatera, and Bali. Their status during the sports events are athletes, referees, officials, coaches, and judges. The incidental technique sampling was used to attract the respondents. Nutritional Knowledge Questionnaires (NKQ) developed by Rosi et al, was used in this study. Data was analyzed with the frequencies distribution technique, and displayed using the percentage.

**Results:** More than half of the total respondents (81%) have good, very good, and excellent knowledge in general nutrition (21%, 34%, 26%) respectively. Similarly, it is also happened in the evaluation of their knowledge for basic nutrition good (5%), very good (29%), excellent (40%), as well as in their knowledge levels for sports nutrition, good 18% and excellent 53%. However, based on the evaluation of their sports nutritional knowledge, we found that there are 8% (n=3) of the respondent were failed as the score <50 points.

**Conclusion:** Overall, the nutritional knowledge for general, basic and sports in sports practitioners evaluated good. However, the sports nutritional knowledge is not well understood evenly by them. At last, this study can be used as a reference to make a better decision on how sports nutrition must be promoted to maximize the athletic performance.

**Keywords:** Sports Nutrition; Sports Event; Elite Sports

### BACKGROUND

The proper physical training program, diet program, and psychological training are believed to be the key factors which affecting the best sports performance for any athlete. Further, social support, family, coach, teammates, athletic ability, athletic experience, and athletic achievements are considered as the contributing factors to either good or poor performance.<sup>1</sup> Aspects involved in a training program such as performance prediction, periodization, training methods and monitoring, techniques, injury prevention and its management.<sup>2</sup> Meanwhile, adequacy, balance, calorie (energy) control, nutrient density, moderation, variety, and consumption time are the aspects involved in the diet program.<sup>3</sup> Last, the psychological aspects such as

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attention, self-confidence, stress control, anxiety, motivation, cohesion, self-control or emotional self-regulation, moods, and interpersonal skills can influence the athlete's performance.<sup>4</sup>

Educational factors such as formal education and informal education in some ways could be one of many determinant factors on human behavior. A study found that there were not any differences on nutritional knowledge and attitudes among elite athletes, amateur athletes, and recreational athletes.<sup>5</sup> Interestingly, there are two scientific evidences about the correlation between nutritional knowledge and sports that were not in line with each other. The first study stated that having a good nutritional knowledge or its practice did not directly determine the athletic performance, and the other study stated that body fat percentage (BF%) was found higher in athletes who have a low level of sports nutrition knowledge.<sup>6,7</sup>

In elite sports, a study analyzed the tennis players' knowledge and attitudes on sports nutrition and doping revealed that coach (teacher, mentor) becomes their main source of any information related to doping and nutrition.<sup>8</sup> Hence, consistent long-term educational intervention is able to change the knowledge, attitudes, and athletes' behavior on sports nutrition. Athletes are motivated to learn, improve diet behaviors, and benefit from team-based nutrition interventions.<sup>9</sup> Both basic nutritional concepts and the understanding of specific effects of nutrients on sports performance still needed to be consistently taught to the athlete by the sports nutrition practitioners. Unclear understanding of nutritional guidelines interpreted into absolute food portions or combinations may found in the athlete. Nutritional interventions by promoting adequate energy intake, lowering BF%, appropriately gaining muscle mass, and the body lean is still needed.<sup>6,7</sup>

Based on the elucidation above, the levels of nutritional knowledge in sports practitioners either athlete, coach, official, or other stakeholders is remains unclear. Therefore, this study aims to evaluate the level of sports practitioners' knowledge on both basic nutrition and sports nutrition.

## **MATERIALS AND METHODS**

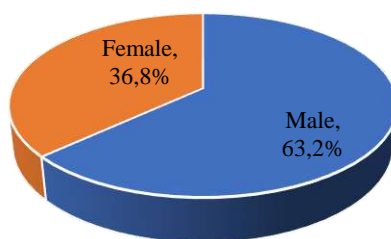
This evaluation study has conducted with a descriptive quantitative approach. The inclusion criteria in this study is all the individuals who were actively participating in the quadrennial national sports competition 2021, Papua. Their status during the sports events are athletes, referees, officials, coaches, and judges. Meanwhile, total respondents in this study are 38 sports practitioners (24 males and 14 females), they were represented from five provinces such as Central Java, Western Java, Eastern Java, Southern Sumatera, and Bali. The incidental technique sampling was used to attract the response.

Nutritional Knowledge Questionnaires (NKQ) developed by Rosi et al, which published in 2020 was used in this study, it was translated into Bahasa Indonesia, with some adjustments on its statements and then it was transferred into Google Forms to make easier distribution and data collection. The NKQ consisted of 16 questions evaluating basic nutrition, and 10 questions evaluating sports nutrition. The NKQ was chosen because it provides a brief, feasible, and validated questionnaire or evaluates the efficacy of education on basic and sports nutrition in both the general population and athletes.<sup>10</sup>

NKQ using the modified Goodman Scales which provides three optional answers (true/false/I do not know). The six-teen questions related to basic nutritional knowledge are: 1) Protein intake and body fat, 2) Carbohydrate content of banana, 3) Carbohydrate content of rice, 4) Fat requirements, 5) Fat content of low-fat cheese, 6) Fat content of butter, 7) Fat content of honey, 8) Daily recommended intake of water, 9) Protein content of hard cheese, 10) Protein content of beans, 11) Protein content of corn, 12) Protein quality of eggs, 13) Energy from vitamins, 14) Daily recommended calcium intake, 15) Alcohol and body fat, and 16) Alcohol intake and recovery from injuries. Meanwhile, the ten questions related to sports nutritional knowledge are: 1) The best meal for increasing muscle mass, 2) Protein needs of vegetarian athletes, 3) Vitamin and mineral supplements and sports performance, 4) Water consumption during training, 5) Dehydration and sports performance, 6) Snacking during training, 7) Carbohydrate intake during training, 8) Label and claims on food supplements, 9) Safety of supplements, and 10) Doping substances.

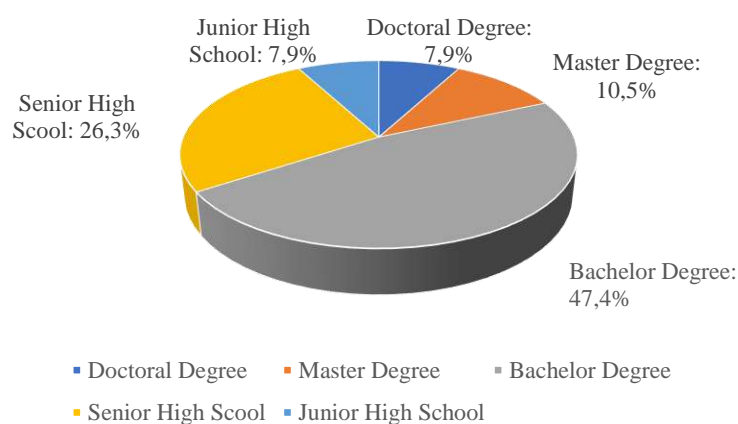
The answers of NKQ were scored. Then it was categorized into eight categories such as Failed <50, Less 51-55, Less than enough 56-60, Enough 61-65, More than enough 66-70, Good 71-80, Very good 81-85, and excellent 86-100.<sup>10</sup> Data were analyzed with the frequencies distribution technique, and displayed using the percentage in the tables and figures.

## RESULTS



**Figure 1. Respondent's Sex**

A total of 38 respondents participated in this study which consists of 24 (63.2%) males and 14 (36.8%) females (Figure 1). The educational backgrounds of respondents were varied starting from Junior High School 3 (7.9%), Senior High School 10 (26.30%), Bachelor Degree 18 (47.40%), Master Degree 4 (10.50%), and Doctoral Degree 3 (7.9%), for the visualization can be seen on Figure 2.



**Figure 2. Educational Degree of Respondent**

**Table 1. Participants Delegation**

Category	n	%
<b>Province</b>		
Central Java	21	55.28
Western Java	8	21.05
Eastern Java	3	7.89
Southern Sumatera	3	7.89
Bali	1	2.63
Unknown	2	5.26
<b>Sports</b>		
Gymnastics	18	47.40
Handball	4	10.52
Softball	3	7.89
Wrestling	2	5.26
6t5 Skates	2	5.26
Sepak Takraw	2	5.26
Wushu	2	5.26
Cricket	1	2.63
Indoor Hockey	1	2.63
Hapkido	1	2.63
Archery	1	2.63
Unknown	1	2.63
<b>Status</b>		
Athlete	28	73.70
Referee	5	13.15
Official	3	7.89
Coach	1	2.63
Judge	1	2.63

There are five identified provinces that have participated in this study: Central Java (55.28%), Western Java (21.05%), Eastern Java (7.89%), Southern Sumatera (7.89%), Bali (2.69%), and 2 respondents (5.26%) were not identified. Further, from those 5 provinces, the respondents were identified actively involved in 11 sports, they are: gymnastics (47.40%), handball (10.52%), 3 softball (7.89%), wrestling (5.26%), skates (5.26%), sepak takraw (5.26%), wushu (5.26%), cricket (2.63%), indoor hockey (2.63%), hapkido (2.63%), archery (2.63%), and one respondent (2.63%) was not identified. At last, from 38 respondents their role in the quadrennial national sports competition 2021 were as athlete (73.70%), referee (13.15%), official (7.89%), coach (2.63%), and judge (2.63%) see Table 1.

Nutritional knowledge is the overall knowledge, both about basic and sports nutrition. The data from sports practitioners can be seen in Table 2. Eight categories were made up based on the common judgmental value for the educational sector. Based on the analysis, regarding the nutritional knowledge found that 10 (26%) respondents are classified into excellent category, 13 (34%) very good, 8 (21%) good, 3 (8%) more than enough, 1 (3%) enough, less than enough 2 (5%) and less 1 (3%). Meanwhile, the understanding data of basic nutrition from respondents found that 15 (40%) were classified into excellent category, 11 (29%) very good, 2 (5%) good, 2 (5%) more than enough, 6 (16%) enough, and 2 (5%) less than enough. Lastly, the nutritional knowledge data of respondents showed that 20 (53%) were classified into excellent category, 7 (18%) good, 5 (13%) more than enough, 3 (8%) less than enough, and unfortunately 3 (8%) of respondents were failed.

**Table 2. Distribution Frequency of Nutritional Knowledge**

Category	Score Range	General Nutrition (n= 38)	Percentage (%)	Basic Nutriti (n= 38)	Percentage (%)	Sports Nutrition (n= 38)	Percentage (%)
Excellent	86-100	10	26	15	40	20	53
Very Good	81-85	13	34	11	29	0	0
Good	71-80	8	21	2	5	7	18
More than enough	66-70	3	8	2	5	5	13
Enough	61-65	1	3	6	16	0	0
Less than enough	56-60	2	5	2	5	3	8
Less	51-55	1	3	0	0	0	0
Failed	<50	0	0	0	0	3	8
<b>Total</b>		<b>38</b>	<b>100%</b>	<b>38</b>	<b>100%</b>	<b>38</b>	<b>100%</b>

Regarding to the sports nutritional data in table 2, although more than half of respondents were categorized into good (18%) and excellent (53%), surprisingly we found that there were three of the respondents failed as their score <50. These respondents backgrounds are three males; senior high school, senior high school, bachelor degree; one from eastern java, and two from western java; one sepak takraw athlete, and two gymnasts; one of them has been participating in sports for more than sixteen years, while the other two over than six years.

## DISCUSSION

Based on this research, the majority of the respondent was male athletes. The gender gap in sports performance has been stable since years ago. These suggest that women's performances at the high level will never match those of men, even when performances still improve, these progressions are proportional for each gender.<sup>11</sup> In general, males have longer limb levers, stronger bones, greater muscle mass and strength, and greater aerobic capacity. Females exhibit less muscle fatigability and faster recovery during endurance exercise.<sup>12</sup>

The educational backgrounds of the respondent also varied from Junior High School to Doctoral Degree. Educational factors such as formal education and informal education in some ways could be one of many determinant factors on human behavior.<sup>5</sup> A systematic literature review found that most nutrition education programs administered to athletes lead to significant improvements in nutrition knowledge (NK).<sup>13</sup>

The sports practitioner that become our respondents were from 5 different provinces in Indonesia. The quadrennial national sports competition is a multi-sport event held every four years in Indonesia. The

participants of this event are athletes from all provinces of Indonesia. It is organized by the National Sports Committee of Indonesia (KONI). The characteristic of the respondent was varied either the type of sports or the status of the sport's practitioners. Social support, family, coach, teammates, athletic ability, athletic experience, and athletic achievements are considered as the contributing factors to either good or poor performance.<sup>1</sup>

In this research, general nutrition is the overall knowledge, both about basic and sports nutrition. Subjects who have a good knowledge were from higher educational background. Higher levels of nutrition knowledge have been reported in those with higher education or socio-economic status and greater levels of nutrition knowledge have been typically found in middle-aged as opposed to younger or older persons.<sup>14</sup> Good nutritional knowledge has been recognized as the key factor that play a critical role in improving athletic performance in terms of improved quality of training and a speedy recovery from exercise. Athletes need sufficient knowledge of this subject to understand the importance of food choices for their athletic performance, recovery, and overall health.<sup>15</sup>

The question about basic nutrition is mostly about the source of macronutrients in food. From the result, we have found that the nutrition knowledge of our respondents was satisfactory as more than half of the participants had good nutritional knowledge. Magazines, parents, coaches, and teammates were the commonly cited sources for nutrition revealed by another study.<sup>7</sup> Athletes are understanding the important role that nutrition has in performance. One thing athletes often forget is that their dietary needs are much higher than those of the general population. Individual dietary requirements vary depending on the type of sport, the athlete's goals, body composition, training schedule, environment, and metabolism.<sup>16</sup>

Most of sports practitioner have scored above 71 for the sports nutrition questions which are categorized as good, very good, and excellent. Sports nutrition is a complex area of nutrition science and has emerged as an entire medical sub-specialty of its own.<sup>17</sup> Sports nutrition focused on meeting the nutritional requirements for physical activity, optimizing the refueling process after physical exercise, and improving athletic performance in training and competitions, as well as promoting general health and well-being.<sup>18</sup>

Surprisingly we found that some sports practitioners were failed (score <50) in sports nutrition knowledge. These respondents backgrounds are three males; 2 of them are senior high school and bachelor degree; one from eastern java, and two from western java; one sepak takraw athlete, and two gymnasts; one of them has been participating in sports more than sixteen years, while the other two over than six years. This finding, however, was similar to findings of other studies in which researchers found female athletes to have significantly higher NK scores than their male counterparts.<sup>19</sup> Adolescent athletes often rely on their coaches for nutrition guidance despite gaining brief information from their regular textbooks. Dependence on the internet search for proper diet and nutrition is growing, however, it's difficult to separate authentic information. Lack of proper training on diet and nutrition creates potential harm if the coaches and athletes are misinformed.<sup>20</sup> Proper nutrition knowledge and healthy dietary practices are important for adolescent athletes as well as for coaches.<sup>7</sup>

## CONCLUSIONS

We conclude that the sport's practitioners have well understanding of basic and sports nutrition, but this phenomenon especially the sports nutrition is still not understood by the whole practitioners. From this point, we suggest that sustainable education both formal and informal related to sports nutrition must be conducted as endless efforts to support the national sports development by the whole practitioners (athletes, referees, officials, coaches, and judges).

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## Anthropometric Measurements and Inflammatory Marker in Obese Women

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### ABSTRACT

**Background:** Obesity is one of global epidemic health problems and its prevalence is higher among women. Obesity can cause low grade chronic inflammation mechanism in adipose tissue, which is characterized by the increase of proinflammatory cytokines and adipokines. Neutrophil lymphocyte ratio (NLR) is a simple inflammatory marker which can be reliable in evaluating the inflammatory status occurring in obese women. Waist to height ratio (WHtR) and waist to hip ratio (WHR) are anthropometric measurements, have been reported to be associated with obesity and risk of metabolic syndrome.

**Objective:** This study aimed to determine the correlation of WHtR and WHR with NLR in population of obese women.

**Materials and Methods:** This was a cross sectional study enrolling 80 obese women with Body mass index (BMI) > 27 aged 30 - 50 years in National Diponegoro Hospital Semarang, Indonesia. WHtR was determined by dividing waist circumference by height and WHR was determined by dividing waist circumference by hip circumference. NLR was examined manually from automatic hematology analyzer by dividing absolute neutrophil count (ANC) and absolute lymphocyte count (ALC). Spearman correlation test was performed,  $p < 0.05$  was considered as statistically significant.

**Results:** There was significant weak positive correlation between WHtR and NLR in obese women ( $p = 0,046$ ;  $r = 0,224$ ). There was no significant correlation between WHR and NLR in obese women ( $p = 0,961$ ;  $r = 0,006$ ).

**Conclusion:** The present study showed that WHtR is one of better anthropometric measurement because it is associate with NLR as a simple marker of inflammation in obese women.

**Keywords:** WHtR; WHR; NLR; Obesity

### BACKGROUND

Obesity is one of the global health problem whose prevalence continues to increase every year. World Health Organization (WHO) in 2016 stated that 1.9 billion adults with 18 years of age or over are overweight and more than 650 million are obese. Based on WHO, approximately 13 % of world adult population were obese that more cases found in woman (15%) than man (11%)<sup>1</sup>. Results of Basic Health Research (Riskesdas) 2007-2018 in Indonesia also shows an increasing trend of obesity, namely 10.5% (2007), 14.8% (2013) and 21.8% (2018)<sup>2</sup> and in Central Java, Indonesia prevalence obesity cases in woman (27,53 %) are higher than in man (13.09 %)<sup>3</sup>.

Obesity is defined as s abnormal or excessive fat accumulation that presents a risk to health. Obesity increase the risk of chronic diseases including type 2 diabetes mellitus (Type 2 DM) and cardiovascular disease<sup>4</sup>. There are two types of obesity based on where fat accumulate in body namely android obesity and gynoid obesity. Abdominal, central, or android obesity characterized by fat distributed around the waist or Gynoid obesity that fat accumulate in the lower part of the body<sup>5</sup>. Risk factor of obesity are multifactorial including genetic, lifestyle, and environmental factors<sup>6</sup>. Women are more at risk for obesity than men because they have more sedentary lifestyle like physical inactivity, consumption food that high simple sugar, high calories and fat that are risk factor of obesity<sup>7</sup>. Body Mass Index (BMI) is anthropometric measurements which is more often used as a parameter of obesity. WHO criteria for obesity are if BMI is  $\geq 30$  kg/m<sup>2</sup>, while this study refers to the classification of obesity for Asia Pacific population which is having BMI  $\geq 27$  kg/m<sup>2</sup><sup>8</sup>. Waist Circumference (WC), Waist to Hip Ratio (WHR), Waist to Height Ratio (WHtR) are another anthropometric measurements that also can be used to predict obesity. Kwang Pil Ko et al stated that WHR is a better method

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of predicting metabolic syndrome in obesity than WC, WHtR, and BMI<sup>9</sup>. A meta-analysis study by Labarrere et al in more than 300,000 multi-ethnic people, shown that measuring obesity with WHtR can better explain its association with cardiometabolic risk from inflammation than using BMI and WC<sup>10</sup>.

Obesity has a negative impact on tissues and body systems related to inflammatory mechanisms. Low grade inflammation due to obesity has been demonstrated in several studies using various markers of inflammation. Obesity measured using BMI parameters was shown to be positively associated with increased CRP levels, leukocyte count, IL-6, tumor necrosis factor alpha (TNF- $\alpha$ ), and neutrophil lymphocyte ratio (NLR)<sup>11</sup>. Neutrophil lymphocyte ratio is effective, simple, inexpensive parameter of inflammation and widely examined in various laboratory<sup>9</sup>. During the inflammatory process, neutrophil count can be increased up to five times the normal number, while the lymphocyte count tends to be constant due to continuous recycling by lymphoid tissue, lymph and blood. This difference in the distribution of cells during inflammation is the basis for the use of NLR. Neutrophil lymphocyte ratio is considered more stable as a marker of inflammation than the absolute leukocyte count which can change according to physiological and pathological conditions<sup>12</sup>. No further study on the correlation between WHtR and WHR and the NLR value in Indonesian obese women. This encourages researchers to determine the correlation between WHtR and WHR and NLR values in obese women.

## MATERIALS AND METHODS

This cross-sectional study was conducted in July - September 2020 at the Diponegoro National Hospital Semarang, Central Java, Indonesia.

### Subject of Study

Minimum subject for this study was 46 people that was calculate with formula below:

$$n = \left( \frac{Z_{\alpha} + Z_{\beta}}{0,5 \ln \frac{1+r}{1-r}} \right)^2 + 3$$

Although minimum subject for this study was 46 people, total subject in this study was eighty obese women with criteria aged 30-50 years, body mass index (BMI)  $\geq 25$  kg/m<sup>2</sup>, healthy and having normal vital sign, and have regular menstrual cycles for 6 months before join the study. Subjects which have history of DM, subjects with cardiovascular disease, hematological abnormality, or pregnant at the time this study was conducted, were excluded from this study. Screening for subject in this study that meeting all criteria using short interview and simple screening form.

#### a. Antropometric Measurements

##### 1. Body Mass Index (BMI)

Body mass index (BMI) in this study were calculated using weight data that obtained by using a digital scale and height data using microtoa with formula:

$$\text{Body Mass Index : } \frac{\text{Weight (kg)}}{\text{Height (meter)} \times \text{Height (meter)}}$$

##### 2. Waist to Hip Ratio (WHR) and Waist to Height Ratio (WHtR)

Waist circumference was measured with inelastic band at the midpoint between the last rib and the anterior superior iliac crest at the end of respiratory movement of expiration in standing position. Hip circumference was measured over thin clothing at the point of the maximum circumference of the buttocks. Both circumferences were measured to the nearest 0.1 cm.

#### b. Blood Analysis

Blood was collected by venipuncture and tested using automatic hematology analyzer (Sysmex XN L Series XS 500, Sysmex Asia Pacific Pte Ltd.) for absolute neutrophil count (ANC) and absolute lymphocyte count (ALC). The NLR value was calculated manually from ANC divided by ALC.

Statistical analysis in this study was performed in this study by SPSS 16.0, Correlation Test using Pearson if data from this study normally distributed and Spearman correlation test if data not distributed normally with  $p < 0.05$  was considered as statistically significant. This study was obtaining an ethical clearance from the Health Research Ethics Commission of the Faculty of Medicine, Diponegoro University / RSUP Dr. Kariadi Semarang No. 32/EC/KPEK/FK-UNDIP/III/2020. Study subjects were providing written informed

consent.

**RESULTS**

**Subjects Characteristics Data**

Total respondent in this study was 81 respondents, only 80 respondents that met the inclusion criteria. The mean age of respondent in this study was  $36.61 \pm 5.20$  years with mean body mass index (BMI) were  $31.97 \pm 4.49$  kg/m<sup>2</sup> and have regular menstrual cycles. Mean Waist Circumference respondent in this study were  $93.86 \pm 9.15$  cm with WHtR and WHR score were  $0.85 \pm 0.06$  and  $0.61 \pm 0.06$ . Respondent mean leukocytes count, neutrophil, and lymphocyte in this study were  $7.08 \pm 1.48$  (10<sup>3</sup>/μL),  $61.15 \pm 5.95$  (%),  $30.32 \pm 5.58$  (%). Average Neutrophil Leucocyte Ratio respondent in this study were  $2.13 \pm 0.63$ . The baseline characteristics of the subjects is presented in table 1.

**Table 1. Data on the Characteristic of Research Subjects**

Parameter	Mean ± SD	Min – Max
Age (years)	36.61	3
Body weight (kg)	76.83 ±	60.4 –
Height (cm)	154.93	145.0 –
BMI (kg/m <sup>2</sup> )	31.97	27.00 –
WC (cm)	93.86	80.00 – 1
WHR	0.85	0.71
WHtR	0.61	0.52
Leucocyte (10 <sup>3</sup> /μL)	7.08	4.50 –
Neutrophil (%)	61.15	47.00 –
Lymphocyte (%)	30.32	19.00 –
NLR	2.13	1.04

BMI : Body mass index, WC : Waist circumference, WHR: Waist to hip ratio, WHtR : Waist to height ratio

The Spearman correlation analysis test between WHtR and NLR showed  $p = 0.046$ ;  $r = 0.224$ , this indicates that there is a significant correlation between WHtR and NLR in obese women. The Spearman correlation analysis test between WHR and NLR showed  $p = 0.961$ ;  $r = 0.006$ , this indicates that there is no significant correlation between WHR and NLR in obese women. The results of the correlation test are shown in Table 2.

**Table 2. Spearman Correlation Test Result of WHtR, WHR, and NLR in Obese Women**

Variable	NLR	
	r	p
WHtR	0.224	0.046*
WHR	0.006	0.961

\*= p value <0.05 is significant

**DISCUSSION**

**Obesity**

In this study we determined several anthropometric measurements include Body Mass Index (BMI), Waist to Hip Ratio (WHR) and Waist to Height Ratio (WHtR). Body mass index (BMI) is common anthropometric measurements as parameter of obesity. People with BMI score  $\geq 25$  kg/m<sup>2</sup> categorized as obese people. All respondents in this study have met the criteria of obesity from BMI score. Lowest BMI score in this study was  $27$  kg/m<sup>2</sup> and highest BMI score was  $52$  kg/m<sup>2</sup>. Obesity is characterized by the accumulation of body fat and unfortunately, body mass index (BMI) cannot be used to determine body fat composition. Someone who has  $\geq 25$  kg/m<sup>2</sup> not necessarily having high body fat percentage because body weight also consist of muscle mass.

Waist Circumference (WC), Waist to Hip Ratio (WHR) and Waist to Height Ratio (WHtR) can be used as a better indicator to determine obesity. Waist circumference (WC) is better indicator that can predict fat deposit in abdominal area. Lowest waist circumference respondent in this study is  $80$  cm that has been

categorized as obese for adult Asian people ( $\geq 80$  cm)<sup>13</sup>. The WHtR distribution in this study ranged from 0.52 to 0.77. The criteria for central obesity were enforced if the WHtR was  $\geq 0.5$  so that all study subjects met the criteria for central obesity<sup>14</sup>. The WHR distribution of study subjects ranged from 0.71 to 1.00. The cut off points of WHR according to WHO is  $\geq 0.85$  in women to categorized people having central obesity<sup>15</sup>. There are 42 (52.50%) study subjects who fall into the criteria for central obesity and 38 (47.50%) study subjects who do not meet the criteria for central obesity. According to the previous study by Hastuti et al, 2017 in Indonesia, it is stated that obesity is central if the WHR is  $\geq 0.77$  in women<sup>16</sup>. Based on these criteria, there are 74 (92.50%) research subjects who fall into the criteria for central obesity.

### **Inflammatory Parameters**

This study using Neutrophil Leukocyte Ratio (NLR) to predict inflammatory state in obese respondents. Obese condition can lead to systemic inflammation in body that can increase Neutrophil Lymphocyte Ratio (NLR). An increase in NLR is determined by an increase of neutrophils and or reduction in lymphocytes. An increase in circulating neutrophils is thus suggestive of an acute or chronic inflammatory response. Chronic inflammation stimulating the release of immunoregulatory granulocytic myeloid-derived suppressor cells from the bone marrow, which can increase up to 10% of peripheral leucocyte and suppress lymphocyte counts and function<sup>17</sup>. The increase in NLR in the obese female population can be caused by increased neutrophils. An increase in the number of neutrophils in obesity is an acute inflammatory response to a chronic inflammatory state<sup>18</sup>. Neutrophils describe a nonspecific immune system condition that initiates the body's response to inflammation<sup>19</sup>. High levels of circulating neutrophils are associated with depressed activity of other immune cells such as T-lymphocytes and natural killer cells. Based on the results of several previous studies, obesity causes a chronic inflammatory condition associated with increased secretion of adipokines and cytokines proinflammatory of adipose tissue<sup>20</sup>.

Currently there is no definite NLR intersection point value. Various studies use NLR intervals (ditile or quartile) or use a receiver operator curve (ROC) to classify NLR values. According to study by Patrice Forget et al., (2017) it was concluded that the threshold value of NLR in a non-geriatric adult population with good health was 0.78 - 3.5<sup>21</sup>. Based on these criteria, there were 4 (5.00%) research subjects who had a value NLR above normal. Possibility factor that cause not all respondents having high NLR value is subjects in this study were not grouped based on their degree of obesity. Dixon et al. revealed that a significant increase in the number of neutrophils occurred in severely obese patients (BMI  $>40$  kg/m<sup>2</sup>) due to the mechanism of neutrophil activation by leptin through TNF- $\alpha$ <sup>22</sup>. Atmaca et al. through his study reported that there was no significant increase in the number of leukocytes in mild obesity (BMI  $<35$  kg/m<sup>2</sup>), besides that it was proved that inflammation which is characterized by an increase in the number of neutrophils and lymphocytes is parallel with the severity of obesity<sup>18</sup>.

### **Correlations of WHtR and NLR in Obese Women**

Increased abdominal adiposity has been reported in previous study as major risk factor of metabolic syndrome. Main pathway to describe the correlation between metabolic syndrome and VAT is insulin resistance (IR). Excessive VAT decreasing insulin sensitivity that lead to systemic inflammation beside inflammation also occur in obesity condition<sup>23</sup>. Increased secretion of inflammatory mediators from visceral fat in obese individuals reflects the ongoing chronic inflammation within the adipose tissue of the individual<sup>24</sup>. NLR is one of the inflammation indicator that simple and easy to do with measuring ratio between neutrophil and leucocyte. Spearman test in this study show that there are no significant correlation between Waist to Hip Ratio (WHR) with NLR in obese woman ( $p = 0.961$  and  $r = 0.006$ ) meanwhile, there was a significant weak positive correlation between WHtR and NLR in obese women ( $p = 0.046$  and  $r = 0.224$ ). The results of this study are in accordance with several previous studies. Study conducted by Rodriguez et al. in 2020 stated that WHtR had a significant positive correlation with NLR in the abdominal obesity population ( $p < 0.001$ ;  $r^2 = 0.011$ )<sup>25</sup>. According to Rodriguez, both obese men and women with chronic inflammatory conditions characterized by increased NLR had higher WHtR values. Serbanescu et al. in 2015 through his study also stated that WHtR had a significant positive correlation with NLR in obesity ( $p < 0.001$ ;  $r = 0.203$ )<sup>26</sup>. WHtR is better indicator to identify central obesity that have higher risk to lead systemic inflammation. According to the Bener study in 2013, WC and WHtR are anthropometric parameters that have a better correlation with central obesity than WHR and BMI and can be used as predictors of cardiovascular and metabolic disease<sup>27</sup>.

### **Correlations of WHR and NLR in Obese Women**

There was no significant correlation between WHR and NLR in obese women ( $p = 0.563$  and  $r = -0.74$ ). The results of this study differ from several previous studies. Study conducted by Carranza et al. in 2020 states that there is a significant positive correlation between WHR and NLR in a population of obese women at premenopausal age ( $p < 0.05$  and  $r = 0.374$ )<sup>28</sup>. Differences in study conducted by Carranza et al. with this study is the subject inclusion criteria. The inclusion criteria in the Carranza study were obese premenopausal women (42 - 55 years) with vasomotor symptoms indicating decreased estrogen. Whereas in this study the subjects were obese women of productive age who still experienced regular menstruation.

The results of this study are consistent with the study of Dev et al. in 2012 which revealed that WHR was not significantly associated with several markers of inflammation, especially CRP in obese non-comorbid female subjects. According to Dev, WHR is not as good as WC in explaining the correlation between increased markers of inflammation<sup>29</sup>.

No correlation between WHR and NLR can be caused by several factors. One of the factors that influence the results is the varied physical activity of the research subjects. According to study by Rias et al. in 2020 shows that moderate and excessive physical activity significantly reduces NLR in a population of women with type 2 diabetes mellitus with and without obesity<sup>30</sup>.

Another factor that can cause an insignificant correlation is that the subjects in this study were not grouped based on the degree of obesity. Dixon et al. revealed that a significant increase in the number of neutrophils occurred in severely obese patients ( $BMI > 40 \text{ kg/m}^2$ ) due to the mechanism of neutrophil activation by leptin through  $TNF-\alpha$ <sup>22</sup>. Atmaca et al. through his study reported that there was no significant increase in the number of leukocytes in mild obesity ( $BMI < 35 \text{ kg/m}^2$ ), besides that it was proved that inflammation which is characterized by an increase in the number of neutrophils and lymphocytes is parallel with the severity of obesity<sup>18</sup>.

The age factor also influenced the subject's NLR. According to study by Jian Li et al. in 2015, NLR was positively correlated with age in the healthy adult female population ( $p < 0.001$ ,  $r = 0.119$ )<sup>31</sup>. Jian Li's study showed that the NLR in the 40-49 years age group was higher than the 30-39 years age group. This is because the number of granulocytes shows an increasing trend with age and the number of lymphocytes shows a decreasing trend with age.

The limitation of this study is that only one type of inflammatory marker was used and the subjects were not classified based on the severity of obesity.

## CONCLUSIONS

WHR is one of better anthropometric measurement because it is association with NLR as a simple marker of inflammation.

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## Provision of Local Food-Based Formula Using *Pila Ampullacea*, Tempeh, and *Moringa Oleifera* Leaves to the Acceptability and Nutrition Intake in Hemodialysis Patients

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### ABSTRACT

**Background:** One of the actions that can be taken to overcome malnutrition in hemodialysis is to improve nutrient intake. It is necessary to provide local food-based formula using *Pila ampullacea*, tempeh with local soybean, and *Moringa oleifera* leaves for hemodialysis patients.

**Objective:** To analyze the effect of local food-based formula using *Pila ampullacea*, tempeh, and *Moringa oleifera* leaves to the acceptability and nutrition intake in hemodialysis patients.

**Materials and Methods:** This study was carried out in Dr. Sardjito Hospital, Yogyakarta, Indonesia from February to March 2020. Subjects were 54 maintenance hemodialysis patients who met the criteria of study. The independent variable was the provision of local food-based formula, while the dependent variable were the acceptability and nutrition intake.

**Results:** As many as 42.59% of subjects were able to consume all the formula given for three days and 50% of subjects have good acceptance of the local food-based formula. The effect of formula intake to the total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, iron showed p-value <0.05, but p-value ≥0.05 for protein, fat, sodium, and potassium. The effect of the non-formula intake to the total intake for all nutrients showed p-value <0.05.

**Conclusion:** Most of the subjects have a good acceptance of the local food-based formula. Formula intake affects total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, and iron, but does not affect total intake of protein, fat, sodium, and potassium. The total intake for all nutrients was affected by the subject's intake of non-formula sources.

**Keywords:** Acceptability; *Moringa oleifera* leaves; Nutrition intake; Snails (*Pila ampullacea*); Tempeh.

### BACKGROUND

Hemodialysis patients are at high risk of experiencing protein energy wasting which increases morbidity and mortality (1). One of the actions that can be taken to overcome malnutrition in hemodialysis is to improve nutrient intake, which can be done by providing additional food during hemodialysis (2). Providing nutritional support to hemodialysis patients can increase protein intake, reduce inflammation, risk of arterial transplant events, cardiovascular events, depression, secondary hyperparathyroidism, and hypertriglyceridemia (3, 4, 5).

Functional food as nutritional support for hemodialysis patients can be made by using a mixture of snails (*Pila ampullacea*), tempeh, and moringa leaves. Each of these local food ingredients contains beneficial nutrients for hemodialysis patients, so that a mixture of the three can form a nutritional support formula that has nutritional content in accordance with the principles of the hemodialysis dietary requirements. The main principle requirements of the hemodialysis diet include the provision of high protein and calcium, but low in phosphorus (6). The priority of providing nutritional support for hemodialysis patients is given orally, which is reported to reduce mortality by up to 35% (7, 8).

Several previous studies related to providing nutritional support to hemodialysis patients have been carried out. Starting from the provision of animal protein sources only in the form of catfish abon which can

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reduce creatinine levels, increase albumin levels, and significantly improve nutritional status based on subjective global assessment, but it can not increase hemoglobin levels of hemodialysis patients (9, 10, 11, 12). The recommendation for protein fulfillment in hemodialysis patients is that 50% of protein needs are met from animal protein and the rest from vegetable protein, which is strengthened by the update of the KDOQI clinical practice guidelines for nutrition in chronic kidney disease in 2020 (13, 14). Previous research related to mixing eel flour as a source of animal protein and tempeh flour as a source of vegetable protein obtained the best proportion of 1:1 (15). Nugget made by mixing eel flour and tempeh flour with a proportion of 1:1 turned out to have a low glycemic index so it can be given to diabetic hemodialysis patients (16). However, these nutritional support products have poor organoleptic results, so a new local food formulation is needed which is predicted to be well received by hemodialysis patients.

The local food-based formula for hemodialysis patients in this study was made from a mixture of local food from snail, tempeh with Indonesian local soybean, moringa leaves, and several food additives such as corn sugar, canola oil, cinnamon powder, rice flour. This formula provides a daily energy contribution of 259.78 kcal, 16.37 grams of protein, 6.23 grams of fat, 34.68 grams of carbohydrates, 6.08 grams of fiber, 1538.32 mg of calcium (17). The nutritional content of the formula has met the requirements for oral nutritional support, which can be given with the addition of 10 kcal/kgBW and 0.3–0.4 grams of protein per kg of body weight every day from daily intake (18).

Local food-based formulas are given in the form of powder and the subjects can turn it into thick liquid food by adding 125 cc of hot water at 90–96°C. The product image is shown in figure 1. Consumers are increasingly interested in functional foods (19).



Figure 1. The local food-based formula product in the form of powder

The organoleptic quality study on local food-based formula products showed that most of the panelists liked the products made from snail, tempeh, and moringa leaves based on the organoleptic quality result. There was no difference between the organoleptic quality studies of the moderately trained panelists group and the trained panelists group in the aspect of color, texture, taste, and aroma. The organoleptic quality study was performed on healthy people (17). Although this local food-based formula is nutritious and meets the requirements of a hemodialysis diet, based on the results of the organoleptic test, it is known that the local food-based formula product is still slightly fishy, slightly unpleasant, and has a bitter after-taste. Therefore, it is necessary to analyze the acceptability and nutritional intake of hemodialysis patients by providing the oral nutritional support formula product. This study aims to analyze the effect of local food-based formula on the acceptance and nutrition intake of hemodialysis patients.

## MATERIALS AND METHODS



This was an experimental research, which was conducted at Dr. Sardjito Hospital, Yogyakarta, Indonesia from February to March 2020. Subjects were 54 maintenance hemodialysis patients who were taken by purposive sampling, which were met the criteria of study. The inclusions criterias were maintenance hemodialysis patients 2 times a week with adequate hemodialysis, aged  $\geq 18$  years, having mild-to-moderate malnutrition based on the Dialysis Malnutrition Score (DMS), no allergy, and willing to be the subject. People with ascites, anasarca edema, having comorbid disease and blood pressure above 160/90 mmHg were excluded.

The independent variable of this study was the provision of local food-based formula, which was defined as the provision of local food-based formula to hemodialysis patients twice a day for three days. The dependent variables were the acceptability and nutrition intake. Acceptability was defined as the ability of hemodialysis patients to receive the local food-based formula which was known based on the food record form, and categorized into good acceptance (if the intake of local food-based formula was  $\geq 75\%$ ) and less acceptance (if the intake of local food-based formula was  $< 75\%$ ).

Nutrition intake was divided into total nutrition intake, formula-based nutrition intake and nonformula-based nutrition intake. Total nutrition intake was defined as the intake of energy, protein, fat, carbohydrates, fiber, water, calcium, phosphorus, sodium, potassium, iron from all foods, drinks, and supplement consumed by the patient, recorded using a 3-days food record form, calculated using Nutrisurvey software, compared to the patient's individual needs, then presented. Formula-based nutrition intake has the same definition as total nutrition intake, but the source of intake comes from the local food-based formula, while the sources of nonformula-based nutrition intake come from other than local food-based formula given.

Local food-based formulas are given in powder form weighing  $\pm 36$  grams per serving which can be diluted with 125 ml hot water at 90–96°C. Previous study showed that protein will be dissolved and denatured at a temperature of 100°C. The increase in heating temperature will cause the protein to be dissolved and denatured. Protein loses its binding power to water so that the water contained in the food will come out (20). Local food-based formulas are recommended to be consumed during the morning and evening interlude hours.

This study can be carried out with the ethical clearance from the Ethical Commission of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia Ref. No. : KE/FK/0989/EC/2019.

## RESULTS

This study involved 54 subjects who were taken by purposive sampling. The sampling process is shown in Figure 2.

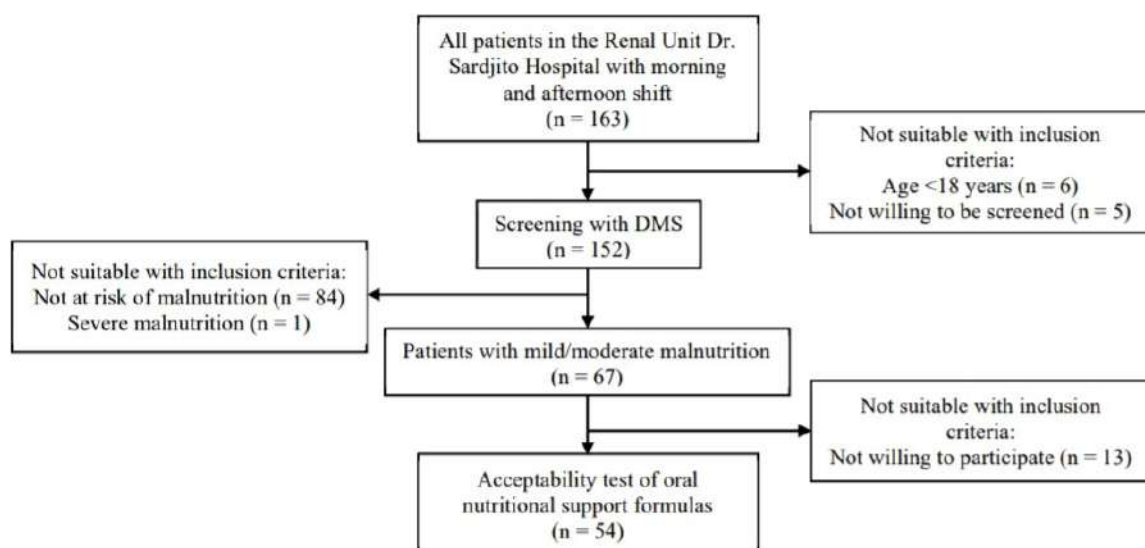


Figure 2. The flow of research

Subjects were given the local food-based formula for three days. Acceptability test was carried out for three days because the interdialytic time is between 3-4 days and a person's acceptability to food or drink could be seen within 3 days of administration. Subjects were asked to record food and drinks consumed during the three days using the food record form. Acceptance and nutritional intake of research subjects were evaluated on the fourth day. The subject's acceptance of the local food-based formula is shown in Figure 3.

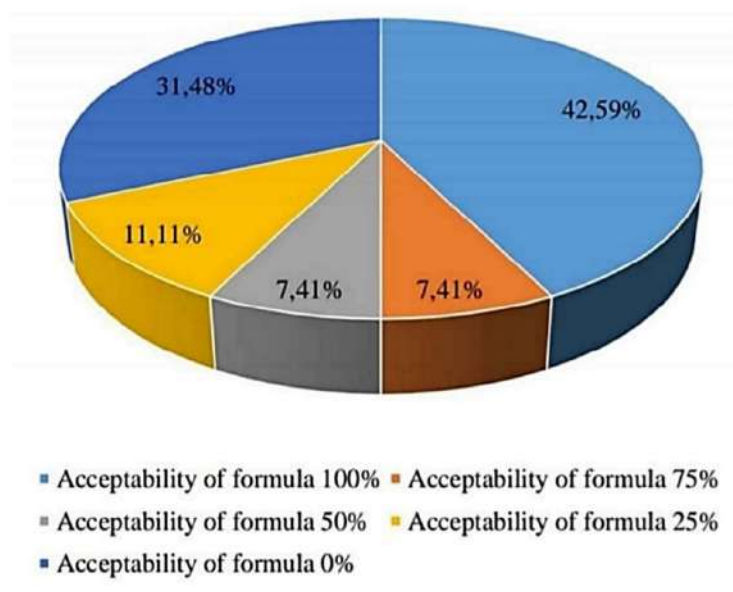


Figure 3. Acceptability of local food-based formula in hemodialysis patients

The results of the acceptance test reported that most of the subjects (42.59%) were able to consume all the local food-based formula given for three days. A small proportion of subjects (7.41%) were able to consume 75% and 50% of the local food-based formula provided by the researchers. There were 31.48% of subjects who did not consume the local food-based formula at all because they felt nauseous and vomited when they smelled the product.

Hemodialysis patients who are categorized as having good acceptance of the local food-based formula are those who are able to consume an average of at least 75% of the product given for three days. As many as 50% of subjects had good acceptance of the local food-based formula.

Table 1. Effect of formula intake and non-formula intake on total intake of hemodialysis patients

Nutrient	Unit	Mean ± SD			R <sup>2</sup>	
		Formula intake	Non-formula intake	Total intake	Formula intake on total intake	Non-formula intake on total intake
Energy	kcal	8,5 ± 7,3	71,2 ± 24,6	79,7 ± 25,9	*0,096	*0,920
Protein	g	14,9 ± 12,6	74,4 ± 30,3	89,3 ± 33,0	0,158	*0,854
Fat	g	6,1 ± 5,3	83,1 ± 34,8	89,2 ± 34,8	0,004	*0,977
Carbohydrate	g	8,2 ± 7,1	64,1 ± 25,4	72,3 ± 27,2	*0,140	*0,933
Fiber	g	11,1 ± 9,0	21,3 ± 17,0	32,4 ± 19,7	*0,263	*0,791
Water	ml	25,5 ± 21,3	79,8 ± 31,1	105,3 ± 42,6	*0,512	*0,773
Calcium	mg	56,0 ± 45,7	85,2 ± 43,8	141,3 ± 58,1	*0,445	*0,397
Phosphorus	mg	7,2 ± 6,1	67,0 ± 27,6	74,2 ± 28,8	*0,088	*0,956
Sodium	mg	2,0 ± 1,6	18,5 ± 14,8	20,4 ± 14,8	0,021	*0,992
Potassium	mg	2,8 ± 2,3	35,2 ± 13,2	38,0 ± 13,7	0,048	*0,983
Iron	mg	31,7 ± 25,8	34,4 ± 16,8	66,0 ± 34,1	*0,772	*0,464

\*p-value is significant based on linear regression analysis

R<sup>2</sup> = the effect of the independent variable on the dependent variable, showed in %

The results reported in Table 1 show that formula intake affects the total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, and iron (p-value <0.05), but does not affect the total

intake of protein, fat, sodium, and potassium ( $p$ -value  $\geq 0.05$ ). However, the magnitude of the effect of formula intake on total nutrient intake is reported to be insignificant, so it is necessary to analyze the effect of non-formula intake on total intake. Analysis of the effect of non-formula intake on total intake was carried out to compare the magnitude of the effect of formula intake and non-formula intake on total intake.

The results of the analysis reported that the total intake for all nutrients was affected by the subject's intake from non-formula sources, including supplements ( $p$ -value  $< 0.05$ ). The magnitude of the effect of non-formula intake on the total intake on average was greater than the magnitude of the effect of formula intake on total intake for all nutrients except calcium and iron.

## **DISCUSSION**

The intake of the subject formula in this study depends on how much the subject accepts the local food-based formula given by the researchers. The acceptability of food is the acceptance of food served that can be accepted by consumers, the measure of the success of food management is that the food served is acceptable and the food is consumed without leaving food leftovers. Acceptance itself as a measure of patient satisfaction (21).

Acceptability of food is directly related to the interaction of food with consumers at any given moment. The factors that influence acceptance include consumer characteristics, sensory characteristics of food and taste factors. Consumer characteristics include consumer expectations, consumer innovation, consumer knowledge and trust, and consumer attitudes towards healthy and functional foods. In sensory characteristics, there are effects of aroma, appearance, taste, and texture on food acceptance (22).

Knowledge of composition, functional properties and to some extent processing steps influence whether a food product will be accepted or rejected by consumers (23). Consumers consume functional foods for health benefits such as disease prevention and access to the protective properties of food. The main factor that encourages the acceptance of functional food is its health characteristics (24). In this study, the subjects have known about the composition of the ingredients used to produce local food-based formulas, as well as the benefits that will be obtained when consuming these products, so as to increase acceptance of the local food-based formula products given.

The patient's acceptance of food affects the nutritional status of the patient. The low food acceptance will have a negative impact on nutritional status, clinical physical condition, and patient recovery (25).

This study shows quite good results, where 50% of the subjects have a good acceptance of local food-based formula products. Clinical formula intake had an effect on increasing the intake of protein, water, and calcium in subjects. The average intake of protein and water from non-formula sources alone is still in the low category ( $< 80\%$  of the need), but after adding the oral nutritional support formula, the total intake of protein and water of the subject is good (80-110% of the needs are met).

The food intake of the subjects in this study was known based on the results of the 3-days food record. The use of the 3-days food record method to determine the food intake of subjects in this study was in accordance with the 2020 Kidney Disease Outcomes Quality Initiative (KDOQI) recommendations regarding the use of the 3-days food record method to assess the nutritional intake of hemodialysis patients (14).

The nutritional requirements used as a comparison for the intake of subjects in this study are based on the KDOQI recommendations for 2020. The recommended protein intake for hemodialysis patients aged  $\geq 18$  years with a stable metabolic condition is 1.0–1.2 g/kg body weight per day. Recommended energy intake of 25-35 kcal/kg body weight per day based on age, sex, level of physical activity, body composition, achievement of expected weight status, and the presence or absence of comorbidities or inflammation in the hemodialysis patient's body (26).

Calcium intake in hemodialysis patients should be considered based on input from dietary calcium, calcium supplements, or calcium-based binders and concurrent use of vitamin D analogues and calcimetics to avoid hypercalcemia or excess calcium (14). The results of this study indicate that the average intake of calcium from non-formula sources alone is in the good category, but after adding oral nutritional support formulas, the average total calcium intake is actually excess ( $> 110\%$  requirement). This is because the subjects are still consuming 3x500 mg of calcium-based phosphate binders per day, so that it makes a big contribution to the calcium intake of hemodialysis patients.

The hemodialysis patient's phosphorus intake should be limited. Dietary potassium intake should be adjusted to maintain serum potassium within the normal range. The fulfillment of potassium from food intake or supplemental potassium is based on the patient's individual needs and the doctor's judgment. Sodium intake should be limited to less than 100 mmol/day (or  $< 2.3$  g/day) to lower blood pressure and

improve fluid volume control in the body. Reducing dietary sodium intake was undertaken as an additional lifestyle modification strategy to achieve better volume control and desired body weight (14).

The results of the analysis of the subject's intake showed that the average intake of total energy, carbohydrates, fiber, phosphorus, sodium, potassium, and iron was still in the low category (<80% requirement) even though it had been added with a nutritional support formula. The average total fat intake was in good category, although the contribution of fat intake from formula was only very small. These results indicate that the compliance of hemodialysis patients in fulfilling nutritional intake is still not good.

The process of hemodialysis can remove most of the waste products in a short time, but some beneficial nutrients are also lost from the body through this process such as protein and water soluble vitamins. Uremia can be accompanied by symptoms of anorexia, nausea, and impaired absorption of food, so as to reduce the nutritional intake of hemodialysis patients. Diet therapy management is very important to maintain hemodialysis stability. Hemodialysis patients need adequate intake of energy, protein, sodium, potassium, phosphorus, and water (26, 27).

The application of dietary management management increases the survival rate of hemodialysis patients and increases the adequacy of hemodialysis, but can cause increased psychological distress in the patient. Many difficulties may be experienced by hemodialysis patients in the practice of diet therapy management. These practical difficulties are related to changes in individual eating habits such as lack of family support, changes in taste, and lack of knowledge (28, 29). Knowledge, family support, attitudes, and behavior can influence dietary adherence of hemodialysis patients in fulfilling nutritional intake according to the recommended dietary therapy (30). Adherence appears to be a multidimensional phenomenon that is patient-related, socioeconomic conditions, therapy-related, health care-related factors and contributes to non-adherence to dietary guidelines and treatment of hemodialysis patients (31).

## CONCLUSION

Most of the subjects were able to finish the local food-based formula for three days. As many as 50% of subjects have a good acceptance of the local food-based formula. Formula intake affects total intake of energy, carbohydrates, fiber, water, calcium, phosphorus, and iron, but does not affect total intake of protein, fat, sodium, and potassium. The total intake for all nutrients was affected by the subject's intake of non-formula sources, including supplements. The magnitude of the effect of non-formula intake on the total intake on average was greater than the magnitude of the effect of formula intake on total intake for all nutrients except calcium and iron. Further research is needed to determine the effect of provision of oral nutrition support formula to nutrition status, immune status, and inflammation status of hemodialysis patients.

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# Unhealthy Diets among Adult Populations in Sleman Districts, Yogyakarta: Pattern and Related Sociodemographic Determinants, Findings from Sleman HDSS

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## ABSTRACT

**Background:** In Yogyakarta Province, the Sleman Regency has the second-highest life expectancy at birth and a high prevalence of non-communicable diseases (NCDs). One of the common NCD risk factors is an unhealthy diet. Thus, it is important to understand the factors that influence an unhealthy diet.

**Objective:** This study aimed to determine sociodemographic factors associated with an unhealthy diet intake in the Sleman Regency population.

**Materials and Methods:** Cross-sectional data from 4,963 adult respondents of the Sleman Health and Demographic Surveillance System was analyzed. A Descriptive test was done to measure the consumption frequency of sweet food and beverages, salty food, high-fat food, and food with monosodium glutamate (MSG). Generalized logistic regression was used to determine socioeconomic factors (residential area, age, gender, education level, marital status, and household wealth) that were associated with a higher frequency of unhealthy food consumption.

**Results:** The majority of respondents reported frequent consumption of sweet food and beverages (82.4%), food that contains high fat (62%), and MSG (75.5%). About 46% of respondents reported frequent consumption of salty food.

**Conclusion:** Education level, sex, age, household wealth status, and residential area are important determinants of a healthy diet.

**Keywords:** Eating habits, Non-communicable diseases, Risk factors, Sociodemographic

## BACKGROUND

Non-communicable diseases (NCDs) are no longer an “affluent countries’ problem”. Low-income and middle-income countries (LMICs) are facing an increase in NCDs while still struggling to control infectious diseases and malnutrition-related problems. According to the World Health Organization report, 71% of global deaths (40.5 million people) in 2016 were attributable to NCDs<sup>1</sup>. Over 75% of NCDs-related deaths occurred in LMICs, and NCDs were also the cause of almost half of premature deaths in these countries<sup>2</sup>.

In 2016, NCDs caused 73% of mortality among Indonesians, mainly due to cardiovascular diseases<sup>3</sup>. In 2019 the estimated six of the top ten causes of death in Indonesia was NCDs<sup>4</sup>. The Indonesia Basic Health Research (RISKESDAS) reported that the prevalence of NCDs among adults in Indonesia has increased between 2013-2018, with increased cases of high blood pressure from 25.8% to 34.1%, stroke from 7.0 per thousand to 12.1 per thousand, and diabetes mellitus from 1.5% to 2.1%<sup>5,6</sup>.

The high prevalence of NCDs undoubtedly put a heavy economic burden on the health and social system, especially in LMICs<sup>7</sup>. Premature mortality and needs for long-term care<sup>8</sup>, due to NCDs, increased the burden on the universal health system, and loss of productivity could hamper the LMICs’ future economic growth<sup>9</sup>. Therefore, NCDs prevention measures are urgently needed in LMICs, especially primary prevention programs that target risk factors to prevent these diseases before they occur. NCDs have been known to have common risk factors, such as elevated blood pressure, high blood total cholesterol, obesity, and lifestyle-related factors e.g., such as low physical activity, tobacco use, excessive alcohol consumption, and unhealthy diets<sup>10</sup>. Unhealthy diets or diets that are associated with a higher risk of NCDs are diets high in sodium, fats, and sugar<sup>10,11</sup>.

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In order to develop a successful intervention, it is important to identify characteristics of sub-population with higher NCD risk factors. For instance, a previous study showed that NCD risk factors were more prevalent in the older age group<sup>12</sup>. In Indonesia, Sleman Regency, Daerah Istimewa (DI) Yogyakarta Province, is among the regencies with the highest life expectancy at birth in Indonesia in 2015 (74.57 years old<sup>13,14</sup>). Consequently, Sleman's older population is increasing<sup>15</sup> and so does the prevalence of NCDs. The 2013 and 2018 RISKESDAS reported that Sleman regency had a relatively higher prevalence of cancer (6.1 per thousand in 2013) and diabetes mellitus (3.1% in 2013, 2.47% in 2018) with an increasing incidence of coronary heart disease (0.7% in 2013)<sup>5,6</sup>.

As for the risk factors of NCDs, Sleman had a lower number of active smokers (around 19% in 2013 and 2018) compared with other regencies in Yogyakarta. However, inadequate physical activity was high (79.5% in 2013) and the consumption of adequate fruits and vegetables (6.8% in 2013, 9.3% in 2018) was low<sup>5</sup>. Most people in Sleman Regency had a frequent consumption of sweet food (77.6%) and high-fat food (53.3%). On the other hand, a lower percentage of the Sleman population had a frequent consumption of salty food (14.5%) and food with monosodium glutamate (MSG; 72.1%)<sup>5</sup>. These findings show that an unhealthy diet is one of the major NCDs risk factors in Sleman Regency. However, research on the factors associated with unhealthy diets, especially in LMICs, is scarce<sup>16</sup>. Thus, the present study used data from the Sleman Health and Demographic Surveillance System (HDSS) Wave Two to describe the patterns of unhealthy diets in the Sleman adults and to determine the sociodemographic factors associated with the frequent consumption of unhealthy food.

## MATERIALS AND METHODS

### Data Source

The present study used data from the Sleman HDSS Wave two (Release 8-0-0). The Sleman HDSS is a population-based survey that gathers data on demographic dynamics and changes in various health problems, including NCDs, infectious diseases, reproductive health, and access to health services. Its first data collection was conducted in 2015, and by 2019, five waves of data collection have been completed. Details concerning the survey methods employed in Sleman HDSS have been described elsewhere<sup>17</sup>. Sleman HDSS data is available for the scientific community upon application for secondary data analysis. More details on data access are available in <https://hdss.fk.ugm.ac.id/>

### Study Sample

There were 4,996 households (20,450 persons) participated in the second wave of Sleman HDSS. Questions regarding the frequency of unhealthy food consumption were asked to the main respondents (head of household or their spouse) in each Sleman HDSS household. A total of 4,965 respondents answered the unhealthy food questionnaire. However, two respondents did not have data on education level; thus, only 4,963 respondents were included in the analysis.

### Main Outcomes

In this study, an unhealthy diet was defined as a diet high in sugar, fat, and sodium. The questionnaire used to assess unhealthy diets was adapted from RISKESDAS 2013. Respondents were asked about how often they consumed sweet food and beverages, salty food, and high-fat food on an average per day, week, month, or year. Their answers were converted into frequency per week, assuming 1 week = 7 days, 1 month = 4 weeks, and 1 year = 48 weeks. The respondents were then divided into three groups according to the frequency of food and beverage consumption: <1/week as rarely (R), 1≤<4/week as occasionally (O), and 4≤/week as frequently (F) consumption groups.

The four types of food were defined as follows: (i) Sweet food and beverages are high in sugar contain, e.g., pastries, candies, cookies, cakes, *dodol* (traditional confection made from sticky rice and palm sugar), *gudeg* (shredded young jackfruits stewed in spices, palm sugar, and coconut milk, canned fruits, processed juice, and syrup-based beverages). Fresh fruit juice, soft drinks, and other beverages labeled as zero-calorie or low sugar were not included in this group. (ii) Salty foods are high in sodium content, e.g., salty snacks and salted food such as salted fish, salted duck eggs, and food that contains soy sauce and shrimp paste. (iii) Food with MSG is any food that contains MSG as a flavor enhancer. (iv) High-fat food includes organ meats (e.g., liver, heart, and brain), egg yolk, shrimp, and coconut milk, as well as assorted fritters (e.g., *tempe* fritters and tofu fritters)<sup>18</sup>.



## Covariates

The residential areas were classified as urban and rural, as defined by Statistics Indonesia. Sex was dichotomized as men and women. Highest education attainment was categorized as low (never schooled or primary education), middle (middle and high school), and high (college and university)<sup>19</sup>. Marital status was categorized as married (currently married) and not married (single or divorced). Household wealth status was derived using principal component analysis based on landholding, durable good ownership (e.g., refrigerator, television, bicycle, motorcycle, and car), and house characteristics (the type of floor, roof, and wall)<sup>20</sup>. The PCA analysis resulted in 5 household wealth quintiles from the highest to the lowest. In this study, we re-categorised them into three household wealth groups, i.e., low/lower-middle, middle, and middle-high/high.

## Statistical Analysis

A total of 4,963 respondents were included in the analysis. Descriptive analysis was conducted to examine the pattern of unhealthy food consumption. Then generalized ordered logistic regression tests were used to determine socioeconomic determinants of higher frequency of unhealthy food consumption<sup>21,22</sup>. This test was used as some of our independent variables violated parallel regression model assumptions, which were tested using the Brant test. Our logistic model, first, was built by regressing each of the food groups in each sociodemographic variable. Then, independent variables found to be significant were entered into the multivariable model. We used post-stratification weighting in both descriptive and inferential tests to reduce sampling error and potential nonresponse bias. Stata 13.1 (StataCorp LLC., Texas, USA) was used to perform all analyses.

## Ethics Approval and Consent to Participate

Sleman HDSS received ethical approval from the Medical and Health Research Ethics Review Committee of the Medical Faculty, Universitas Gadjah Mada (KE/FK/842/EC). Written consent was obtained from Sleman HDSS' respondents after they received an explanation regarding the objectives, design, and procedure of the study. They were also informed that their responses are confidential and that they could withdraw their participation from this study anytime.

## RESULTS

**Table I. Sociodemographic Characteristics of Respondents**

Sociodemographic variables	Weighted proportion (%)	Number of observations (n)
Gender		
Men	50.1	1,791
Women	49.9	3,174
Age group (years)		
18–49	72.4	2,563
50+	27.6	2,402
Education level		
Low	19.0	1,483
Middle	62.9	2,679
High	18.3	801
Marital status		
Not married	34.5	1,033
Married	65.5	3,932
Household wealth		
Low/lower-middle	39.2	2,015
Middle	20.5	977
Middle-high/high	40.3	1,973
Residential area		
Rural	16.5	828
Urban	83.5	4,137

Table I present the weighted proportion of respondents' sociodemographic characteristics. The proportion of men and women in this study was in balance. Most of them were aged 18 to 49 years (72%), had middle-level education (63%), were married (65%), lived in urban areas (83%), and from a household with higher economic status (40%).

More than half of the respondents reported that they frequently consumed food and beverages that contain high sugar (82.4%), as well as food with high-fat content (62%) and MSG (75.5%), and around 46% reported frequent consumption of salty food (Figure 1).

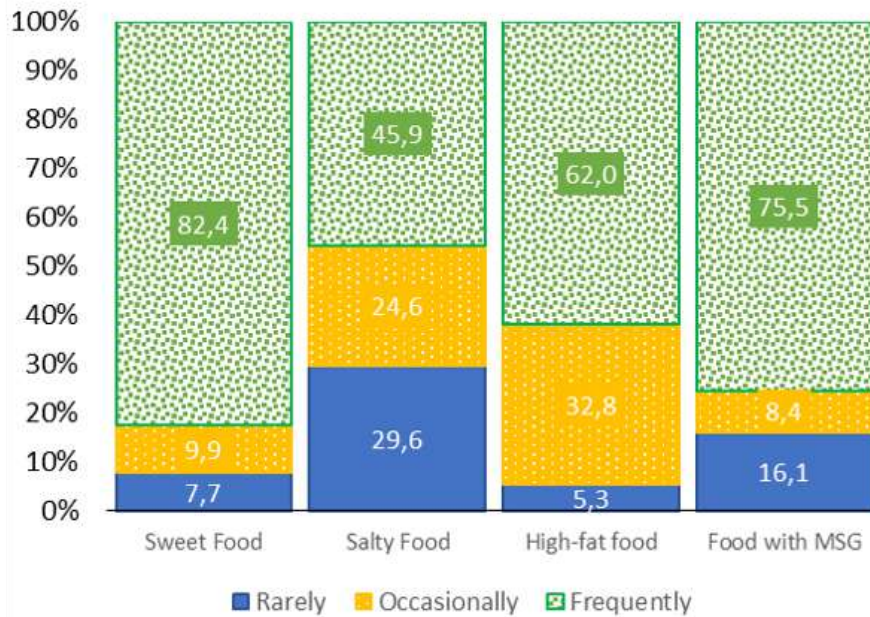


Figure 1. The Distribution of Categorical Response to Each Food/Beverage Type

Results from multivariable generalized ordered logistic regression tests are shown in Table II. We found some covariates tested did not meet the parallel regression assumption. For age group and education (salty and MSG models) and sex (sweet and high-fat food models), the odds ratios (OR) that describe the relationship between the lowest versus all higher categories of the covariates were not the same as those that describe the relationship between the next lowest category and all higher categories.

Our results showed that women and people with higher education levels are less likely to have frequent consumption of sweet food and beverages. The OR for women was less than one and decreased across outcome categories (R vs. O&F, OR=0.7 95% confidence interval [CI]=0.5–0.9; R&O vs. F, OR=0.5 95%CI=0.4–0.7), which showed that women were more likely to consume sweet food and beverages occasionally compared to men. The opposite effect was observed for household wealth. Higher household wealth was associated with 1.4 times higher frequency of sweet food and beverage consumption (Table 2) and predicted probability of the outcome is available in the appendix.

Similarly, women consumed salty food more frequently compared to men (OR=1.2 95%CI=1–1.4). People with a higher education level had 1.5 times higher odds of consuming salty food occasionally or frequently (R vs. O&F, OR=1.5 95%CI=1.1–2.1). On the other hand, being older (more than 50 years) was associated with less frequent consumption of food with high salt content (R vs. O&F, OR=0.6 95% CI=0.5–0.7; R&O vs. F, OR=0.8 95% CI=0.7–0.9).

Concerning the consumption of high-fat food, people who lived in urban areas (OR=1.4 95%CI=1.1–1.7) and those from households with higher socioeconomic status (OR=1.4; 95%CI=1.1–1.8) consumed fatty food more frequently. On the contrary, older people consumed this food group less frequently (OR=0.7 95%CI=0.6–0.9). Sex was only significant when comparing the frequency of unhealthy consumption with a combination of rarely and occasionally (R&O vs. F, OR=1.3 95%CI=1.1–1.6). Indicating that the odds of having frequent or occasional instead of rare consumption were not different between men and women. However, women significantly had a higher OR of reporting frequent high-fat food consumption.

As for food with MSG, older age (R vs. O&F, OR=0.5 95%CI=0.4–0.6; R&O vs. F, OR=0.6 95%CI=0.5–0.7), higher household wealth (OR=0.6; 95%CI=0.5–0.8), and higher education level (R vs. O&F, OR=0.4 95%CI=0.3–0.6; R&O vs. F, OR=0.5 95%CI=0.4–0.7) were associated with less frequent consumption of food with MSG.

**Table 2. Multivariate Logistic Regression of The Association Between Sociodemographic Factors Among Sweet Food, Salty Food, High-Fat Food, and Food Containing MSG**

	Sweet food			Salty food			High-fat food			Food containing MSG		
	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI
Combined model												
Residential area (vs. rural)												
Urban	0.84	0.26	0.62 1.14	0.96	0.73	0.76 1.21	1.35	0.01	1.06 1.72	0.77	0.05	0.60 1.00
Sex (vs. Men)												
Women				1.18	0.05	1.00 1.39				0.86	0.14	0.70 1.05
Age group (vs. <50 years)												
50+	0.94	0.55	0.77 1.14				0.74	0.00	0.64 0.86			
Wealth status (vs. low)												
Middle	0.97	0.88	0.70 1.36	1.00	0.96	0.79 1.28	1.05	0.74	0.80 1.37	1.10	0.49	0.83 1.48
Higher middle/high	1.4	0.04	1.02 1.91	1.08	0.51	0.86 1.34	1.42	0.00	1.12 1.80	0.64	0.01	0.49 0.84
Education (vs. low)												
Middle	0.86	0.30	0.66 1.13				0.81	0.04	0.66 0.99	0.93	0.53	0.73 1.18
High	0.56	0.01	0.37 0.84				0.88	0.42	0.65 1.19			
Marital status (vs. not married)												
Married	1.14	0.32	0.88 1.49	0.89	0.26	0.73 1.09	0.94	0.61	0.75 1.18	0.95	0.69	0.74 1.22
Unique model: Rarely vs. Occasionally and Frequently												
Sex (vs. men)												
Women	0.72	0.04	0.52 0.99				0.81	0.29	0.56 1.19			
Age group (vs. <50 years)												
50+				0.62	0.00	0.53 0.73				0.49	0.00	0.40 0.59
Education (vs. low)												
Middle				1.17	0.15	0.94 1.45						
High				1.51	0.01	1.11 2.05				0.42	0.00	0.30 0.59
Unique model: Rarely and Occasionally vs. Frequently												
Sex (vs. Men)												
Women	0.54	0.00	0.42 0.69				1.34	0.00	1.11 1.61			
Age group (vs. <50 years)												
50+				0.80	0.00	0.68 0.93				0.58	0.00	0.48 0.69
Education (vs. low)												
Middle				0.96	0.69	0.77 1.18						
High				1.01	0.94	0.74 1.38				0.50	0.00	0.36 0.70

Note: Combined model is for covariates that follow parallel regression assumption; MSG, monosodium glutamate; OR, odds ratio; CI, confidence interval.

## DISCUSSION

The present research aimed to describe patterns of unhealthy food consumption in Sleman Regency, DI Yogyakarta Province, and to determine sociodemographic factors associated with frequent consumption of unhealthy food. We found mixed association between sociodemographic factors and each food group assessed.

In our study, the older Sleman population consumed salty, fatty, and food with MSG less frequently. Studies have shown that older populations tend to make food choices based on health considerations<sup>23–26</sup>. However, there was no significant difference in frequency of sweet food and beverages consumption by age group, around 82% of younger adults and 83% of older adults in this study reported frequent consumption of sweet food and beverages (data not shown). These findings seem to indicate that older adult in Sleman put more consideration on health value when deciding whether to consume food contains high sodium and fat but not for food and beverages with high sugar content.

Contextual factor e.g., culture, may have a significant influence on sweet food consumption in our population. Yogyakarta's cuisine is characterized by its sweet taste. Approximately 75% of Yogyakarta's traditional dishes require sugar<sup>27</sup>. Most of the traditional beverages also contain palm sugar or lump sugar. However, we suspect that the high frequency of sweet food and beverages consumption was related to the majority of Javanese people who drink traditional tea daily, which is called *teh nasgitel*. *Nasgitel* is an abbreviation of the Javanese words for *panas* means hot, *legi* means sweet, and *kenthel* means thick.

The importance of sugar in Javanese diets can be traced back to the Dutch colonization era. Between 1830 and 1940, *Tanam Paksa* ("Enforcement Planting") policy was implemented in Indonesia. In Java, export crops, such as sugarcane, had to be grown instead of rice. Thus, sugar became an energy source that was easily accessible by Javanese people<sup>27</sup>. As food and beverages with a sweet taste have always been part of their habitual food selection, adults in Sleman, especially older adults, may persist in their sweet food preference even when changes in their health required the opposite.

Our findings also showed that women and people with a high education level were more likely to consume sweet food and beverages less frequently. Higher education level was also associated with less frequent consumption of food with MSG and fatty food. Previous studies have reported that women have a healthier diet and they are more likely to take up and adhere to healthy behavior. Similarly, education level is also a known factor associated with dietary change in adulthood<sup>26</sup>. Adults with higher education have a better comprehension and uptake of health education or advice from health professionals<sup>26,28</sup>.

Surprisingly, we also found that adult women in our population consumed salty and fatty food more frequently. Similar findings were reported by RISKESDAS 2018. That is more women reported frequent consumption of salt (30.5% vs. 28.9%) and fatty (42.8% vs. 40.7%) food compared to men<sup>6</sup>. On contrary, a study conducted on university students from 23 countries in Europe and Asia reported that women were more likely to report consumption of fruits and restrict intake of high-fat foods and salt<sup>29</sup>.

Snacking habits might contribute to the sex-difference in fatty and salty food intake. Ovaskainen et al.<sup>30</sup> reported that a "snack-dominating meal pattern" was observed in 19% of men and 24% of women among a sample of 2,007 Finnish adults (25–64 years old)<sup>30</sup>. Kuczmarski et al. reported that 86% of African-American women prefer snacking<sup>31</sup>. The most frequently consumed snack groups are salty snacks (16.4%), grain-based desserts (14.8%), and then sweetened beverages (10.7%). A recent qualitative study from the World Food Program involving adolescents in Indonesia showed that the most favorite snack foods among the adolescents are meatball soup (*bakso*; 54%), fried snack (fritters; 53%), steamed fish dumplings with vegetables and peanut sauce (*siomay*; 46%), instant noodles (39%), and beverages and dessert (37%)<sup>32</sup>. These various foods contain a high fat and high salt content.

In our study, adults from the more affluent households reported more frequent consumption of food with high sugar and fat content but less frequent consumption of food with MSG. Household wealth and education level are resources that influence food choices. In making food selections, people are aware of their available resources<sup>33</sup>. In this study, having more economic resources allowed adults in Sleman to have more food or snack choices that have a high sugar and fat content. As mentioned before, the popular snacks in Indonesia are likely to have a high content of fat, salt, and sugar. Similar findings have been reported before, showing that the higher socioeconomic status was related to high energy and saturated fat consumption<sup>34</sup>.

On the other hand, being from a wealthy household gave them more decision-making power to choose food with no MSG. There is common knowledge that MSG is associated with harmful health effects and that several previous studies also support this claim<sup>35,36</sup>. Still, MSG is a popular flavor enhancer used by

food producers. The increasing demand for food without MSG increases its price. Radam reported that respondents are willing to pay more for food that has the label “No Added MSG”<sup>37</sup>. Therefore, the association between high household wealth and less consumption of food with MSG is more likely because they could afford to buy food without MSG.

In our study, frequent consumption of high-fat food was also associated with living in urban areas. One possible explanation is that modern/fast food is more available in urban areas and is characterized by its high-fat content. The differences in nutritional intake between people in urban and rural areas have already been reported. The 2011 China Health and Nutrition Survey found that children (4–17 years old) living in urban and rural areas have similar total energy intake, but children from urban areas have the highest consumption of fat and animal source (40% of daily energy intake)<sup>38</sup>. The urban population tends to consume more high-fat food because they are more exposed to easier access to cheap energy-dense food, higher-quality food, high-fat food availability, supermarket existence, and lower food prices<sup>34,39,40</sup>.

One strength of this study is related to the used of data from a population survey, the Sleman HDSS, making our findings more representative of the adult Sleman population in general. Additionally, we adopted an instrument used to measure our main outcomes from a National Survey (RISKESDAS), thus ensuring the comparability of our findings to other areas in Indonesia. However, we also acknowledge that because of the nature of the self-reporting instrument, our findings may overestimate or underestimate the true frequency of consumption. Also, we can not objectively define “unhealthy” diet in this study as there was no information about the amount of food or beverages consumed. Thus, future studies are needed to evaluate further examine sociodemographic factors associated with the actual salt, sugar, and fat intake in LMICs.

## CONCLUSION

Majority of adults in Sleman regency frequently consumed foods or beverages that high in sugars, fats, and contain MSG. Education level, sex, age, household wealth status, and residential areas are important determinants of a healthy diet in the Sleman adult population. These findings support the need for health intervention programs that target changes in food preference and consumption in Sleman adults’ populations. These programs should be designed by considering targets’ health and sociodemographic profiles.

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**Appendix**

Table A1. Predicted probability of Sweet Food, Salty Food, High-Fat Food, and Food Containing MSG consumption, overall and by covariate

		Sweet food			Salty food			High-fat food			Food containing MSG		
		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI	
<b>Rarely</b>	<i>Overall</i>	0.08	0.07	0.09	0.32	0.31	0.34	0.06	0.05	0.07	0.18	0.17	0.19
<b>Occasionally</b>	<i>Overall</i>	0.11	0.09	0.12	0.23	0.21	0.25	0.33	0.31	0.34	0.09	0.08	0.1
<b>Frequently</b>	<i>Overall</i>	0.82	0.8	0.83	0.45	0.43	0.47	0.62	0.6	0.63	0.73	0.72	0.75
<b>Rarely</b>	<i>Residential area</i>												
	Rural	0.07	0.05	0.09	0.31	0.27	0.36	0.07	0.05	0.09	0.15	0.12	0.18
	Urban	0.08	0.07	0.09	0.32	0.3	0.34	0.05	0.04	0.06	0.19	0.17	0.2
<b>Occasionally</b>	<i>Residential area</i>												
	Rural	0.1	0.07	0.12	0.23	0.21	0.25	0.37	0.33	0.41	0.08	0.06	0.09
	Urban	0.11	0.09	0.12	0.23	0.21	0.25	0.32	0.3	0.34	0.09	0.08	0.1
<b>Frequently</b>	<i>Residential area</i>												
	Rural	0.84	0.8	0.87	0.46	0.41	0.51	0.56	0.51	0.61	0.77	0.73	0.81
	Urban	0.81	0.8	0.83	0.45	0.43	0.47	0.63	0.61	0.65	0.73	0.71	0.74
<b>Rarely</b>	<i>Sex</i>												
	Men	0.06	0.05	0.08	0.34	0.32	0.37	0.05	0.04	0.06	0.17	0.15	0.19
	Women	0.09	0.07	0.1	0.31	0.29	0.33	0.06	0.05	0.07	0.19	0.17	0.21
<b>Occasionally</b>	<i>Sex</i>												
	Men	0.07	0.05	0.08	0.23	0.22	0.25	0.38	0.35	0.41	0.08	0.07	0.09
	Women	0.13	0.11	0.15	0.23	0.21	0.25	0.3	0.28	0.32	0.09	0.08	0.1
<b>Frequently</b>	<i>Sex</i>												
	Men	0.87	0.85	0.89	0.42	0.39	0.45	0.57	0.54	0.6	0.75	0.72	0.78
	Women	0.78	0.76	0.8	0.46	0.44	0.49	0.64	0.62	0.66	0.72	0.7	0.74
<b>Rarely</b>	<i>Age group</i>												
	18-49	0.08	0.06	0.09	0.27	0.25	0.3	0.05	0.04	0.06	0.13	0.12	0.15
	50+	0.08	0.07	0.09	0.37	0.35	0.39	0.06	0.05	0.08	0.24	0.22	0.26
<b>Occasionally</b>	<i>Age group</i>												
	18-49	0.1	0.09	0.12	0.25	0.23	0.28	0.3	0.28	0.32	0.08	0.07	0.1
	50+	0.11	0.09	0.12	0.21	0.19	0.23	0.35	0.33	0.38	0.09	0.07	0.1
<b>Frequently</b>	<i>Age group</i>												
	18-49	0.82	0.8	0.84	0.48	0.01	0.5	0.65	0.63	0.67	0.78	0.76	0.8
	50+	0.81	0.79	0.83	0.42	0.4	0.44	0.58	0.56	0.6	0.68	0.66	0.7
<b>Rarely</b>	<i>Wealth status</i>												
	Low	0.09	0.07	0.11	0.33	0.3	0.36	0.06	0.05	0.08	0.16	0.13	0.18
	Middle	0.09	0.07	0.11	0.33	0.29	0.37	0.06	0.05	0.08	0.14	0.12	0.17
	Higher middle/high	0.06	0.05	0.08	0.31	0.28	0.34	0.05	0.04	0.06	0.22	0.2	0.25
<b>Occasionally</b>	<i>Wealth status</i>												
	Low	0.12	0.1	0.13	0.23	0.22	0.25	0.35	0.32	0.38	0.08	0.07	0.09
	Middle	0.12	0.09	0.14	0.23	0.21	0.25	0.35	0.31	0.38	0.07	0.06	0.09
	Higher middle/high	0.09	0.07	0.11	0.23	0.21	0.25	0.29	0.26	0.32	0.1	0.09	0.12



		Sweet food			Salty food			High-fat food			Food containing MSG		
		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI		Predicted probability	95% CI	
<b>Frequently</b>	<i>Wealth status</i>												
	Low	0.8	0.77	0.83	0.44	0.41	0.47	0.58	0.55	0.62	0.76	0.73	0.79
	Middle	0.79	0.75	0.83	0.44	0.4	0.49	0.59	0.55	0.64	0.78	0.74	0.82
	Higher middle/high	0.84	0.82	0.87	0.46	0.42	0.49	0.66	0.63	0.7	0.68	0.65	0.71
<b>Rarely</b>	<i>Education level</i>												
	Low	0.07	0.05	0.08	0.35	0.32	0.39	0.05	0.04	0.06	0.15	0.13	0.18
	Middle	0.08	0.06	0.09	0.32	0.29	0.34	0.06	0.05	0.07	0.16	0.14	0.18
	High	0.11	0.08	0.15	0.27	0.22	0.31	0.06	0.04	0.07	0.29	0.25	0.34
<b>Occasionally</b>	<i>Education level</i>												
	Low	0.09	0.08	0.11	0.19	0.17	0.22	0.3	0.27	0.33	0.08	0.07	0.1
	Middle	0.1	0.09	0.12	0.24	0.21	0.26	0.34	0.32	0.36	0.09	0.07	0.1
	High	0.14	0.11	0.17	0.28	0.23	0.33	0.32	0.28	0.37	0.08	0.06	0.1
<b>Frequently</b>	<i>Education level</i>												
	Low	0.84	0.81	0.87	0.45	0.41	0.49	0.65	0.61	0.68	0.76	0.73	0.8
	Middle	0.82	0.8	0.84	0.44	0.42	0.47	0.6	0.57	0.62	0.75	0.73	0.77
	High	0.75	0.69	0.8	0.46	0.4	0.51	0.62	0.57	0.67	0.62	0.57	0.68
<b>Rarely</b>	<i>Marital status</i>												
	Not married/ divorced	0.18	0.15	0.2	0.3	0.27	0.34	0.05	0.04	0.07	0.18	0.15	0.2
	Married	0.18	0.17	0.2	0.33	0.31	0.34	0.06	0.05	0.07	0.18	0.17	0.2
<b>Occasionally</b>	<i>Marital status</i>												
	not married/ divorced	0.08	0.07	0.1	0.23	0.21	0.24	0.32	0.28	0.35	0.08	0.07	0.1
	Married	0.09	0.08	0.1	0.23	0.22	0.25	0.33	0.31	0.35	0.09	0.08	0.1
<b>Frequently</b>	<i>Marital status</i>												
	not married/ divorced	0.74	0.7	0.78	0.47	0.43	0.51	0.63	0.58	0.67	0.74	0.7	0.78
	Married	0.73	0.71	0.75	0.44	0.42	0.46	0.61	0.6	0.63	0.73	0.71	0.75

## Prevalence of Anemia and Correlation with Knowledge, Nutritional Status, Dietary Habits among Adolescent Girls at Islamic Boarding School

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### ABSTRACT

**Background:** Anemia is a globally public health problem, including in Indonesia (22.2%) and it has negative health impacts. Adolescent girls have high risk of anemia. Previous studies reported that adolescent girls at Islamic boarding school had low food intake and poor knowledge about nutrition in preventing anemia.

**Objectives:** To assess the prevalence of anemia and to analyze association between knowledge, nutritional status, and dietary habits and anemia in adolescent girls.

**Materials and Methods:** A cross-sectional study was conducted in November 2020 among adolescent girls at Islamic boarding school in Semarang. A total of 162 respondents were selected by cluster sampling. Anemia was determined by measuring the hemoglobin level in the blood by Cyanmethemoglobin method. Knowledge and dietary habits were collected through questionnaires. Nutritional status was assessed by measuring weight and height, then classified by body mass index for age using WHO Anthro. Bivariate and multivariate logistic analysis were used to test hypothesis and it was significant if  $p < 0.05$ .

**Results:** The prevalence of anemia was found to be 17.3%. In the bivariate analysis, overweight was more likely to have anemia ( $p = 0.044$ ). There was no association between father's education, mother's education, knowledge, frequency of staple food, breakfast habits, consumption of animal side dishes, consumption of vegetable side dishes, consumption of sweet tea and anemia. Multivariate model showed that overweight ( $OR = 3.658$ ;  $95\%CI = 1.224-10.932$ ;  $p = 0.020$ ) and good knowledge ( $OR = 3.652$ ;  $95\%CI = 1.221-10.922$ ;  $p = 0.020$ ) were significant associated with the anemia.

**Conclusion:** Nutritional status and knowledge were significantly associated with anemia among adolescent girls.

**Keywords:** anemia, adolescent girl, Islamic boarding school, knowledge, nutritional status

### BACKGROUND

Anemia is one of the global health problems which happened in the low, middle, and high income countries.<sup>1,2</sup> The group which has high risk of anemia is adolescent girls.<sup>3</sup> According to The Ministry of Health Indonesia, adolescents are individuals in 10-18 years age group.<sup>4</sup> Adolescent girls have high risk of anemia because of some conditions such as increased need of iron intake, blood loss during menstruation, lack of iron intake, worm infections, early marriage, and teenage pregnancy.<sup>3,5</sup> Adolescent girls can suffer from anemia if their blood hemoglobin level is less than 12 g/dl.<sup>5</sup>

Anemia is caused of many factors. The main factor is 50% iron intake deficiency.<sup>2,3</sup> Some studies have reported high iron diet consumption, nutritional status, and knowledge are related to anemia among adolescent girls.<sup>6-8</sup> Anemia can caused various adverse impacts on adolescent girls, such as decreasing immunity, easily exposed infections, decreasing physical fitness and thinking agility due to muscle cells and brain cells lack of oxygen, decreasing learning achievement and performance productivity.<sup>5</sup> A study in India have reported anemic adolescent girls had low scores on numeracy test and visual memory than non-anemic adolescent girls.<sup>9</sup> Anemic adolescent girls will have a high risk of anemia during pregnancy. It has negative impacts on the fetus' growth and development. Moreover, anemia in pregnancy have risks to pregnancy and delivery complications such as low birth weight, stunting, and child and maternal mortality.<sup>5,10</sup>

The prevalence of anemia among adolescent girls in the world is approximately 29%.<sup>2</sup> Some studies reported that anemia prevalence in Indonesia is estimated at 30%.<sup>3</sup> There are less study about anemia among Indonesian adolescent girls. The prevalence of anemia as a public health problem is categorized as follows:  $< 5\%$ , no public health problem;  $5-19.9\%$ , mild public health problem;  $20-39.9\%$ , moderate public health problem; and  $\geq 40\%$ , severe public health problem.<sup>2</sup>

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A study in Indonesia reported that anemia prevalence among adolescent girls at islamic boarding school was 52.25%.<sup>11</sup> Central Java, the third largest province in Indonesia, has 57.1% adolescent girls aged 10-18 years old who suffer from anemia.<sup>12</sup> Semarang is the capital city of Central Java. There has been no official report from *Dinas Kesehatan Kota Semarang* regarding the prevalence of anemia in adolescent girls. There is only a few study about anemia among adolescent girls in Semarang such as a study by Annisa reported 21.9% adolescent girls in Senior High School 11 Semarang had anemia.<sup>13</sup>

Islamic boarding school is one of choice to study for adolescent girls beside studying in public school. At islamic boarding school, students have food intake from their school. A study in 2019 showed that 72% of female students in islamic boarding school had bad dietary habits.<sup>14</sup> Islamic boarding school serves almost the same food menu every day. Therefore, adolescent girls at islamic boarding school have low food intake because they are bored of the food.<sup>15</sup> Low food intake quality and low iron bioavailability are the main factors of iron deficiency.<sup>16</sup> A previous study has reported that 54% adolescent girls had poor knowledges.<sup>17</sup> Studies about anemia among adolescent girls in Semarang especially at islamic boarding school is still limited. Measurement of hemoglobin (Hb) level to determine anemia status in previous studies used a portable hemoglobinometer. It is used for screening of anemia. Cyanmethemoglobin method is a method to measure Hb level recommended by International Committee for Standarization in Hematology (ICSH). In this study, the researchers used Cyanmethemoglobin to determine the Hb level. This study aimed to assess prevalence of anemia and to analyze association between knowledge, nutritional status, and dietary habits with anemia among adolescent girls at islamic boarding school in Semarang. This result of this study can be useful for supporting anemia prevention program among adolescent girls.

## MATERIALS AND METHODS

An observational analytic study with cross-sectional design was conducted in November-December 2020 among adolescent girls aged 14 to 18 years at islamic boarding school in Semarang. This study was an initial study from a study entitled "The Effectiveness of Iron-Folic Acid Tablet Supplementation and Anemia Education as Prevention Anemia Among Adolescent Girls in Semarang City". The inclusion criteria of the subjects are female students aged 14 to 18 years old living at islamic boarding school, capable to communicate well, and willing to be respondent in this study. Respondents taking iron-folic acid tablet for the last 3 months, having disease or getting treatment in one last month such as tuberculosis, intestinal worms, menstrual bleeding, and HIV/AIDS were excluded from the study. A total of 162 adolescent girls from 3 islamic boarding schools were selected as subjects for this study by *cluster sampling* (40, 40, 82 students from school A, B, C, respectively). This number has fulfilled the minimum sample size 94 which calculated by Lemeshow formula, which  $d=10\%$ ,  $P=0.58$ ,  $Z^2 \cdot 1-\mu/2=1.96$ .<sup>18</sup>

Ethical clearance was obtained from the Ethical Review Board of Faculty of Medicine, Diponegoro University No. 265/EC/KEPK/FK-UNDIP/XII/2020. The informed consent was given to respondent's parents through the islamic boarding school's trustee. To collect the data during the COVID-19 pandemic, the researcher and respondents always obey the health protocol in prevention COVID-19 such as wearing masks, maintaining distances, and washing hands with soap before entering and leaving the islamic boarding school.

Dependent variable was anemia status. Anemia was measured by taking the blood by laboratory analysis to assess Hb level by Cyanmethemoglobin method. Cyanmethemoglobin method is a method to measure Hb level recommended by International Committee for Standarization in Hematology (ICSH). Respondents were categorized anemia if Hb level  $<12$  gr/dl and normal if Hb level  $\geq 12$  gr/dl. Anemia was classified as mild anemia if Hb level 11.0-11.9 gr/dl, moderate anemia if Hb level 8.0-10.9 gr/dl, and severe anemic if Hb level  $<8.0$  gr/dl.

Independent variables were nutritional status, knowledge, and dietary habit. Demographic data such as age, parent's education was also observed as additional data. The researcher measured respondents' weight by digital scale and the height by microtoise staturmeter to assess body mass index (BMI). The digital scale and microtoise had been calibrated by the researcher. BMI for age was calculated by using WHO calculator with help of z scores tables. Nutritional status was determined by BMI results. Knowledge was tested through questionnaire which consist of 30 true or false questions. The questionnaires were about description, sign and symptom, risk factor, impact, and nutrition prevention of anemia. Knowledge level was classified into 'poor knowledge' if the correct answer was  $<75\%$  and 'good knowledge' if the correct answer was  $\geq 75\%$ . Dietary habits were staple food frequency, breakfast habit, snack habit, animal and vegetable side dishes consumption, vegetable and fruit consumption, sweet tea and street food consumption. The dietary habit was collected by questionnaire.

Data was edited, entry and analyzed by univariate, bivariate, and multivariate using SPSS 20 software. The univariate analysis used descriptive test. Bivariate logistic regression was used to analyze factors associated with anemia. Variable observed in the bivariate logistic regression analysis with a p-value <0.025 were included in the multivariate binary logistic regression. Results with p-value <0.05 were considered statistically significant.

## RESULTS

### Prevalence of anemia

From a total of 164 students participated in this study, 162 (98.7%) responded for the enquiry. Twenty eight (17.3%) respondents had anemia and classified into mild anemia 13.6% and moderate anemia 3.7%. None of respondents was classified as severe anemia ([figure 1](#)).

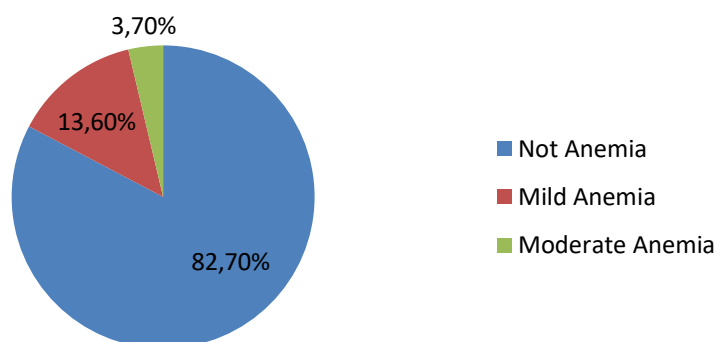


Figure 1. The prevalence of anemia among adolescent girls at Islamic boarding school in Semarang, 2020

### Respondent characteristics

The respondents were in the age range of 14-18 years old and in high school. High school graduated was the most parent's education. More than half (59.3%) respondents had normal nutritional status and good knowledge (66%) ([table 1](#)).

Table 1. Respondents characteristic, nutritional status and knowledge among adolescent girls at islamic boarding school in Semarang, 2020

Variable	Frequency n(%)	Mean ( $\pm$ SD)	Median (Min-Max)
<b>Age</b>		16.48( $\pm$ 1.059)	17(14-18)
<b>Father education</b>			
Primary school	43 (26.5%)		
Secondary school	42 (25.9%)		
Senior high school	62 (38.3%)		
Bachelor Degree	15 (9.3%)		
<b>Mother education</b>			
Primary school	41 (25.3%)		
Secondary school	50 (30.9%)		
Senior high school	58 (35.8%)		
Bachelor Degree	12 (7.4%)		
<b>Nutritional status</b>			
Underweight	15 (9.3%)		
Normal	96 (59.3%)		
Overweight	21 (13%)		
Obese	30 (18.5%)		
<b>Knowledge</b>			
Poor	55 (34%)		
Good	107 (66%)		

### Dietary habit

The majority (57.4%) of respondents had staple food 3 times a day, and 77.2% had snacks sometimes. The examples of snacks consumed by respondents were cakes, chips, bread and snacks sold in the school canteen. Most of the respondents (80.2%) answered that they sometimes consume animal side dishes in a day such as eggs, chicken, and fish. The majority (74.7%) of respondents admitted consuming vegetable side dishes every day, such as tempeh and tofu. There were 63.6% of respondents that eat vegetables every day such as soup, mustard greens, spinach, kale, and long beans. It was different from the habit of consuming fruit which most of respondents (74.1%) consumed fruit occasionally. The fruits were consumed by respondents were orange, watermelon, apple and papaya. Most of the respondents rarely consumed sweet tea (90.7%) and often consumed street food (93.2%) (table 2). The snacks were chips, fried foods, chocolate, and other snacks in the canteen.

**Table 2. Description of dietary habit for adolescent girls at islamic boarding school in Semarang**

<b>Variable</b>	<b>Frequency (%)</b>
<b>Staple Food Frequency</b>	
<3x /day	69 (42.6%)
3x /day	93 (57.4%)
<b>Breakfast Habit</b>	
Rarely	7 (4.3%)
Sometimes	94 (58%)
Always	61 (37.7%)
<b>Snack Habit</b>	
Rarely	18 (11.1%)
Sometimes	125 (77.2%)
Always	19 (11.7%)
<b>Animal Side Dishes Consumption</b>	
Rarely	28 (17.3%)
Sometimes	130 (80.2%)
Always	4 (2.5%)
<b>Vegetable Side Dishes Consumption</b>	
Rarely	2 (1.2%)
Sometimes	39 (24.1%)
Always	121 (74.7%)
<b>Vegetable Consumption</b>	
Rarely	12 (7.4%)
Sometimes	47 (29%)
Always	103 (63.6%)
<b>Fruit Consumption</b>	
Rarely	37 (22.8%)
Sometimes	120 (74.1%)
Always	5 (3.1%)
<b>Sweet Tea Consumption</b>	
Rarely	147 (90.7%)
Often	15 (9.3%)
<b>Street Food Consumption</b>	
Rarely	11 (6.8%)
Often	151 (93.2%)

### **Associated factors of anemia among adolescent girls**

There was a significant association between nutritional status ‘overweight’ (p=0.044;OR=2.860;95%CI=1.026-7.969) with anemia. There was no relationship between father’s education level, mother’s education, staple food frequency, breakfast habit, consumption of animal side dishes, consumption of vegetable side dishes, sweet tea consumption, knowledge and anemia status (table 3). Multivariate logistic regression analysis showed that the variables associated with anemia were overweight

( $p=0.020$ ;  $OR=3.658$ ;  $95\%CI=1.224-10.932$ ) and good knowledge ( $p=0.020$ ;  $OR=3.652$ ;  $95\%CI=1.221-10.922$ ) (table 4).

**Table 3. Bivariate analysis of associated factors of anemia among adolescent girls in Semarang, 2020**

Variable	Anemia Status				p value	OR (95% CI)
	Anemic		Normal			
<b>Father education</b>						
Primary school	6	14%	37	86%	0.109	0.324 (0.082-1.285)
Secondary school	7	17%	35	83%	0.182	0.400 (0.104-1.536)
Senior high school	10	16%	52	84%	0.140	0.385 (0.108-1.368)
Bachelor Degree	5	33%	10	67%	1	
<b>Mother education</b>						
Primary school	5	12%	37	88%	0.666	0.676 (0.114-4.016)
Secondary school	7	14%	43	86%	0.814	0.814 (0.146-4.525)
Senior high school	14	24%	44	76%	0.577	1.591 (0.311-8.144)
Bachelor Degree	12	55%	10	45%	1	
<b>Nutritional status</b>						
Underweight	1	7%	14	93%	0.302	0.332 (0.041-2.698)
Overweight	8	38%	13	62%	0.044*	2.860 (1.026-7.969)
Obese	2	7%	28	93%	0.157	0.332 (0.072-1.529)
Normal	17	18%	79	82%	1	
<b>Knowledge</b>						
Poor	5	9%	50	91%	1	
Good	23	21%	84	79%	0.055	2.738 (0.979-7.658)
<b>Staple Food Frequency</b>						
Less than 3 times/day	10	14%	59	86%	1	
3 times/day	18	19%	75	81%	0.420	1.416 (0.608-3.296)
<b>Breakfast Habit</b>						
Rarely	1	14%	6	86%	0.852	1.231 (0.139-10.934)
Sometimes	16	17%	78	83%	0.806	1.320 (0.144-12.097)
Always	11	18%	50	82%	1	
<b>Animal Side Dishes Consumption</b>						
Rarely	6	21%	22	79%	1	
Sometimes	21	16%	109	84%	0.503	0.706 (0.256-1.952)
Always	1	25%	3	75%	0.872	1.222 (0.107-13.974)
<b>Vegetable Side Dishes Consumption</b>						
Rarely/Sometimes	4	10%	37	90%	0.149	0.437 (0.142-1.345)
Always	24	20%	97	80%	1	
<b>Sweet Tea Consumption</b>						
Rarely	24	16%	123	84%	1	
Often	4	27%	11	73%	0.319	1.864 (0.547-6.345)

\*significant if  $p\text{ value} < 0,05$

**Table 4. Multivariate logistic regression analysis of associated factors of anemia among adolescent girls in Semarang, 2020**

	B	p value	OR	95%CI	
				Lower	Upper
Nutritional status		0.015			
Underweight	-1.129	0.295	0.323	0.039	2.671
Overweight	1.297	<b>0.020*</b>	3.658	1.224	10.932
Obese	-1.194	0.128	0.303	0.065	1.412
Good knowledge	1.295	<b>0.020*</b>	3.652	1.221	10.922

\*statistically significant at  $p < 0.05$

## DISCUSSION

In this study, we found that the prevalence of anemia among adolescent girls at islamic boarding school was 17.3%. High prevalence of anemia at islamic boarding school was also founded in other studies in Kediri City, Indonesia of 29,93% adolescent girl.<sup>19</sup> This result was similar to study in Jakarta that showed anemia was founded in 19.6% of adolescent girls aged 12-15 years.<sup>20</sup> Those study was conducted in adolescent girls who live with their parents. It showed there was no difference about prevalence of anemia between adolescent girls at islamic boarding school with who living with their parents.

According to WHO, the anemia prevalence rate of 17.3% is categorized into a mild public health problem if prevalence <20%.<sup>2</sup> The respondents of this study were adolescent girls had no consume iron folic tablet for the last 3 months. It showed that the Indonesian government policy through the iron folic supplementation program for adolescent girls aged 12-18 years in school are not optimally implemented. Even though previous studies have shown that iron supplementation interventions can reduce the prevalence of anemia from 20.9% to 15.7%.<sup>21</sup>

This study found that 13% of adolescent girls had overweight BMI and 18.5% was obese. BMI can describe individual nutritional status at the time. One of the risk factors of anemia was nutritional status.<sup>22-25</sup> It was found that overweight was significantly related to the anemia in this study. The overweight girls tended to be at risk of anemia compared to normal weight girls. It was similar to previous study in children aged 2-19 years showed prevalence of anemia increased along the increasing of BMI from normal to overweight.<sup>26</sup> The lack of nutrients in thin woman affected to anemia case, but there was an increasing of hepcidine concentration in overweight women, especially extreme obesity which can interfere with iron absorption, so that iron deficiency anemia occurred.<sup>27</sup>

Nutritional status can be influenced by food intake.<sup>28</sup> An assessment of nutritional intake can be seen from dietary habits such as staple food frequency, breakfast habits, consumption of animal or vegetable side dishes, vegetable and fruit consumption and consumption of sweet tea after meals. The eating habits, frequency of meals, quantity of food and types of food such as animal and vegetable side dishes that were eaten by respondents at islamic boarding school tended to be the same. The variety of food menu provided by islamic boarding school was almost the same; therefore, all students consumed almost the same food every day.<sup>29</sup> It may be related to this study that dietary habits were not significantly associated with anemia among adolescent girls. It was in line with a study in Ethiopia explained that the tea consumption and side dishes consumption were not risk factors of anemia. The study in Canada also showed that the consumption of animal side dishes was not associated with anemia.<sup>30,31</sup>

In this study, good knowledge about anemia and nutrition for anemia prevention had a significant relationship with the anemia prevalence ( $p=0.029$ ). Adolescent girls with a good knowledge had a risk of anemia compared to adolescents with poor knowledge in this study. Good knowledge might not affect to behave well. Food intake consumed was provided by head of islamic boarding school. So, they could not choose the food. Beside that, adolescent girls had less attention to the food nutrition value. This result was in contrast with previous study which stated that adolescent girls with a poor knowledge were more risk to have anemia than good knowledge.<sup>22,32</sup> We found that there were more than one third of subjects (34%) had poor knowledge about anemia prevention in this study. So, it is necessary to provide information and counseling about anemia and nutrition to prevent anemia for adolescent girls.

The father and mother's educations are not related to anemia in this study as in several previous studies.<sup>20,24</sup> A higher education level will lead a better individual knowledge level. Parents with good knowledge about anemia nutrition will provide food that is suitable for the nutritional needs for adolescents. In this study, the adolescents did not live with their parents so that their food intake was not determined by the parents.

The limitations of this study are the precision to measure the sample size (10%), the food intake measurement by qualitative method has the weakness, namely there was bias about the differences between each respondent regarding the frequency and quality of meals. For further research, it is expected to use smaller precision samples and food intake quantitative assesment with the SQ-FFQ (Semi Quantitative Food Frequency Questionnaire).

## CONCLUSIONS

Anemia among adolescent girls at islamic boarding school in Semarang still becomes a public health problem where the prevalence is 17.3%. There was a significant association between nutritional status, knowledge about nutrition and anemia status among adolescent girls. It is necessary to provide a regular nutrition education and

monitoring from public health center to *Pos Kesehatan Pesantren* of islamic boarding schools (adolescent girls and head of islamic boarding school) about the importance of nutrition in adolescents to improve the knowledge about nutrition and change the behaviour of food intake. Head of islamic boarding school must provide the good nutritions for students, so students can keep the normal weight and it can decrease and prevent anemia among adolescent girls.

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## Differences in Eating Habits and Physical Activity Before and During Distance Learning

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### ABSTRACT

**Background:** The COVID-19 pandemic has led to the enforcement of distance learning. This may cause negative impacts on adolescents' eating habits and physical activity.

**Objectives:** This study aimed to analyse the differences in eating habits and physical activity before and during distance learning in adolescents.

**Materials and Methods:** A cross-sectional study was conducted on a sample of 95 adolescents aged between 15-18 years. Subjects were selected using a simple random sampling method. Eating habits and physical activity variables were measured using modified Eating Habit and Lifestyle Changes in COVID-19 and Eating Habits Questionnaire. Wilcoxon Signed-Rank and McNemar tests were used to analyse the data.

**Results:** There was an increase in frequency of meals two times/day (9.5%) and snacking three times/day (4.2%) reported during distance learning. There were significant differences in number of meals ( $p=0.014$ ) and snacking ( $p=0.034$ ), carbohydrates sources intake ( $p=0.046$ ), sweet food ( $p=0.014$ ), snack ( $p=0.016$ ), exercise ( $p=0.035$ ), exercise duration ( $p=0.004$ ), and exercise frequency ( $p=0.030$ ) before and during distance learning. There were no significant differences in protein-sources intake, vegetable, fruit, sweetened beverages, fried food, processed food, junk food, emotional eating, physiological eating, and ways of obtaining food before and during distance learning ( $p > 0.05$ ).

**Conclusion:** Significant differences were found in eating habits comprised of the number of main meals and snacking, intake of carbohydrates sources, sweet food, snack, and physical activity before and during distance learning

**Keywords:** eating habit; physical activity; distance learning; adolescent

### BACKGROUND

The 2019 Coronavirus disease (COVID-19) is an infectious disease that was first reported in Wuhan, China, in December 2019.<sup>1</sup> This disease is caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) virus transmitted through droplets of infected patients.<sup>2</sup> This disease has spread to more than 60 countries in the world within three months.

The COVID-19 pandemic led Indonesia to implement social restrictions policies regionally. Especially in Jakarta, the capital city of Indonesia. Jakarta is the most populous city in Indonesia so it had the highest number of COVID-19 compared to other cities.<sup>3</sup> This causes the activities of Jakarta residents to be severely restricted by the government, public places are closed, restaurants limit take-out or online delivery services, and social gatherings related to political, sports, entertainment, academic and cultural gatherings are stopped provisionally during the social restrictions. The public is advised not to engage in activities outside their house except to meet basic or medical needs. The restrictions include the temporary cessation of school activities so that all learning activities are carried out at their respective residences through the distance learning method.<sup>4</sup> Distance learning leads adolescents to feel stressed, causing discomfort such as fear and anxiety to the point that it might change their eating habits.<sup>5,6</sup> Staying at home leads to increased food consumption because the possibility of access to food is higher. This can disrupt mealtimes, which can maintain metabolism and protect the body from dysmetabolism and obesity.<sup>7</sup>

In addition, distance learning restricts adolescents to do spontaneous physical activities related to the necessities of daily life outside the house.<sup>8</sup> Distance learning can make teens spend hours sitting in front of a device or learning media, causing an increase in sedentary behaviour that triggers a decrease in energy levels.<sup>8,9</sup> Sedentary behaviour related to eating habits is directly proportional to energy intake, where energy intake is higher (an increase of 350 kcal) when sedentary behaviour increases (decrease in energy expenditure of 100 kcal).<sup>10</sup> Based on a recent study of Palestinian adolescents, there was an increase in food

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intake by 50% compared to before school closures. Subjects also experienced changes in eating habits with increases in vegetable intake by 40%, fruit intake by 33%, fried food by 37%, and sweet food intake by 47%. In addition, as many as 45% of adolescents reported no physical activity while schools are closed. Factors such as staying at home and keeping a distance from other people have a significant relationship with increased intakes.<sup>11</sup> Another previous research by Ruiz-Roso et al. during restriction, showed intake of vegetables and fruits were increased because subjects have time to cook and intake of fried and sweet food were increased because staying at home can trigger boredom and stress, causing a change in eating patterns and increasing food consumption.<sup>12</sup>

Another study in Italy stated that appetite increased significantly in subjects with relatively younger age. Regarding eating habits, 37% of subjects ate healthier food, and 36% of respondents ate less healthy food. In the consumption of junk food, there was a decrease in subjects who consumed 30% compared to subjects who experienced an increase of 26%. Decreased junk food intake correlates with healthy food consumption, while increased junk food intake correlates with increased food intake and hunger after dinner. During social restriction, physical activity increased slightly (38%), especially bodyweight training. The percentage of subjects who trained five days/week also increased by 10%. This happened because subjects have more time to exercise. However, subjects who were not used to do sports did not take the opportunity to start.<sup>13</sup> Social restrictions change people's eating habits and physical activity. Moreover, distance learning and the psychological impact on adolescents may cause a lack of physical activity that triggers an increase in sedentary lifestyles and changes in unhealthy eating patterns. Based on the description above, this paper aimed to analyse differences in eating habits and physical activity before and during distance learning in high school students as there have not been many studies on this topic in Indonesia, especially in Jakarta.

## MATERIALS AND METHODS

This study is an observational analytic study with a cross-sectional design—was conducted in December 2020 with the subject of public school's students in Central Jakarta. This research has obtained approval from the Health Research Ethics Committee, Faculty of Medicine, University of Diponegoro No. 06/EC/KEPK/FK-UNDIP/I/2021. The participants consented to participate in the study with a digital informed/parental consent form. The cluster random sampling method was used to determine which schools from 5 sub-districts in Central Jakarta are chosen to collect the data. The sample size was calculated using binomial proportions with  $\alpha = 0.05$ ,  $N$  (population of high school students in Jakarta) = 9,202 people,  $d = 10\%$ ,  $p = 0.5$  and the probability of dropout = 20%. Based on the calculations, the minimum sample size in this study was set at 114 samples. The data was collected using the simple random sampling method. The subjects were eligible if they were students of a public high school in Central Jakarta, between 15-18 years of age, implementing distance learning since March 2020, not on a specific diet, nor engage in a physical exercise program. Based on the screening results, 19 out of 114 subjects were dropped out of the study because they did not meet the inclusion criteria. Hence, the analysed subjects were 95 samples. The data was collected through a structured questionnaire created in Microsoft Forms—consisted of more than 60 questions about socio-demographic characteristics, eating habits, physical activity during distance learning, and the previous period.

The independent variable in this study is the school hours during distance learning. The school hours were measured using a questionnaire by dividing the duration into three categories based on Ministry of Education and Culture guidelines issued under special conditions such as COVID-19; <5 hours/day, 5 hours/day, and >5 hours/day. The dependent variables in this study are eating habits and physical activity. Data on eating habits and physical activity variables were collected from filling out modified of the Eating Habit and Lifestyle Changes in COVID-19 and Eating Habits questionnaires which have been tested for validity and reliability.<sup>13,14</sup> The eating habits questionnaire consisted of types and amounts of food and beverages consumed per day or per week. The subject recorded the number of main meals (1-4 times/day) snacking (0-4 times/day), amount of food consumed per day, including carbohydrates sources intake (<3 servings, 3-4 servings), >4 servings), animal and plant-based protein sources intakes (0 to >4 servings), vegetables (0 to >4 servings), fruits (0 to >3 servings), and amounts of certain food per week like sweet food, sweetened beverages, fried food, processed food, snacks, and junk food (do not consume, 1-3 servings, 4-6 servings, >6 servings).

Data on eating behaviour including emotional eating (never, seldom, sometimes, always), physiological eating consisting of changes in hunger/satiety perception (no, less appetite, more appetite), and sense of hunger (before mealtime, between mealtimes, after dinner), eat late at night (yes/no), portion sizes

per meal (1 portion, >1 portions), pay attention to nutritional intake (never, sometimes, always), changes eating habits (no, unhealthy, healthier), and ways of obtaining food (cooking/purchasing). The physical activity questionnaire consisted of 4 questions; exercise (yes/no), type of exercise (outdoor, indoor), exercise duration per day (<60 minutes, 60 minutes, >60 minutes), and exercise frequency per week (<3 times, 3 times, >3 times).

The data obtained were analyzed using IBM SPSS Statistics 25 software. Data analysis was initiated by testing the instrument's validity using the Principal Component Analysis (PCA) method to reduce the dimensions of interrelated variables while retaining most of the information in the data in an interpretable way.<sup>15,16</sup> The method is used to determine the factors that are considered relevant, describe whether the question items are included in the same factor or not, and reduce irrelevant question items in the questionnaire.<sup>17</sup> Two criteria need to be met to determine whether the data is eligible to be tested; Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)  $p > 0.50$  and Bartlett's Test of Sphericity  $p < 0.05$ .<sup>18</sup> If the data is eligible, factor analysis is carried out by looking at the extraction value with the communality standard variable  $p > 0.50$  considered high or ideally  $p \geq 0.70$ .<sup>19,20</sup> The number of existing factors can be determined if the components with total initial eigenvalues  $> 1.00$  in the total variance explained table.<sup>17</sup> The interpretation of the results is made by looking at the factor loading on the rotated component matrix table, which is significant at a value of  $> 0.30$ .<sup>18,21</sup>

The results of the construct validity test showed that there are 15 relevant factors out of 47 questions in the modified questionnaire of this study. The validity test results found that the p-value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) = 0.548 with Bartlett's Test of Sphericity p-value of  $X^2 = 3634.027$  and p-value = 0.00. The validity test using Pearson correlation and reliability test was found that the modification of the questionnaire on eating habits and physical activity was reliable with Cronbach's Alpha  $p = 0.704$ . There are 15 out of 60 items with an insignificant p-value; however, these items are habitual questions that are important to explore so they are still used.

Univariate analysis was performed using a frequency distribution to show the value of each variable in percentage. The data normality test was carried out using the Kolmogorov-Smirnov with a significance of 0.05 because it had a sample size of  $> 50$ .<sup>22</sup> All data were known to be not normally distributed, so the bivariate analysis was carried out using a non-parametric test. Bivariate analysis aimed to see the differences of dependent variables towards independent variable. Differences in eating habits comprised of the number of daily meals and snacking, amount and types of food consumed, eating behaviour (except ways of obtaining food), and physical activity comprised of exercise duration and frequency before and during distance learning were analysed using the Wilcoxon signed ranks test. Differences in the variable eating habits comprised of eating behaviour (ways of obtaining food) and the variable physical activity with the sub-variable exercise were analysed using the McNemar test. The test was carried out with a confidence interval of 95% and significant if  $p < 0.05$

## RESULTS

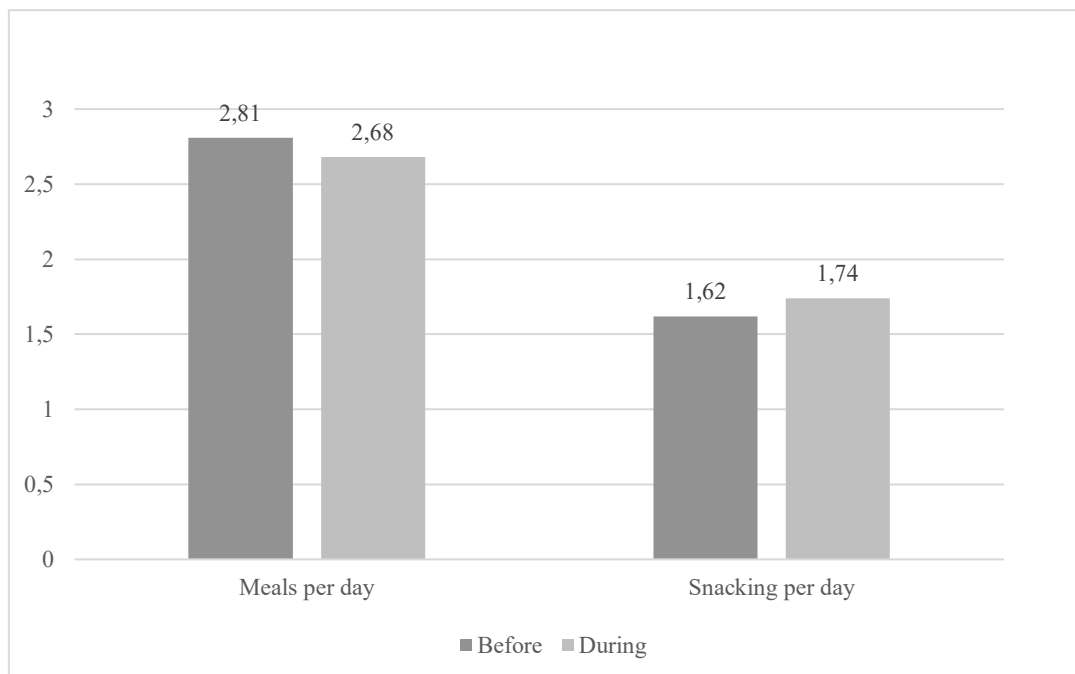
**Table 1. Socio-demographic Characteristics**

Characteristics	Frequency	Percentage
	(n= 95)	(%)
<b>Gender</b>		
Male	33	34.7
Female	62	65.3
<b>Age (years)</b>		
15	16	16.8
16	37	38.9
17	30	31.6
18	12	12.6
<b>Grade</b>		
10 <sup>th</sup>	24	25.3
11 <sup>th</sup>	35	36.8
12 <sup>th</sup>	36	37.9
<b>School hours during distance learning</b>		
<5 hours/day	14	14.7
5 hours/day	18	18.9
>5 hours/day	63	66.3

A total of 95 adolescents from several schools participated in this study. The characteristics of the subjects in the study, which included gender, age, school origin, grade, and school hours during distance learning, are presented in Table 1.

Table 1. shows that the subjects' age range is 15-18 years old and consisted of 34.7% males and 65.3% females. As many as 25.3% of the subjects are 10<sup>th</sup>-grade students, 36.8% are 11<sup>th</sup>-grade students, and 37.9% are 12<sup>th</sup>-grade students. Most students study for >5 hours/day during distance learning, while 18.9% study 5 hours/day, and 14.7% of students study <5 hours /day.

Table 2 and figure 1 presenting the frequencies of each variable and the bivariate analysis of subject eating habits.



**Figure 1. Mean of Food Intake (Meals and Snacking) Per Day Before and During Distance Learning**

Table 2 shows 9.5% increase number of subjects in 2 times/day-meals during distance learning from 20% into 29.5%.. The average number of meals before distance learning presented in figure 1 was  $2.81 \pm 0.551$  times, whereas during distance learning was  $2.68 \pm 0.551$  times. There is an increase number of subjects in 3 times/day-snacking from 7.4% into 11.6% during distance learning. The average number of snacking before distance learning was  $1.62 \pm 0.702$  times, whereas during distance learning increased to  $1.74 \pm 0.703$  times. The frequency distribution table shows 10.5% decrease in carbohydrates sources intakes of 3-4 servings/day from 58.9% into 48.4% during distance learning. Most subjects consumed animal protein intakes of 2-4 servings/day and plant-based protein intake <2 servings/day during distance learning. Some subjects consumed <3 servings of vegetables/day and <2 servings of fruit/day during distance learning.

In certain types of food, there is an 8.4% decrease in subjects consuming sweet food of 4-6 servings/week from 15.8% before distance learning into 7.4% during distance learning and 8.5% increase in subjects who do not eat snacks during distance learning from 16.8% into 25.3%. Before and during distance learning, the average subject consumed sweetened beverages, fried food, processed food, and junk food as much as 1-3 servings/week. On average, before and during distance learning subjects sometimes have emotional eating, feel hungry after dinner, and obtain food by cooking.

Results of the analysis presented in Table 2. found that there are significant differences in the number of meals ( $p=0.014$ ) and snacking ( $p=0.034$ ), type and amount of carbohydrates sources intake ( $p=0.046$ ), sweet food ( $p=0.14$ ) and snacks ( $p=0.016$ ). No significant differences in the type and amount of animal protein ( $p = 0.317$ ) and plant-based protein ( $p = 0.366$ ), vegetables ( $p = 0.166$ ), fruits ( $p = 0.827$ ), sweetened beverages ( $p = 0.166$ ), fried food ( $p=0.109$ ), processed food ( $p=0.285$ ) and junk food ( $p=0.096$ ), emotional eating ( $p=0.467$ ) and physiological eating ( $p=0.190$ ), and ways of obtaining food ( $p= 1.000$ ) before and during distance learning with  $p > 0.05$ .

Table 2. Frequency Distribution and Bivariate Analysis of Eating Habits

Variables	Before (n= 95)		During (n= 95)		p
	n	%	n	%	
<b>The number of main meals per day</b>					
1	2	2.1	2	2.1	0.014 <sup>a*</sup>
2	19	20	28	29.5	
3	69	72.63	63	66.3	
4	5	5.3	2	2.1	
<b>The number of snacking per day</b>					
0	2	2.1	-	-	0.034 <sup>a*</sup>
1	41	43	38	40	
2	44	46.45	45	47.4	
3	7	7.4	11	11.6	
4	1	1.1	1	1.1	
<b>Carbohydrates sources intake per day (portion)</b>					
<3	38	40	47	49.5	0.046 <sup>a*</sup>
3-4	56	58.46	46	48.4	
>4	1	1.1	2	2.1	
<b>Animal protein sources intake per day (portion)</b>					
2-4	94	98.93	93	97.9	0.317 <sup>a</sup>
>4	1	1.1	2	2.1	
<b>Plant-based protein sources intake per day (portion)</b>					
0	8	8.4	7	7.4	0.366 <sup>a</sup>
<2	72	75.71	71	74.7	
2-4	14	14.16	16	16.8	
>4	1	1.1	1	1.1	
<b>Vegetables intake per day (portion)</b>					
0	15	15.15	15.8		0.166 <sup>a</sup>
<3	52	54.56	58.9		
3-4	27	28.24	25.3		
>4	1	1.1	-	-	
<b>Fruits intake per day (portion)</b>					
0	17	17.18	18.9		0.827 <sup>a</sup>
<2	57	60.57	60		
2-3	18	18.16	16.8		
>3	3	3.2	4	4.2	
<b>Sweet food intake per week (portion)</b>					
0	14	14.18	18.9		0.014 <sup>a*</sup>
1-3	63	66.67	70.5		
4-6	15	15.7	7.4		
>6	3	3.2	3	3.2	
<b>Sweetened beverages intake per week (portion)</b>					
0	10	10.9	9.5		0.166 <sup>a</sup>
1-3	61	64.68	71.6		
4-6	19	20.13	13.7		
>6	5	5.3	5	5.3	
<b>Fried food intake per week (portion)</b>					
0	8	8.4	9	9.5	0.109 <sup>a</sup>
1-3	67	70.71	74.7		
4-6	17	17.12	12.6		
>6	3	3.2	3	3.2	

Variables	Before (n= 95)		During (n= 95)		p
	n	%	n	%	
<b>Processed food intake per week (portion)</b>					
0	12	12.6	13	13.7	0.285 <sup>a</sup>
1-3	64	67.4	68	71.6	
4-6	17	17.9	10	10.5	
>6	2	2.1	4	4.2	
<b>Snacks intake per week (portion)</b>					
0	16	16.8	24	25.3	0.016 <sup>a*</sup>
1-3	62	65.3	58	61.1	
4-6	12	12.6	9	9.5	
>6	5	5.3	4	4.2	
<b>Junk food intake per week (portion)</b>					
0	17	17.9	19	20	0.096 <sup>a</sup>
1-3	69	72.6	71	74.7	
4-6	8	8.4	3	3.2	
>6	1	1.1	2	2.1	
<b>Emotional eating</b>					
Never	20	21.1	19	20	0.467 <sup>a</sup>
Seldom	27	28.4	27	28.4	
Sometimes	38	40	38	40	
Always	10	10.5	11	11.6	
<b>Sense of hunger</b>					
Before mealtime	34	35.8	32	33.7	0.190 <sup>a</sup>
Between mealtimes	37	38.9	36	37.9	
After dinner	24	25.3	27	28.4	
<b>Ways of obtaining food</b>					
Cooking	79	83.2	80	84.2	1.000 <sup>b</sup>
Purchasing	16	16.8	15	15.8	
<b>Paying attention to nutrition intake</b>					
Never	34	35.8	-	-	
Sometimes	48	50.5	-	-	
Always	13	13.7	-	-	
<b>Change in eating habits</b>					
No	-	-	53	55.8	
Yes, healthier	-	-	25	26.3	
Yes, unhealthy	-	-	17	17.9	
<b>Change in hunger/satiety perception</b>					
No	-	-	36	37.9	
Yes, more appetite	-	-	34	35.8	
Yes, less appetite	-	-	25	26.3	
<b>Portion size(s) in each meals</b>					
1 portion	78	82.1	72	75.8	
>1 portions	17	17.9	23	24.2	
<b>Eat late in the night</b>					
No	53	55.8	55	57.9	
Yes	42	44.2	40	42.1	

<sup>a</sup>Wilcoxon signed-ranks test <sup>b</sup>McNemar test; \*significant at p<0.05

**Table 3. Frequency Distribution and Bivariate Analysis of Physical Activity**

Variables	(n=95)		(n=95)		p
	n	%	n	%	
<b>Exercise</b>					
No	31	32.6	42	44.2	0.035 <sup>b*</sup>
Yes	64	67.4	53	55.8	
<b>Exercise type</b>					
Do not exercise	31	32.6	42	44.2	
Outdoor	42	44.2	6	6.3	
Indoor	22	23.2	47	49.5	
<b>Exercise duration per day</b>					
Do not exercise	31	32.6	42	44.2	
<60 minutes	39	41.1	41	43.2	0.004 <sup>a*</sup>
60 minutes	13	13.7	0	0	
>60 minutes	12	12.6	12	12.6	
<b>Exercise frequency per week</b>					
Do not exercise	31	32.6	42	44.2	
<3 times	49	51.6	40	42.1	0.030 <sup>a*</sup>
3 times	11	11.6	9	9.5	
>3 times	4	4.2	4	4.2	

<sup>a</sup>Wilcoxon signed-ranks test <sup>b</sup>McNemar test; \*significant at  $p < 0.05$

Results in Table 3, physical activity variables show an increase in the number of subjects who do not exercise by 11.6% during distance learning. All subjects who exercised for 60 minutes/day before distance learning do not exercise during distance learning. In addition, there is a decrease in the frequency of exercise <3 times/week by 9.5% during distance learning. Results of the analysis presented in Table 3. found that there are significant differences in the physical activity included exercise ( $p=0.035$ ), exercise duration ( $p=0.004$ ) and exercise frequency ( $p=0.030$ ) before and during distance learning with  $p < 0.05$ .

**Table 4. Distribution of Most Consumed Food and Beverages during Distance Learning**

Types of Food and Beverages	n	%
<b>Sweet food</b>		
Do not consume	17	17.9
Chocolate or confectionery	48	50.5
Baked products (e.g cake or cookie)	21	22.1
Other	9	9.5
<b>Sweetened beverages</b>		
Do not consume	9	9.5
Bubble tea	48	50.5
Soft drinks	6	6.3
Other	32	33.7
<b>Fried foods</b>		
Do not consume	9	9.5
French fries	42	44.2
Fritters	34	35.8
Other	10	10.5
<b>Processed foods</b>		
Do not consume	13	13.7
Sausages/meatballs	21	22.1
Nugget	41	43.2
Other	20	21.1
<b>Snacks</b>		
Do not consume	22	23.2
Chips	35	36.8
Extruded snacks	32	33.7
Other	6	6.3
<b>Junk food</b>		
Do not consume	19	20
Starchy meatballs (Bakso aci)	13	13.7
Crackers soup (Seblak)	41	43.2
Other	22	23.2

Table 4. presents certain types of most consumed food and beverages during distance learning. Table 4 showed the distribution of the most consumed of sweet food were chocolate or confectionery (50.5%) while the most consumed of sweet drinks were bubble tea (50.5%). The most consumed fried foods were



french fries (44.2%), the most consumed of processed foods were nuggets (43.2%), the most consumed of snacks were chips (36.8%) and the most consumed of junk food were crackers soup such as seblak (43.2%)

## DISCUSSION

Distance learning is a learning method from home carried out in a state of emergency COVID-19 pandemic. This method is meant to limit exposure to the spread of the virus that can occur in schools. Before distance learning, school hours ran for 8 hours/day.<sup>21</sup> Meanwhile, school hours are set at least 24 hours a week during distance learning.<sup>22</sup> This study indicates that most of the subjects study for >5 hours/day during distance learning. This happens because the online meeting schedule is tentative, and students are often given assignments outside of school hours so that students tend to study until the afternoon and even at night.

Based on the study results, there is an increase number of subjects with 2 times/day-meals and decrease number of subjects with 3 times/day-meals during distance learning Eating less than 3 times/day was included as a poor diet. Under normal conditions, each individual is advised to consume the main food 3 times a day. This study is in line with previous research which stated that the majority of students eat twice a day during the pandemic.<sup>23</sup> However, this research is in contrast with another study which found an increase in eating meals 5 times/day by 31.1% during social distancing, where previously it was 19.9%.<sup>24</sup>

The risk of overeating also corresponds to an increase in the frequency of 3 times/day-snacking during distance learning. The results of this study are compatible with other studies that stated that 18.9% of subjects snacking 3 times/day among the 21.1% of the subjects who are snacking more frequently during social restrictions.<sup>25</sup> Increased consumption of distractions can occur because of the tendency to feel hungry at dinner time. This is in line with the increase in subjects who feel hungry at dinner time during distance learning compared to before. Irregular snacking poses a risk to adolescent health, including cardiovascular, neurological, and metabolic complications, especially when done at a young age. Irregular snacking can affect the number of main meals and may increase snacking between meals.<sup>26,27</sup>

The recommended consumption of carbohydrates sources in a day is 3-4 servings.<sup>23</sup> This research showed there is a decrease number of subjects who consumed 3-4 servings of carbohydrates sources per day during distance learning and an increase number of subjects who consumed less than 3 of carbohydrates sources per day. In another study, a similar thing was found where there was a decrease in consumption of carbohydrates-based food to 13% of subjects during social restrictions compared to the previous 16.7% of subjects.<sup>28</sup> A decrease in consumption occurs because the subject feels less appetite during distance learning. Carbohydrates are the body's primary source of energy. The body requires adequate carbohydrates intake so as not to break down protein to meet energy needs. In addition, the body needs carbohydrates to break down fat and prevent the buildup of ketone bodies in the blood.<sup>29</sup>

There is a decrease in sweet food consumption of 4-6 servings/week during distance learning, where some subjects reduced their consumption to 1-3 servings/week, and several other subjects stopped consuming sweet food. This is due to subjects who try to change their eating habits to be healthier during distance learning. The addition of sugar to food aims to increase palatability and is used to preserve food. Although required in certain clinical conditions, additional sugar is not necessary for a healthy adolescent diet.<sup>30</sup> Excessive consumption of sweet food can cause cavities, weight gain, and increased blood glucose levels so that the consumption of sugar in sweet food is limited to 50 grams/day.<sup>31</sup> There is an increase in the number of subjects who do not eat snacks during distance learning. This result is different from other studies, which found an increase in the consumption of snacks during social distancing compared to before.<sup>24</sup> The increased number of subjects who do not eat snacks was due to the subjects changing their eating habits to be healthier during distance learning.

A study found acrylamide compounds, carcinogenic substances, in starchy snacks that have gone through the roasting and frying process.<sup>32,33</sup> In adults with normal weight and overweight, consumption of energy-dense snacks is associated with weight gain.<sup>34</sup> This also applies to children and adolescents where the total number of snacks consumed is associated with overweight status, but the risk of being overweight tends to be low.<sup>35</sup> There are no changes in animal and plant-based protein sources consumed during distance learning compared to before. On average, subjects consumed chicken and beef as sources of animal protein and consumed tofu and tempeh as sources of plant-based protein before and during distance learning. Based on research conducted in America, protein intake is more stable than carbohydrates intake. This shows that the body's biological mechanism strictly regulates protein intake to affect the elements of food and other macronutrient intakes.<sup>36</sup> During adolescent development, protein is needed to build new tissues and maintain existing tissues.<sup>37</sup> Animal protein has more complete amino acids, higher nutritional quality, and is more

easily absorbed by the body, while plant-based protein contains isoflavones which function as antioxidants and anti-cholesterol, so that they need to be consumed together every day to achieve balanced nutrition.

There are no differences in the intake of vegetables and fruits before and during distance learning. On average, spinach and water spinach are the most consumed vegetables. At the same time, mango, orange, and apple are the most consumed fruits before and during distance learning. These results confirm a previous study that found no difference in fruit and vegetable intake during restriction.<sup>38</sup>

Riskesdas 2018 data shows that 67.9% of Indonesian teenagers only consume 1-2 servings of fruit/vegetables/day. In addition, almost all Indonesian teenagers have not met their daily needs for vegetables and fruits (96.4%).<sup>39</sup> Vegetables and fruits are a high-fibre food group that is good for the body because they take longer to digest, thus providing a more prolonged feeling of fullness. In addition, the fibre contained in vegetables and fruits also serves to bind cholesterol and prevent constipation.<sup>29</sup>

There are no differences in the consumption of sweetened beverages and fried food before and during distance learning. During distance learning, the most consumed sweetened beverage is bubble tea, and fried food most often consumed is french fries. Fried food and sweetened beverages are fatty and high sugar drinks with a mood-boosting effect.<sup>40,41</sup> Physiologically, consuming fatty food and high-sugar drinks increases the production of serotonin and dopamine, which affect mood for the better.<sup>42</sup> However, excessive consumption can have adverse effects such as weight gain. No difference was found in the consumption of processed food and junk food before and during distance learning. Most of the subjects eat processed food because it is easy to be obtained, could be stored for a long time, and easy to serve. Although there is limited access to leave the house regarding the intake of junk food, some subjects choose to make their food at home or using a delivery service.

Processed food and junk food tend to be high in sodium, high in calories, and contain low nutritional value. Adolescents with normal weight should consume junk food in small amounts, while teenagers on a diet are recommended to limit their consumption of junk food. Regular consumption of junk food and processed food can increase the risk of chronic diseases such as cardiovascular, type 2 diabetes, liver disease, and cancer.<sup>43</sup> In addition, the sodium contained in processed food may cause water retention in the body, causing bloating, swelling, and weight gain.<sup>44</sup> Before and during distance learning, no significant differences in subjects who sometimes eat because of emotional eating were identified, possibly because the data were collected when some subjects already adapted to the pandemic conditions. Emotional eating is a tendency to overeat as a form of response to negative emotions that are felt.<sup>45</sup> Difficulty regulating emotions, feeling unhappy with body image, being on a diet, boredom, childhood habits, and social influences are some of the factors that may cause emotional eating.<sup>46</sup>

There are no significant differences in the self-reported sense of hunger before and during distance learning. However, there is an increase in subjects who declared to feel hungry after dinner during distance learning compared to before. Increased hunger after dinner occurred related to activities before bedtime, increased appetite, and the tendency to consume snacks at night.<sup>13</sup> In this study, it was found that 35.8% of subjects felt enhanced appetite during distance learning.

Leptin and ghrelin are part of the body's physiological mechanism to regulate food intake.<sup>47</sup> Leptin, sometimes referred to as satiety hormone, functions to inhibit appetite and stimulates increased energy expenditure. In contrast, a hunger hormone, ghrelin, stimulates hunger by increasing neuropeptide Y (NPY) release, an appetite stimulator.<sup>47-49</sup> Ghrelin levels tend to decrease in individuals who overeat and increase in individuals who eat less. In individuals with normal weight, increased leptin levels inhibit NPY and suppress appetite. Low-carbohydrates food can reduce leptin resistance, while food high in protein and fibre can inhibit ghrelin.<sup>50</sup>

There are no significant differences in the ways of obtaining food before and during distance learning. This contrasts with research conducted in America, where most parents who have children at school age (5-18 years) limit purchasing food from outside their houses and increase home-cooked meals for their families during the pandemic.<sup>51</sup> There is no difference in ways of obtaining food before and during distance learning because most family members have time to cook. Besides, cooking at home also tends to cost less than buying food.<sup>52</sup> Consumption of home-cooked meals has a significant relationship with indicators of a healthier diet.<sup>53</sup> Cooking their food will allow individuals to control the ingredients used and the portion served.<sup>54</sup> Research shows that individuals who cook at home consume lower calories than those who cook less.<sup>55</sup>

There is a decrease in the number of subjects, duration, and exercise frequency during distance learning. This result is consistent with another study in which there was a decrease in subjects who exercised

during social distancing.<sup>56</sup> Before distance learning, some subjects spent 60 minutes/day exercising, while no subjects exercised for 60 minutes/day during distance learning. Another study found a decrease in subjects who exercise >60 minutes/session by 11.9% during social distancing. The decrease of subjects who do not exercise was similar to other studies which found a decrease in exercise <3 times / week to 32.3% where before social restrictions was 35.4%.<sup>28</sup>

Social restrictions are reported to cause negative feelings, lack of personal space, and social pressure in adolescents, limiting their willingness and possibility to remain active.<sup>57</sup> Moreover, obstacles such as much schoolwork, lack of free time, limited space for movement, and the loss of opportunities to participate in sports at school may change the habits of teenagers, which is essential to form behaviour in current conditions.<sup>58,59</sup> Exercise can become a routine and a way to stay in touch with family and friends. Exercise is beneficial for improving bone and muscle strength, balance, flexibility, and fitness. In addition, exercise is also good for mental health, reduces the risk of depression and anxiety, and improves mood.<sup>60-62</sup>

Teenagers are advised to be able to eat food according to the recommendation of Tumpeng Gizi Seimbang. Besides, it might be good for teenagers to do physical activity with light intensity for 3-4 minutes, such as walking or stretching to relax the muscles and improve blood circulation during school hours.<sup>60</sup> This activity is sufficient to increase energy expenditure to improve the body's metabolic health by controlling the glycemic index.<sup>63</sup> Adolescents are expected to do 60 minutes/day of moderate-intensity physical activity such as aerobics or physical exercise outside of school hours.<sup>60</sup> In terms of research, it is recommended to conduct further research regarding the factors that influence eating habits before and during distance learning that were not examined in this study, such as nutritional status, socioeconomic status, stress level, and lifestyle.

The limitations of this study used categorical analysis to see the difference in the variables; however, it cannot show the magnitude of the decrease or increase numerically for each variable value. This research data was collected online using Microsoft Forms, so there are limitations in the validity of the data even though the researchers had tried to validate the data.

## CONCLUSIONS

There are significant differences in adolescents' eating habits and physical activity during distance learning. Significant differences were found in eating habits comprised of the number of main meals and snacking, intake of carbohydrates sources, sweet food, snack, and physical activity before and during distance learning with  $p < 0.05$ . However, there are no significant differences in eating habits comprised of intake of animal and plant-based protein sources, vegetable, fruit, sweetened beverages, fried food, processed food, junk food, and eating behaviour with  $p > 0.05$ .

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## Anthropometric Markers, Visceral Adipocyte Index, Inflammation Markers and Bone Density in Reproductive Obese Women

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### ABSTRACT

**Background:** Obesity has been associated with the risk of various diseases. The correlation between anthropometry and bone health is complex. Visceral adipocyte index (VAI) is one of the compositions of body fat compositions that mostly associated with proinflammatory cytokine, which can stimulate C- reactive protein (CRP) that affects bone density.

**Objectives:** This study aimed to prove the correlation between VAI, CRP and BMD in Asian reproductive obese women

**Materials and Methods:** A cross sectional study was conducted in November 2020 - February 2021 and a total of 134 women of reproductive age with obesity participated in this study. Weight, height, body mass index (BMI) and rate of visceral fat were measured by body composition analyzer. Waist (WC) and hip circumferences (HC) measured by using tape; lipid profile and CRP level were examined using a clinical chemistry automatic analyzer, and the examination of bone mineral density (BMD) using dual-energy x-ray absorptiometry. Waist to hip ratio (WHR) and VAI calculated manually. Pearson and Spearman test were used for statistical analysis.

**Results:** There were positive weak correlations between weight, height, BMI, WC, HC, rate of visceral fat, WHR and VAI. There were weak positive correlations between HC, WHR and CRP. There were positive moderate correlations between weight, height, BMI, waist, visceral fat, WHR and CRP.

**Conclusion:** Although there were correlations between anthropometric parameters and VAI and also CRP, but we did not found correlation between VAI and CRP to all BMD parameters.

**Keywords :** VAI, CRP, BMD, anthropometry, obesity, women

### BACKGROUND

Obesity is often associated with the risk of various diseases and encountered in the world as well as in Indonesia. The prevalence of obese women in Indonesia is 29.3% higher than in men, and 14.3% of most cases are at the age of 35-49 years.<sup>(1)</sup> The relationship between body composition and bone health is complex.<sup>(2)</sup> Cytokines and adipokines produced by fat mass can affect bone density. The C-Reactive Protein (CRP) is one of the acute phase proteins secreted by the liver in the presence of interleukin-6 stimulation<sup>(3, 4)</sup>, and also with bone density.<sup>(5)</sup>

Previous study has shown that there is an anthropometric relationship including body mass index (BMI) and visceral fat with the risk of bone damage in obesity.<sup>(6)</sup> The bone mineral density is said to be positively correlated to subcutaneous fat, but negatively related to visceral fat. <sup>(7) (8, 9)</sup> Adipocyte produces adipokines which can stimulating bone growth. In the other hand, adipocytes can also produce proinflammatory cytokines that will affect bone density.<sup>(10)</sup> Another parameter of body fat composition is the visceral adipocyte index (VAI). Previous studies linking bone density with body anthropometry are still contradicting each other. This study wanted to use VAI parameters involving several lipid profile parameters to find out more about the relationship between VAI and markers of inflammation with bone density. The parameters used in the VAI calculation can be modified and involve the blood lipid profile, so that if detected early, treatment or intervention can be carried out so that the situation does not become worse. This parameter indicates distribution and function of fat tissue, also, is widely associated with metabolic syndrome and cardiometabolic risk

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There are still few studies on women of reproductive age with obesity regarding the relationship between anthropometric parameters, VAI and CRP to BMD. This study aims to prove the correlation between VAI, CRP and BMD in Asian reproductive obese women.

## MATERIALS AND METHODS

A cross-sectional observational study was carried out at Diponegoro University academic community Semarang from November 2020 to February 2021. The subjects were 134 women at Diponegoro University aged 25-50 years and BMI >24 kg/m<sup>2</sup>. Participants had regular menstruation in the last 6 months, normal body temperature, normal liver and kidney functions, history of bone disorder/fractures during the past 6 months, breastfeeding, taking vitamin D, contraceptions or long-term corticosteroid were excluded from this study. Measurements of WC, hip circumference (HC), height and weight were carried out 2 times and the average results were obtained by 2 nutritionists and tested using the kappa test. Measurements of WC, hip circumference (HC), height and weight were carried out by 2 nutritionists and had been tested using kappa test. The index is calculated based on BMI, waist circumference (WC) and lipid profile in blood including triglyceride levels and high-density lipoprotein cholesterol (HDL) with the formula of  $\{[WC/36.58 + (1.89 \times BMI)] \times (\text{triglycerides}/0.81) \times (1.52/\text{HDL-cholesterol})\}$ .<sup>(11, 12)</sup> The examination of triglycerides was done using the principle of glycerol phosphate oxidase (GPO) while HDL was done by direct method and CRP by immunoturbidimetry using Indiko Thermo Fisher Scientific automatic clinical chemistry analyzer. The bone mineral density (BMD) examination was done using dual energy X-ray absorptiometry (GE-Lundar Prodigy-iDXA instrument) and interpretation was performed by a radiologist. Statistical correlation test with Pearson and Spearman Test. The value of significance if  $p < 0.05$ .

The study was conducted after obtaining permission from the Health Research Ethics Commission, Faculty of Medicine, Diponegoro University/Dr.Kariadi Semarang with number 242/EC/KPK/FK-UNDIP/X/2020. All subjects signed an informed consent prior to study.

## RESULTS

Total of 134 women were participated in the study The subject characteristics could be seen in table 1.

Table 1. Subject Characteristics

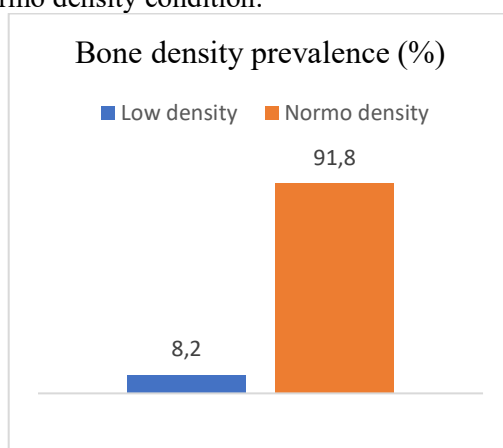
PARAMETER	Mean ± SD	Median (Min, max)
Age (years)	35.04 ± 6.12	34 (25 – 50)
Systole (mmHg)	115.15 ± 12.49	110 (90 – 170)
Diastole (mmHg)	73.43 ± 9.97	70 (60 – 110)
Height (cm)	155.18 ± 5.09	155.5 (145 – 169.5)
Weight (kg)	76.40 ± 13.99	72.6 (58.40 – 137.60)
BMI (kg/m <sup>2</sup> )	31.71 ± 5.05	30.50 (25.30 – 53.10)
Rate of visceral fat	9.62 ± 2.48	9 (6 – 19)
Waist circumference (cm)	93.39 ± 10.00	91(77 – 138)
Hip circumference (cm)	110.16 ± 9.86	110 (90 – 150)
WHR	0.86 ± 0.68	0.85 (0.68 – 1.04)
Total cholesterol (mg/dL)	186.49 ± 32.87	184 (98 – 257)
HDL cholesterol (mg/dL)	51.39 ± 12.05	51 (26 – 102)
LDL cholesterol(mg/dL)	113.49 ± 30.47	111 (56 – 188)
Triglyceride (mg/dL)	115.19 ± 54.26	101 (31 – 300)
VAI	4.57 ± 2.92	3.47 (0.81 – 12.53)
CRP (mg/L)	5.78 ± 5.05	4.25 (0.20 – 25)
SGOT (mg/dL)	24.57 ± 9.55	22 (14 – 78)
SGPT (mg/dL)	25.15 ± 14.37	21 (6 – 82)
Ureum (mg/dL)	23.34 ± 10.09	21 (5 – 81)
Creatinine (mg/dL)	0.78 ± 0.15	0.77 (0.49 – 1.28)
BMD lumbar	0.74 ± 1.34	0.7 (-7.2 – 3.60)
BMD femur neck	0.62 ± 0.97	0.50 (-1.70 – 4.60)
BMD femur total	0.76 ± 1.02	0.55 (-1.70 – 4.80)

Note : BMI = Body Mass Index; WHR = waist to hip ratio; VAI = Visceral Adipocyte Index; HDL = high-density lipoprotein; L low-density lipoprotein; CRP = C reactive protein; SGOT = serum glutamic oxaloacetic transaminase; SGPT = serum glutamic p transaminase; BMD = bone mineral density

Twenty out of 134 subjects (14.9%) had higher CRP levels (CRP levels > 10 mg/dL). A total of 10 out of 134 subjects (7.5%) had blood fasting glucose levels > 126 mg/dL, while the rest were within normal limits. None of the subjects were taking oral glucose and fat-lowering drugs. Bone mineral density examination



on all subjects is shown in picture 1. A total of 11 (8,2%) subjects had decreased bone density and the remaining 123 (91.8%) subjects were in normo density condition.



Picture 1. BMD result

Table 2 shows the statistical analysis of the correlation between VAI, CRP and the anthropometry.

**Table 2. The correlation between anthropometry marker, VAI, and CRP**

Parameter	VAI		CRP	
	r	p	r	p
Weight (kg)	0.250	0.004	0.448	0.0001
Height (cm)	-0.115	0.172*	-0.014	0.874*
BMI (kg/m <sup>2</sup> )	0.314	0.0001	0.491	0.0001
Waist circumference (cm)	0.334	0.0001	0.447	0.0001
Hip circumference (cm)	0.183	0.034	0.368	0.0001
Rate of visceral fat	0.312	0.0001	0.455	0.0001
WHR	0.234	0.006*	0.175	0.043*

Note : WHR =waist to hip ratio; BMD = bone mass density

\*Pearson correlation test

There were positive weak correlations between weight, height, BMI, WC, HC, rate of visceral fat, WHR and VAI. Increase in body weight, height, BMI, WC, HC, rate of visceral fat, there will be an increase in VAI. There were weak positive correlations between HC, WHR and CRP. There were positive moderate correlations between weight, height, BMI, waist, visceral fat, WHR and CRP. Which means, increase HC, WHR, weight, height, BMI, waist, rate of visceral fat and WHR, there will be an increase CRP levels.

**Table 3. The correlation between anthropometry parameters, VAI, CRP and BMD**

Parameter	BMD lumbar spine		BMD femur neck		BMD femur total	
	r	p	r	p	r	p
Weight (kg)	0.046	0.600	0.271	0.002	0.366	0.0001
Height (cm)	0.107	0.219*	0.122	0.159*	0.087	0.319*
BMI (kg/m <sup>2</sup> )	0.001	0.992	0.246	0.004	0.357	0.0001
Waist circumference (cm)	-0.028	0.749	0.212	0.014	0.319	0.0001
Hip circumference (cm)	-0.110	0.207	0.087	0.319	0.160	0.065
Rate of visceral fat	-0.023	0.792	0.245	0.004	0.353	0.0001
WHR	0.108	0.213*	0.204	0.018*	0.259	0.003*
VAI	-0.001	0.994	0.031	0.721	0.107	0.220
CRP (mg/L)	0.009	0.916	0.016	0.856	0.111	0.202

Note : BMI = Body Mass Index; WHR = waist to hip ratio; VAI = Visceral Adipocyte Index; CRP = C reactive protein

\*Pearson correlation test

Based on table 3, there were weak positive correlations between weight, BMI, waist, visceral fat, WHR and BMD neck and total femur. No correlations were found between VAI, CRP and all BMD parameters. However, in this study, there was positive weak correlation between VAI and CRP ( $r = 0.306$ ;  $p = 0.0001$ ; data was not shown).

## DISCUSSION

A moderately positive correlations between body anthropometry markers (HC, WHR, weight, height, BMI, waist, rate of visceral fat and WHR) HC, WHR, weight, height, BMI, waist, rate of visceral fat and WHR and CRP is supported by Aguirre's previous study which stated that increased CRP levels was accompanied by increased body fat mass.<sup>(6)</sup> Furthermore, Mulyamin (2021) concluded that there was a correlation between

BMI, WC, visceral fat and CRP. Meta-analysis studies have shown the same results between BMI, WC, WHR and CRP.<sup>(13)</sup> The increase in body fat mass examined from anthropometric parameters indicates the presence of chronic inflammation in an individual.<sup>(14)</sup> In this study, there was no relationship between CRP and BMD. This result is different from previous research by Sinya Ishii (2014) which showed that CRP levels > 3 mg/L increased the risk of fractures.<sup>(5)</sup> This different result may be due to population differences, namely, only obese-reproductive women without drinking-habit were analyzed in this study. However, the previous study was conducted on Caucasians and American-Africans with moderately high drinking-habit without taking BMI into account.

Another possible cause is the population in this study were productive-age women with regular menstrual cycles for the last 6 months. This condition allowed for the protection of the hormone estrogen. The estrogen plays an important role in bone homeostasis in longitudinal bone growth. During the early stages of puberty in women, low levels of estrogen stimulates the secretion of growth hormone/ insulin-like growth factor-1 which plays a significant role in bone growth at puberty. Towards the end of puberty, high estrogen levels cause the closure of bone growth.<sup>(15, 16)</sup>

Sex hormone receptors were detected in osteoblasts, osteoclasts, osteoblast progenitor cells and mesenchymal stromal cells. Estrogen and androgen hormones in bone tissue will work through estrogen and androgen receptors (ER $\alpha$ , ER $\beta$ , AR) which are mostly found in the cytoplasm and cell membranes.<sup>(17)</sup>

Achieving peak bone mass is crucial for bone health, and plays a key role in preventing osteoporosis and bone fracture risk. The risk of hip fracture can be reduced up to 30% with a 10% increase in peak bone mass. Estrogen deficiency during menopause will affect the normal bone turnover cycle due to the presence of estrogen receptors in osteoclasts, thus, osteoclast resorption activity is increased and osteoblastic activity is decreased. Enhanced overall bone resorption may weaken the inhibitory effect on osteoclastogenesis and osteoclast activity due to the decreased of estrogen levels.<sup>(18, 19)</sup>

An increase in CRP level without a decrease in BMD could be due to the role of adipokines (such as adiponectin) which have bone-protective properties but did not analyze in this study. The state of obesity with increased number of adipocytes stimulates the production of adipokines, including adiponectin and leptin which are protective against the bone. Adiponectin is secreted by adipocytes and plays role in osteogenesis, specifically the differentiation of mesenchymal stem cells into pro-osteoblasts and the proliferation and maturation of osteoblasts. Leptin is produced by white fat mass and has protective effect on bone by stimulating osteoblastic proliferation and differentiation.<sup>(20, 21)</sup>

Decrease of bone mineral content from BMD examination appears if there has been real damage to the bone. Osteoporosis is characterized by bone fragility which can be seen from the quality of micro-architecture, micro-damage and the level of bone remodeling that will affect the bone fracture. The reading of two-dimensional DXA technique still has intrinsic limitations to determine the changes of bone geometry. While measuring BMD with DXA is not sufficient enough to determine a diagnose, so bone biomarker examinations are needed for bone damage early screening.<sup>(22)</sup>

A meta-analysis study mentions several bone biomarkers such as osteocalcin (OC), procollagen type 1 propeptide and urine N-terminal crosslinking telopeptide of type 1 collagen (U-NTX) might have a role in evaluating long-term changes in BMD and predict future fracture risk.<sup>(23)</sup> There is weak positive correlation between VAI and CRP, in accordance with the study of Carbone (2019) which showed that there was a significant relationship between visceral fat and CRP.<sup>(24)</sup> Previous study stated that higher VAI was followed by increase CRP levels.<sup>(25)</sup> This study showed positive results between BMI, WC, rate of visceral fat with BMD of the femur and neck. This result is different from research by Zhang (2015) which shows the opposite relationship between visceral adiposity and bone density. This could be due to the population in this study was female subjects of reproductive age with obesity. The BMI of the subjects in this study was above the normal average, so there was an increase in subcutaneous and/or visceral fat that could affect the production of adipokines that are protective to bone.<sup>(9)</sup>

Visceral adipose tissue secretes inflammatory mediators, which stimulate liver and endothelial-cell acute-phase proteins. Adipocytes express and secrete TNF- $\alpha$ , which enhances the secretion of CRP by hepatocyte. This statement explains how body fat mass correlates with the inflammation. Increased abdominal fat mass which associated with increased CRP levels, and independent of BMI, is measurable for general adiposity detection. CRP levels were higher in individuals with abdominal adiposity than control group even though they had a similar BMI.<sup>(26)</sup>

In this study, VAI measurements based on WC, triglycerides and HDL were associated with CRP examination. The fat accumulation is identified by the balance of triglyceride synthesis and breakdown in the intestine or liver. Adipose tissue is the main source of pro-inflammatory cytokines, one of which is IL-6. This cytokine will induce liver lipogenesis and trigger systemic acute phase responses. <sup>(27)</sup> This study did not examine adipokines or proinflammatory cytokines levels produced by adipocytes. Further investigation is needed by measuring subcutaneous fat thickness, adipokines and proinflammatory cytokines levels to find out more about the relationship between anthropometric parameters and BMD especially in women of reproductive age with obesity.

## **CONCLUSION**

There were weak positive correlations between VAI and anthropometric parameters but CRP had moderate positive correlations with other anthropometric parameters. However, VAI and CRP had no correlation to all BMD parameters but weak correlations were found between some anthropometrics parameters and BMD neck and total femur

## **ACKNOWLEDGMENT**

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## Effect of Moringa (*Moringa oleifera*) Leaf Flour Supplementation on Total Antioxidant Content of Sprague Dawley Rat Serum Given High-Fat Diet

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### ABSTRACT

**Background:** Moringa oleifera leaf is high in quercetin which can be a source of exogenous antioxidants. Together with endogenous antioxidants, both the antioxidants will be able to counteract oxidative stress conditions.

**Objectives:** To analyze the effect of Moringa leaves flour supplementation on Total Antioxidants Content (TAC) of Sprague Dawley (SD) rat serum given a high-fat diet (HFD).

**Materials and Methods:** A randomized control group post-test design was used on 24 SD rats which were divided into 4 groups, namely healthy control (K<sub>1</sub>), HFD (K<sub>2</sub>), supplementation with Moringa leaf flour at a dose of 100 mg/100 g BW/day (K<sub>3</sub>), and a dose of 200 mg/100 g BW/day (K<sub>4</sub>). After 28 days of supplementation, serum TAC was analyzed using the ELISA method. Data analysis used Paired-T Test, One Way ANOVA, and Post-Hoc Bonferroni follow-up test.

**Results:** The results showed that the TAC of groups K<sub>1</sub>, K<sub>2</sub>, K<sub>3</sub>, and K<sub>4</sub> respectively were  $4.806 \pm 0.239$ ,  $1.323 \pm 0.292$ ,  $4.020 \pm 0.239$ , and  $5.123 \pm 0.695$ . There was a significant difference in serum TAC ( $p=0.000$ ) between supplementation groups. Significant differences in serum TAC were also found in the supplementation group compared to the HFD control group.

**Conclusion:** Moringa leaves flour supplementation for 28 days at a dose of 200 mg/100 g BW/day increases serum total antioxidant content higher than at a dose of 100 mg/100 g BW/day.

**Keywords:** High Fat Diet; Moringa Oleifera leaves Flour; TAC

### BACKGROUND

Reactive Oxidative Stress (ROS) has beneficial effects at moderate levels, and is involved in various physiological functions such as boosting the immune system. However, at higher levels, it produces oxidative stress, thereby damaging various molecules including lipids, proteins, and DNA. Oxidative stress develops when there is an increase in ROS production on one hand and a lack of antioxidants on the other<sup>1</sup>. A continuous increase in ROS causes the body to remain in a state of oxidative stress<sup>2-4</sup>. Meanwhile, the body has an effective defense mechanism boosted by endogenous antioxidants, thereby preventing excessive ROS formation<sup>5,6</sup>. Endogenous (synthesized by the body) and exogenous (obtained from food) antioxidants work synergistically to protect the body cells and organ systems from further damages due to excessive ROS<sup>7</sup>. Furthermore, less intake of exogenous antioxidants can decrease the endogenous<sup>8,9</sup>, which can also be increased by optimizing consuming foods containing antioxidants daily<sup>10</sup>. Good food intake pattern arrangements in supporting the availability of exogenous antioxidants was food that contains polyphenols, such as flavonoids<sup>11</sup>. Moreover, its daily consumption contributes to the production of exogenous antioxidants for the body<sup>12</sup>.

Flavonoids are one of the bioactive compounds with antioxidant properties<sup>13</sup> which are found in high content in Moringa (*Moringa oleifera*) leaf. Based on the type of flavonoid, quercetin in Moringa leaf is present in higher amounts than others and contain Provitamin A, Vitamin C, Vitamin E, and minerals, such as selenium and zinc that also act as antioxidants<sup>14-16</sup>. According to Ganatra (2017), Moringa leaf contains 8 times more polyphenols than red wine, 30 times more vitamin A than spinach and four times of carrots, and 7 times more vitamin C than oranges<sup>17</sup>. The antioxidant combination found is more effective compared to the single ones, due to the synergistic mechanism in suppressing ROS<sup>18</sup>. Following research conducted by

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Nilanjini (2012), the antioxidants contained in Moringa leaf had a beneficial effect on experimental animals fed on a high-fat diet by increasing Superoxide Dismutase (SOD), Catalase (CAT), and Glutathione Peroxidase (GPx) levels and reducing the free radicals, thereby inhibiting lipid peroxidation and tissue damage<sup>19</sup>.

Moringa leaf flour is one of the processed products that have experienced the initial drying and refining process. It is first ground and stored for months without refrigeration, also this does not reduce the nutritional content significantly<sup>20</sup>. Additionally, In the present study, two doses of Moringa leaf flour were selected as 200 mg/100 g BW/day and 100 mg/100 g BW/day. These doses were selected on the basis of previous reports of the acute toxicity study performed using the dose administered until 2000 mg/kg of dried leaf powder of Moringa which shows no signs of toxicity in rats and based on average daily flavonoid requirements<sup>21,22</sup>. Preliminary research has not been carried out on experimental animals and humans, therefore, this research aimed to prove the effect of Moringa (*Moringa oleifera*) leaf flour on increasing serum total antioxidant contents.

## MATERIALS AND METHODS

This experimental research was carried out with a post-test and randomized control design group. The production of Moringa leaf flour, rearing of experimental animals, and biochemical analysis of serum samples were carried out at the Nutrition Laboratory of the Inter-University Center for Food and Nutrition Studies (PSPGPAU), Gadjah Mada University, Yogyakarta, from March to April 2021.

The research subject is a male white rat Sprague Dawley (SD), and the number used was calculated based on the provisions of the World Health Organization (WHO), which postulates the need for a minimum of 5 experimental animals. To anticipate dropout, one experimental animal is added to each group, thereby amounting to a total of 24. Determination of the research subjects considered the inclusion criteria, namely experimental animals aged 8 to 11 weeks, body weight  $\pm$  150 g, healthy (active movement), and without defects. The independent variable used is the dosage variation of Moringa leaf flour dose I 100 mg/100 g and 200 mg/100 g BWs of experimental animals/day while the dependent is the TAC of the animal serum.

Research tools include basins, blenders, ovens, 80 mesh sieves, slicers, rat oral sonde, digital animal scales, hand gloves, and masks. The materials used include Moringa leaf, AD II standard feed, High Fat Diet (HFD), and water. High fat diet is a mixture of 10% lard and 2 ml of duck egg yolk in AD II standard feed. The process of making Moringa leaf flour is as follows: 1). The fresh, light, and dark green leaves that are not too dry are separated from the stems, 2). Washed, 3). Drained, 4). Then, dried in an oven at a temperature of 55°C for 60 minutes, 5). After which it is ground using a blender, and 6). Finally, it is sieved with an 80 mesh sieve. Moringa leaf flour used in this research was placed in an airtight container and stored in a refrigerator. Furthermore, primary data were collected from the measured body weight and examination of total serum antioxidant contents which is a comparison of the healthy, and HFD controls, including the treatment groups. Weight measurement data was recorded at the beginning of the research and this continued every week, besides, the total serum antioxidant examination data underwent a post-test.

Body weight was measured every 7 days using a digital animal scale, while examination of the total antioxidant contents was carried out using the ELISA method at the end of the research. In addition, blood samples were taken from the retroorbital plexus of the experimental animals. Subsequently, they were put in different cages and acclimatization lasted for 7 days with the provision of standard AD II feed and *ad libitum* drink daily.

Afterward, the animals were randomly grouped into 4 with 6 in each, namely K<sub>1</sub>, K<sub>2</sub>, K<sub>3</sub>, K<sub>4</sub>. Group K<sub>1</sub> was provided standard feed and *ad libitum* drink, while K<sub>2</sub>, K<sub>3</sub>, and K<sub>4</sub> were fed with HFD. The HFD administration period lasts for 2 weeks and the body weight of the animals was measured every week. This was followed by the intervention stage, which lasted for 28 days with all groups provided standard AD II feed and *ad libitum* drink whereas the intervention group was given additional Moringa leaf flour through an oral probe with a dose of 100 mg/100 g and 200 mg/100 g body weights of rats/day in groups K<sub>3</sub> and K<sub>4</sub> respectively. The animals' body weight was measured weekly during the intervention period and samples of their blood were collected from the retroorbital plexus to examine the total serum antioxidants after this stage.

The data were tested for normality using the Shapiro-Wilk test. The first statistical analysis determined the differences between the pre and post-test. The average weight of the experimental animals was normally distributed, with the Paired t-test and One way ANOVA used to examine changes and differences in the

groups. Furthermore, the Kruskal-Wallis test was also used to determine the same attribute among experimental animal groups. The second statistical analysis is the post-test carried out on serum TAC data, which proved that the serum TAC was normally distributed. Furthermore, the One Way ANOVA and Bonferroni Post-Hoc tests were used to examine the difference in the intervention effects in the groups. The significant difference with  $p$ -value  $<0.05$  shows the mean  $\pm$  SD and median (min  $\pm$  max) for data that were normally and abnormally distributed, respectively.

The analyzed data were computerized using SPSS. Meanwhile, this research was approved by the Health Research Ethics Commission (KEPK) of the Faculty of Medicine, Diponegoro University as stated in the Ethical Clearance NO.25/EC/H/FK-UNDIP/III/2021 dated March 17, 2021.

## RESULTS

The body weight characteristics of the experimental animals during the acclimatization period ranged from 182 to 187 g. Besides, none of the animals dropped out during the research and the consumption of HFD for 2 weeks led to a significant increase in weight. The results of statistical tests carried out after its administration (Table 1) showed an increase in body weight before and after being given standard feed AD II K<sub>1</sub> and HFD (K<sub>2</sub>, K<sub>3</sub>, K<sub>4</sub>), although a significant difference was observed in the groups ( $p = 0.000$ ).

**Table 1. Body Weight Value of Experimental Animals (g) Before and After HFD Administration**

Group	n	Before	After	<i>p</i>	$\Delta$	% $\Delta$
K <sub>1</sub>	6	185.00 $\pm$ 4.43	196.17 $\pm$ 5.12	0.00	11.00(10 $\pm$ 12)	6.03 $\pm$ 0.29
K <sub>2</sub>	6	187.00 $\pm$ 2.53	215.33 $\pm$ 2.16	0.00	28.00(27 $\pm$ 30)	15.16 $\pm$ 0.65
K <sub>3</sub>	6	185.17 $\pm$ 4.36	213.50 $\pm$ 4.42	0.00	28.00(28 $\pm$ 30)	15.31 $\pm$ 0.57
K <sub>4</sub>	6	182.83 $\pm$ 2.48	211.00 $\pm$ 2.61	0.00	28.00(27 $\pm$ 29)	15.41 $\pm$ 0.46

*p*=Paired T-Test; <sup>a</sup>=One Way ANOVA Test; <sup>b</sup>=Kruskal-Wallis Test

An insignificance difference ( $p = 0.282$ ) was observed in the average body weight of the experimental animals in all groups at the beginning of the research. After 2 weeks of being fed with HFD, a significant difference was observed among the groups ( $p = 0.000$ ). The results of the Kruskal-Wallis test showed that there was a significant difference in weight change among the 4 groups ( $p = 0.002$ ). Descriptively, the highest percentage of weight gain was exhibited by the group that was fed with HFD ( $\pm 15\%$ ) compared to the one that was only given standard feed ( $\pm 6\%$ ).

**Table 2. Body Weight Value of Experimental Animals (g) Before and After Moringa Leaf Flour Administration**

Group	Before	After	<i>p</i>	$\Delta$	% $\Delta$
K <sub>1</sub>	196.17 $\pm$ 5.12 <sup>e</sup>	221.83 $\pm$ 5.67	0.000	26.00(24 $\pm$ 27)	13.09 $\pm$ 0.48
K <sub>2</sub>	215.33 $\pm$ 2.16 <sup>e</sup>	266.50 $\pm$ 2.74	0.000	51.00(50 $\pm$ 53)	23.76 $\pm$ 0.52
K <sub>3</sub>	213.50 $\pm$ 4.42 <sup>e</sup>	245.50 $\pm$ 4.23	0.000	32.00(31 $\pm$ 33)	14.99 $\pm$ 0.60
K <sub>4</sub>	211.00 $\pm$ 2.61 <sup>e</sup>	236.83 $\pm$ 3.06	0.000	25.00(25 $\pm$ 28)	12.24 $\pm$ 0.63

*p*=Paired T-Test; <sup>a</sup>=One Way ANOVA Test; <sup>b</sup>=Kruskal-Wallis Test

The results of statistical tests on experimental animal body weight before and after the administration of Moringa leaf flour (Table 2) showed that all groups including the treatment group which was given standard feed, and HFD, experienced a significant increase in body weight ( $p = 0.000$ ). The average body weight after 4 weeks of treatment was significantly different ( $p = 0.000$ ). The average body weight between groups was observed after administering Moringa leaf flour for 28 days. Descriptively, the least percentage of weight gain was shown by the group with the highest dose ( $\pm 12.24\%$ ). Administration of Moringa leaf flour at a dose of 200 mg higher suppressed weight gain in the treatment group compared to 100 mg.

**Table 3. Total Antioxidant Contents of Experimental Animal Serum (mmol/L)**

Group	n	Serum Total Antioxidant Content	<i>p</i>
K <sub>1</sub>	6	4.806 $\pm$ 0.239 <sup>a</sup>	0.000
K <sub>2</sub>	6	1.323 $\pm$ 0.292 <sup>a</sup>	
K <sub>3</sub>	6	4.020 $\pm$ 0.239 <sup>a</sup>	
K <sub>4</sub>	6	5.123 $\pm$ 0.695 <sup>a</sup>	

*p*=One Way Anova Test, <sup>a</sup>=Post-Hoc Bonferroni Test

The results of the one-way ANOVA statistical test (Table 3) showed that serum total antioxidant contents were significantly different in the 4 groups ( $p = 0.000$ ). The Bonferroni Post-Hoc Statistical Test showed that the comparison of serum total antioxidant contents in the K<sub>3</sub> group to K<sub>4</sub> was significantly

different ( $p = 0.022$ ) after administration of Moringa leaf flour. Treatment with a dose of 200 mg/100 g BW and 100 mg/100 g BW indicated that the total serum antioxidant contents were significantly different to the  $K_2$  group fed with HFD ( $p = 0.000$ ,  $p = 0.000$ ). Meanwhile, it was discovered that  $K_3$  treated with a dose of 100 mg/100 g BW was significantly different to the  $K_1$  healthy control group ( $p=0.001$ ). The treatment of  $K_4$  with a dose of 200 mg/100 g BW showed a higher content compared to  $K_3$  treated with a dose of 100 mg/100 g BW, although it was not significantly different from the  $K_1$  healthy control group ( $p = 1.000$ ).

## DISCUSSION

These results indicate that the least total serum antioxidant contents were discovered in the group given HFD. The storage of excessive fat increases body weight thereby increasing the production of proinflammatory cytokines, such as Tumor Necrosis Factor- $\alpha$  (TNF- $\alpha$ ) and Interleukin-6 (IL-6)<sup>23</sup>. Furthermore, increased inflammation causes an increase in ROS production and depletion in endogenous antioxidants that exchanged oxidative stress<sup>24-26</sup>. Endogenous antioxidants depletion was caused by its increased consumption in suppression of ROS progression<sup>27</sup>, thus endogenous antioxidants are required in sufficient quantities. Intake deficiency of exogenous antioxidants may cause endogenous antioxidants to decrease continuously and the body remains in a state of oxidative stress<sup>28</sup>. Decreased endogenous antioxidants required exogenous antioxidants obtained from food<sup>29</sup>. Endogenous and exogenous antioxidants synergistically maintain or rebalance antioxidants and ROS due to the presence of ROS reducing compounds in exogenous antioxidants such as flavonoids, vitamins, and minerals through mechanism induced enzymes factor transcription, scavenging process by capturing ROS to donate one electron and hydrogen, metal chelating that helps ROS to become relatively stable and unreactive to induce further oxidative stress, and also act as a cofactor of antioxidants enzymes<sup>30,31</sup>.

Giving Moringa leaf flour to the treatment group significantly increased the total antioxidant content of serum, therefore, Moringa leaf flour can act as a source of antioxidants that restores or normalizes serum total antioxidant content efficiently. Mabrouki (2020) analyzed the effect of administering Moringa leaf extract on endogenous antioxidants in experimental animals. Endogenous antioxidants were significantly recovered by administration with Moringa leaf extract by mechanism to reduce and maintain ROS in a balanced concentration<sup>32</sup>. In this research, the increased contents are also due to reduced antioxidants used in the suppression of ROS progression. The previous research also showed an increase in the constituents after the extract intervention due to reduced antioxidants use in reducing ROS and the provision of hydrogen to make it more stable<sup>33</sup>.

Based on the content of Moringa Leaf flour, flavonoids as a source of exogenous antioxidants are present in high quantities<sup>34</sup>. Furthermore, Rodríguez-Pérez (2015), and Makita (2016), reported that methanol extract of Moringa leaf contained 26, and 14 flavonoids, respectively<sup>35,36</sup>. Compared to vegetables, previous research discovered that the flavonoid content in the dried Moringa leaf was 3 to 12 times more high than other types of vegetables consumed by families, namely 12 times more than cauliflower, 9 times of peas, 5 times of cabbage, 4 times of spinach, and 3 times of broccoli<sup>37</sup>. Another research showed that the experimental animals are given HFD, and dietary intervention containing flavonoids for 4 weeks increased endogenous antioxidants through the mechanism of interacts synergistically with exogenous antioxidant system, then captured free radicals, prevent further oxidative damage, thereby maintaining a balanced ROS system<sup>38,39</sup>. Additionally, quercetin, a flavonol bioactive compound, is a class of flavonoids that was found high in Moringa leaf<sup>40</sup>. In previous studies, it was discovered to have reached approximately 50% of the total flavonoids in Moringa leaf extract<sup>41</sup>. Subsequently, quercetin had an antioxidant function that affected the increase of endogenous antioxidant<sup>42</sup>. Quercetin increased endogenous antioxidant Glutathione Peroxidase (GPx), Catalase (CAT), and Superoxide Dismutase (SOD) by directly or indirectly induced the Nrf2-mediated transcription activity by increase Nrf2 expression of the antioxidants. These antioxidants are regulated by the transcriptional factor Nuclear Factor E2-Related Factor (Nrf2) which responds by binding to the Antioxidant Response Element (ARE) as a promoter of genes that code the antioxidant. Quercetin also regulates levels of endogenous antioxidant Glutathione (GSH). Superoxide Dismutase captures  $O_2^-$  of ROS and transforms it into  $H_2O_2$ . Catalase and Glutathione Peroxidase further catalyze the decomposition of  $H_2O_2$  to unreactive  $H_2O$ . This Reaction requires GSH as a hydrogen donor On the other hand, Quercetin has the ability to act directly as free radical scavengers or hydrogen donors, hydroxyl radical scavenging, and metal-chelating ability<sup>43,44</sup>.



Moringa leaf flour also has vitamins such as vitamin E, vitamin C, pro-vitamin A, and complete minerals such as Cu, Mn, Fe, and Zn<sup>45</sup>. These vitamins act as free radical scavengers and reduce free radicals, donating electrons and hydrogen to free radicals to prevent their oxidation and to generate a much less reactive species than most other free radicals<sup>44,45</sup> whereas minerals play an important role as cofactors of endogenous antioxidants that may increase the efficiency of endogenous antioxidant function. Endogenous antioxidants are metal ion cofactor-requiring enzymes that catalyze the dismutation of highly reactive superoxide radicals (O<sub>2</sub><sup>-</sup>) into unreactive and relatively stable molecular oxygen (O<sub>2</sub>) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>)<sup>48</sup>. However, through this mechanism, all bioactive compounds and micronutrients in Moringa leaf flour become extremely effective so that they may improve the efficiency of endogenous antioxidant function. After 28 days of treatment, the mean increase in serum total antioxidant contents was higher at dose II than dose I, and the increase at dose II was equivalent to the healthy group.

The average weight gain in the group given HFD ( $\pm 15\%$ ) was significantly different compared to the others. This is in line with previous research which proved HFD caused an increase of 9 to 23%<sup>49</sup>. There are two possible causes of weight gain due to the influence of HFD. First, fat as the main composition of HFD that contains high energy compared to other macronutrients<sup>50,51</sup>. Second, types of fat such as saturated fatty acids and cholesterol which are high in pork oil and duck egg yolk increase the HFD energy density and ease of absorption by the body, therefore, it is stored in excess which ultimately increases bodyweight<sup>52-54</sup>. Furthermore, administration of Moringa leaf flour at a dose of 100 mg and 200 mg was able to maintain and suppress the increase in body weight. This study is in accordance with previous studies which showed that administration of 200 mg and 400 mg of Moringa leaf extract were proven to be able to lose and maintain weight because of their high fiber content<sup>55</sup>. Moringa oleifera leaf can provide 41.20 g carbohydrate, 29.40 g protein, 5.20 g fat, and 12.50 g fiber by 100 g dry leaves whereas 100 g dried Moringa leaf powder contains approximately 38.20 g carbohydrate, 27.10 g protein, 2.30 g fat, and 19.20 g total fiber<sup>56</sup>. Due to high fiber content, Moringa can be used to suppress weight gain by mechanism increasing water-binding and swelling capacities. This slows gastric emptying, which in turn increases satiety, longer meal intervals and ultimately decreases food intake<sup>57</sup>.

However, there are some limitations associated with this research, such as difficulty in analyzing macronutrient and micronutrient content, especially specific polyphenols in Moringa oleifera leaf flour.

## CONCLUSION

In conclusion, the administration of Moringa leaf flour at a dose of 100 mg/100 g and 200 mg/100 g body weight/day increased the total antioxidant content of the serum in Sprague Dawley rats. Furthermore, the dosage of 200 mg/100 g body weight/day had a better effect.

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# The CIPP Model of Stunting Management Program During Covid-19 Pandemic in Semarang City

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## ABSTRACT

**Background:** Semarang City has successfully reduced in reducing the stunting rate by 2.7% in 2018 and 2.5% in 2019. With the Covid-19 pandemic, the stunting prevention program in Semarang City faces problems that have the potential to increase the prevalence risk of stunting. The problem are limited access of intervention and decline of the stunting program quality in work area of the Puskesmas in Semarang City. In addition, it is still unknown how the stunting program was implemented at the puskesmas during the Covid-19 pandemic.

**Objectives:** The purpose of this research was to identify and evaluate the implementation of the stunting prevention program in Semarang City during the Covid-19 pandemic by using the CIPP model.

**Materials and Methods:** This research used a survey research with a qualitative approach. This research was carried out from August to October 2021. The informants for this study consisted of 5 main informants: nutritionists at the puskesmas, 15 triangulation informants, the head of the puskesmas, posyandu cadres, and mothers who had stunted children in five health centers in Semarang City, namely Bandarharjo Health Center, Lamper Tengah Health Center, Tlogosari Wetan Health Center, Gunungpati Health Center, and Pegandan Health Center. Determination of informants using a purposive technique based on the geographic location of the Public Health Center. In-depth interviews used prepared guidelines. Data analysis used content analysis.

**Results:** The results showed that the in the context component, the nutritionists had understood goals and targets of the stunting program. The input component showed that Human Resources was not optimal because they helped in succeed in the Covid-19 program. Funding was disrupted because there were still no technical guidelines for funding during the Covid, infrastructures were not optimal due to a lack of training for posyandu cadres. The process components included: a monitoring program that was carried out door to door, no administration of PMT F100, ineffective online counseling, fewer mothers who were participated in nutrition consultations, no monitoring related to vitamin A administration.

**Conclusion:** The stunting prevention program in the work area of the puskesmas during the Covid-19 pandemic has not been able to be implemented well during the Covid-19 pandemic.

**Keywords :** Stunting; CIPP Model ; Program

## BACKGROUND

Toddler is an age group that is prone to nutrition and disease. Undernourished toddler can cause disruption of physical, mental and spiritual growth and development and resulting in low quality of human resources. Nutritional status is an important health indicator for toddlers because children under five years of age are a group that is prone to health and nutrition whose physical impact is measured anthropometry and categorized based on WHO standards with the index of WAZ (Weight for Age Score), HAZ (Height for Age Z-scores) and WHZ (Weight/Height Z-scores).<sup>1</sup>

Reducing the stunting prevalence is one of the national priority programs in health development. Reducing of the stunting prevalence is listed in the main target in 2020-2024 Medium-Term Development Plan, it is improving the health and nutrition status of the community with a target of stunting prevalence in 2024, which is 14%.<sup>2</sup> Stunting are toddlers with nutritional status based on length or height according to When compared to the WHO-MGRS (Multicentre Growth Reference Study) standard, the z-score is less than -2SD and is categorized as very short if the z-score is less than -3SD. Toddlers who experience stunting will have an impact on the level of intelligence that is not optimal, more susceptible to disease and can be at risk of decreasing productivity levels. The result of a low level of productivity will have an impact on stunting economic growth and increasing poverty.<sup>3</sup>

Although the Ministry of Health has determined that reducing stunting prevalence is one of the national priority programs in health development, nationally the reduction in stunting prevalence has not been going

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well. This is evidenced by the prevalence of stunting in Indonesia, namely in 2017 it was 22.7%, in 2018 it was 30.8% and in 2019 it was 27.67%.<sup>3</sup>

Meanwhile, Semarang City is a city that has succeeded in reducing the stunting rate for toddlers, namely in 2017 by 14%, in 2018 by 2.7%, and in 2019 by 2.5%.<sup>4</sup> This is an achievement that can be used as an achievement. a reference for stunting prevention systems in Indonesia and Central Java.

In 2020, the world community witnessed the emergence of a new type of corona virus that causes coronavirus disease or what is now known as Covid-19. to accelerate the handling of the corona virus outbreak (Covid-19) in an effort to control Covid-19.<sup>5</sup> This can increase the risk of increasing the prevalence of stunting in the world, including Indonesia.<sup>6</sup> five years will increase by 14.3% or equivalent to 6.7 million additional cases.<sup>7</sup>

The Large-Scale National Restriction Policy in the Context of Accelerating the Handling of Covid-19 is contrary to the Stunting Prevention Program, because the stunting prevention program requires direct contact with the program target. This has led to an increase in the risk of stunting prevalence in Indonesia during the Covid-19 pandemic due to the obstruction of access for mothers and children in obtaining optimal health services. It was noted that only 19.2 percent of Public Health Center continued to run posyandu (Integrated Healthcare Center) activities during the pandemic. Based on data from the Ministry of Health, the number of antenatal care visits and health services for infants, toddlers, and children has decreased so that immunization services, monitoring activities for the development and growth of infants and toddlers, as well as maternal and child health interventions cannot run optimally. This is in accordance with Efrizal's research which states that a decrease in children's nutritional status can have an impact on increasing the prevalence of children at risk of stunting.<sup>6</sup>

Although Semarang has succeeded in reducing stunting for three consecutive years, with the Covid-19 pandemic, the stunting prevention program in the city of Semarang has several problems that have the potential to increase the risk of increasing stunting prevalence rates caused by limited access to interventions from stunting prevention programs and quality stunting program in the work area of the Semarang City Health Center. Limited access to health services has an impact on increasing the prevalence of children at risk of stunting.<sup>6</sup> In addition, it is not yet known how stunting programs are implemented in Public Health Center during the Covid-19 pandemic.

Therefore, to get a qualified health program, evaluation activities are needed. The CIPP ((context, input, process, product) Evaluation Model is an evaluation method that can be implemented to obtain qualified health programs because the advantages of the CIPP model provide a comprehensive and complete evaluation format at each evaluation stage, they are context, input, process, and product stages. Advantages of CIPP evaluation concept that an important purpose of evaluation is not to prove, but also to improve. This is in accordance with the evaluation of the stunting prevention program during the Covid-19 pandemic which emphasized program improvement in order to obtain a complete program quality.

Therefore, the researcher intends to evaluate the stunting prevention program for nutritionists in Semarang City as a city that is able to reduce the incidence of stunting and how to implement the handling program during the Covid-19 pandemic using the CIPP Evaluation model.

The purpose of this study was to determine and evaluate the implementation of stunting prevention programs in Semarang City during the Covid-19 pandemic using the CIPP model covering context aspects, namely Identification of Program Objectives and Targets, input aspects namely human resources, funds, facilities and infrastructure, process aspects, namely planning. programs, implementation programs, monitoring and evaluation and outcome aspects.<sup>8</sup>

## **MATERIALS AND METHODS**

This research used a survey research with a qualitative approach. This research was carried out from August to October 2021. Sources of data in this study included primary data (in-depth interviews with informants and observations), and secondary data consisting of nutritional status health data processed by the relevant health agencies (Bandarharjo Public Health Center, Lamper Tengah Health Center, Tlogosari Wetan Health Center, Gunungpati Health Center, Public Health Center Pegandan, Semarang City Health Office, and the Indonesian Ministry of Health). The research has passed ethical approval in Health Research Ethics Commite Faculty of Public Health Diponegoro University with number 239/EA/KEPK-FKM/2021.

The informants of this study consisted of 5 main informants, namely nutritionists at the puskesmas and 15 triangulation informants, namely the head of the puskesmas, posyandu cadres and mothers who had

stunting toddlers. Determination of informants using a purposive technique based on the geographic location of the puskesmas. After identification, a representative sample was obtained: the northern part of Semarang was the Bandarharjo Health Center; the eastern part of the Semarang was the Central Lamper Health Center ; the eastern part of the Semarang area was the Tlogosari Wetan Health Center; the southern part of the Semarang Public Health Center the Gunungpati Health Center; the middle part of the Semarang was the Pegandan Health Center.

The main informants in the research were those who directly handled and understood the implementation process of the stunting program. The main informants of this research consisted of 5 nutritionists and in charge of the stunting program at the Puskesmas Bandarharjo, Puskesmas Lamper Tengah, Puskesmas Tlogosari Wetan, Puskesmas Gunungpati, Puskesmas Pegandan. The triangulation informants in this research were 15 people with details of 5 head of puskesmas, 5 posyandu cadres and 5 mothers who had stunted toddlers. In this research, the research will focused on 4 aspects of the CIPP evaluation model, they are Context, Input, Process, Product that can explained how the stunting program during the pandemic were implemented

In-depth interviews were using prepared guidelines. Validity tests in qualitative research were included credibility tests (internal validity), transferability (external validity), dependability (reliability), and confirmability (objectivity).<sup>9</sup>

The data analysis technique used in this research is to analyze all forms of communication, such as data derived from interview answers, manuscript documents, pictures, photos, and other information. The steps in the data analysis process are data reduction, data presentation, conclusion drawing, and verification.<sup>10</sup>

## RESULTS

### 1. Context Aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

Nutritionists as the person in charge for the stunting program were involved in policies making regarding to the stunting prevention programs at the puskesmas. Nutritionists understood and base program development based on the purpose of the stunting program at the Semarang city level during the COVID-19 pandemic, namely reducing the stunting prevalence rate.

*"tujuan program stunting saat pandemi ini, untuk menekan angka pandemi dengan keberjalanan program yang maksimal, sesuai arahan DKK " (IU 1)*

*"jelas to mas, tenaga gizi kan selaku koordinator program stunting, jadi kami terlibat dari awal sampe hasilnya gimana" (IU3)*

*"The purpose of the stunting program during this pandemic is to reduce the number of pandemics with maximum program implementation, according to the direction of the DKK" (IU 1)*

*"Obviously, sir, the nutritionist is the coordinator of the stunting program, so we are involved from the beginning until the results are there" (IU3)*

The informations were also supported by triangulation informations which stated that the main informant underlied the stunting program during the pandemic with the goal of the stunting program from the Semarang city level.

*"itu baru ya mas, iya mmm.. karena baru ya mungkin belum pernah ya disampaikan " (IT-KA 1)*

*"program di puskesmas, terutama stunting sudah sesuai dengan arahan kota, karena stunting merupakan program prioritas di kota semarang juga" (IT-KA 3) "That's new, sir, yes, mmm.. because it's new, maybe it's never been conveyed" (IT-KA 1)*

*"The program at the puskesmas, especially stunting, is in accordance with the direction of the city, because stunting is a priority program in the city of Semarang as well" (IT-KA 3)*

*"yang berbeda, tentu saja kegiatannya door to door mas, jadi dicek dari satu rumah ke rumah yang lain" (IU 1)*

*"untuk pelaksanaannya, nanti kader kan ada posyandu terus dicatat timbangan dan tinggi si anak. Nanti laporannya diserahkan ke kita lalu di cek di aplikasi buat lihat zscorenya. Semisal zscorenya termasuk kategori stunting, kita kesana buat ngecek bener ngga ini anaknya stunting. Kalau bener kita lakukan intervensi. Jadi sama mau pandemi atau tidak bedanya kita ngga di posyandu lagi tapi door to door" (IU 5)*

*"kalau bisa disebut kelebihan ya, lebih efektif mas karena bisa dapat semua data, tapi ya kasihan bu kadernya harus keliling keliling, nggih to bu? hehe (IU 1)*



"What's different, of course, is door to door, mas, so it's checked from one house to another" (IU 1)  
"For the implementation, there will be a posyandu for the cadres, and the scales and height of the child will be recorded. Later the report will be submitted to us and then checked in the application to see the zscore. For example, if the zscore is in the stunting category, we go there to check whether or not this child is stunted. If so, we will intervene. So whether it's a pandemic or not, the difference is that we're not at the posyandu anymore but door to door" (IU 5)  
"If you can call it an advantage, yes, it's more effective, bro, because you can get all the data, but it's a pity that the cadres have to go around, can't you, ma'am? hehe (IU 1)

Door to door monitoring is more effective than monitoring carried out at posyandu before the pandemic because it can reach all areas.

*"Kadang ke rumah lo anaknya tidur, kendalanya gitu mas lo mas, Ya to, kalau mau dibangunkan rewel, ya gitu to kendalanya disitu untuk pemantaunyanya (IU 5)*  
*"memang lebih capek daripada biasanya, tapi maug gimana lagi"(IU3)*  
"Sometimes when your child goes to your house to sleep, that's the problem, bro, yes, if you want to wake up fussy, yes, the problem is there for the monitoring (IU 5)  
"I'm more tired than usual, but what can I do"(IU3)

On the negative side, monitoring is difficult because some toddlers are sleeping when visited, in addition to the energy and energy expended by posyandu cadres.

## 2. Input aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

The input for the stunting prevention program during the pandemic at the puskesmas in the Semarang City consisted of human resources, funds, facilities and infrastructures.

Based on research conducted by Rustam, the efficiency and effectiveness of an implementation of a program depends on human resources.<sup>11</sup> Based on the results of in-depth interviews with key informants, it is known that the personnel who play role in the malnutrition prevention program at the Health Center are nutritionists, KIA officers, all Puskesmas employees, regional responsible persons, cadres in posyandu.

*"intinya, dari gizi, kader posyandu, dan kepala puskesmas sebagai pengawas"(IU 3)*  
*"Itu dari petugas puskesmas, kader posyandu ya" (IU 5)*  
"Essentially, from nutrition, posyandu cadres, and the head of the puskesmas as supervisors" (IU 3)  
"That's from puskesmas officers, posyandu cadres, yes" (IU 5)

In carrying out the stunting program the adequacy of officers is an important component in the implementation of a program.<sup>12</sup> The program can run well if the program has sufficient resources, but the program cannot run well if the resources are not sufficient.

*Kekurangannya yaa, otomatis kita belum bisa maksimal... karena kita tenaganya Cuma 2, yang satunya sering dilibatkan ke vaksin jadi otomatis susah gitu" (IU 1)*  
*"ya dimasa pandemi ini, beban kerja menjadi tambah" (IU 5)*  
The drawback is, we can't automatically maximize... because we only have 2 staff, the other one is often involved in vaccines, so it's automatically difficult." (IU 1)  
"Yes, during this pandemic, the workload has increased" (IU 5)

One component of the resources needed in implementing a health program is the health financing budget. The Health Budget aims to provide health financing in sufficient amounts, utilized and allocated equitably. During the Covid-19 pandemic, stunting funding was sourced from the BOK and BLUD Puskesmas. BOK is Health Operational Assistance from the State Budget and Expenditure Revenue (APBN)

Although there is a budget from the BOK, in its implementation during the pandemic, there was a temporary suspension of the flow of aid and BOK at the beginning of the year, because there was no technical guidance that regulates the funding of the BOK nutrition program during the Covid-19 pandemic.

*"untuk pendaan saat awal juga belum ada juknisnya jadi pas awal tahun agak mandeg" (IU 1)*  
*"iya dana BOK belum cair pada awal tahun" (IT-KA 1)*

"There is no technical guideline for funding at the beginning, so at the beginning of the year it stagnates a bit" (IU 1)

"Yes, BOK funds have not been disbursed at the beginning of the year" (IT-KA 1)

All key informants stated that the availability of infrastructure at all puskesmas was complete including body scales (stepping scales for adults and baby scales), measuring instrument for infant body length, microtoise to measure height, measuring tape/metline to measure head circumference, arm circumference, waist and hip circumference.

"Kalau sarpras di puskesmas sudah menunjang ya, kita punya peralatannya, tapi ya yang masih belum terealisasi itu yang di beberapa wilayah di posyandu" (IU 1)

"beberapa alat perlu dicek kembali karena ada yang kemungkinan sudah tidak layak pakai" (IU 3)

"ada mas di posyandu sebelah belum dapat bantuan, kadang pinjam alat dikita" (IT-KP 1)

"seperti timbangan badan bayi mas, sudah ngga bisa dipake, jadi biasanya kita pake timbangan biasa" (IT-KP 3)

"If the infrastructure at the puskesmas is already supporting, yes, we have the equipment, but yes, what has not been realized is in several areas at the posyandu" (IU 1)

"several tools need to be re-checked because some may not be suitable for use" (IU 3)

"There's a man at the posyandu next door who hasn't gotten help yet, sometimes he borrows tools from us" (IT-KP 1)

"It's like a baby's scale, you can't use it anymore, so we usually use a regular scale" (IT-KP 3)

Regarding the availability of infrastructure facilities in the posyandu area (Integrated Healthcare Center), two of the five main informants stated that the availability of infrastructure facilities in posyandu (Integrated Healthcare Center), was not evenly distributed, especially anthropometric tools between one region and another. Meanwhile, the two main informants confirmed by triangulation informants stated that some anthropometric tools were damaged and unfit for use. This, of course, must be given more attention because the implementation of the nutrition program is determined by the nutritional infrastructure, especially the anthropometric tool used as a measuring tool for the growth and development of toddlers.<sup>13</sup>

### 3. Process aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

Stunting prevention programs at the Puskesmas during the Covid-19 pandemic during the Covid-19 Pandemic were Monitoring toddlers, Providing PMT, Health Counseling, Nutrition Counseling at the Puskesmas and Giving Vitamins and Minerals. This is in line with Syahputra's research which states that the nutrition program at the puskesmas is in the form of monitoring, providing education, providing complementary foods and vitamins. Stunting prevention programs at the Puskesmas during the Covid-19 pandemic during the Covid-19 Pandemic were Monitoring toddlers, Providing PMT, Health Counseling, Nutrition Counseling at the Puskesmas and Providing Vitamins and Minerals. This was in line with Syahputra's research which states that the nutrition program at the puskesmas is in the form of monitoring, providing education, providing complementary foods and vitamins.<sup>8</sup>

"pertama pemantauan pertumbuhan, kemudian makanan tambahan, penyuluhan sama eee ada konseling di puskesmas mas" (IU 1)

"... dalam programnya untuk stunting ada pemberian PMT, promosi kesehatan, pemberian vitamin, zink dan ada pemantauan balita apakah dai stunting atau tidak" (IU 4)

"kita melaksanakan pemantauan, pemberian pmt, berupa kemarin itu saya kasih mpasi sama susu, dikasih vitamin juga, lalu pembinaan" (IU 5).

"First is growth monitoring, then additional food, counseling is the same as there is counseling at the Mas Health Center" (IU 1)

"... in the program for stunting there is provision of PMT, health promotion, provision of vitamins, zinc and there is monitoring of toddlers whether they are stunted or not" (IU 4)

"We carry out monitoring, giving PMT, in the form of yesterday I gave complementary milk, given vitamins too, then coaching" (IU 5).

### 4. Product aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

After monitoring and evaluating each activity carried out to see the quality of services from the stunting prevention program. Then a product evaluation was carried out, whether the stunting program during the current pandemic will be continued, modified or discontinued. Product indicators are

assessments carried out to measure the success of stunting prevention programs during the pandemic in achieving the goals that have been set. The data generated will greatly determine whether the activity will be continued, modified or discontinued in the stunting control program at the puskesmas during the pandemic. Evaluation of each activity of the stunting prevention program is presented to the head of the puskesmas which contains the implementation of activities, obstacles and performance achievements of the stunting prevention program during the pandemic. Covid-19.

*“lapornya kita paparkan ya mas, setahun sekali kalo pemaparan ke kapus. Tapi tiap bulan juga ada laporan rutin juga.”*

*(IU 5)*

*“minimal setaun sekali kita kumpul bersama membahas program” (IT-KA 5)*

*“We will explain the report, sir, once a year for the exposure to the head office. But every month there are also regular reports as well.”*

*(IU 5)*

*“at least once a year we gather together to discuss the program” (IT-KA 5)*

## DISCUSSION

### 1. Context Aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

To create a stunting program that is in accordance with the program's objectives, the Puskesmas as a health service organization as well as the holder of the stunting program is obliged to improve the quality of organizations and programs at the Puskesmas. Improving the quality of organizations and programs, especially the stunting program at Puskesmas during the Covid-19 pandemic, can be done by identifying the strengths and weaknesses of the organization.<sup>14</sup> By identifying the strengths and weaknesses of the organization, it is expected to improve the quality of policy making, especially policies related to stunting prevention program.

Based on the results of interviews regarding the objectives of the stunting prevention program during the Covid-19 pandemic, it was found that all informants understood that the purpose of the stunting program was primarily to reduce stunting during the Covid-19 pandemic, in addition, several key informants used various terms such as zero stunting, reducing stunting, stunting prevalence and maximize stunting programs.

All informants stated that the purpose of the stunting prevention program during the Covid-19 pandemic was based on directions from the Semarang City Health Office. Some of the main informants stated that the stunting program objectives directed by the Semarang City Health Office were adjusted to the vision and mission of each puskesmas.

Nutrition workers understand the advantages and disadvantages of organizations that are used as references in making stunting programs, namely: Government support, Posyandu Cadre activity, Limited access, lack of coordination with cross-sectors during the Pandemic, Negative public stigma towards health services during the Covid-19 pandemic. Understanding of the organization affects the effectiveness and efficiency of a program. In addition, identifying the strengths and weaknesses of the organization can increase the capabilities, independence, and resources owned.<sup>15,16</sup>

All key informants stated that the targets for stunting in the city of Semarang were stunted toddlers, pregnant women, mothers who had stunting toddlers and non-stunted toddlers. Two of the five main informants also explained the target for stunting under five, namely toddlers with a body length of less than 48 cm for boys and 47 cm for girls. This is in accordance with the target of the stunting program at the puskesmas that has been set by the Semarang City Health Office. Determining program targets is one of the important tools in formulating a program because program objectives act as the point we want to achieve.<sup>17</sup>

### 2. Input aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

The input desc<sup>12</sup>ription result of the three indicators have not implemented well during the pandemic. The quality component of nutrition officers can be said to be competent and qualified, this is evidenced by direct exposure from the head of the puskesmas and posyandu cadres as triangulation informants, in addition to support for educational competence, namely all nutrition officers with a minimum education of D3 nutrition science, and supported by training carried out by the DKK . The qualifications of nutritionists as coordinators of nutrition programs are in accordance with the Regulation of the Minister of

Health Number 26 of 2013 concerning the implementation of work and practice of nutrition workers. Qualified nutrition workers or officers affect the quality of the nutritional program quality.<sup>18,19,20</sup>

Meanwhile, the lack of skills of posyandu cadres, especially in monitoring children under five, is caused by the lack of training provided. Training is an effort to invest in human resources to improve work abilities and skills so that employee performance increases.<sup>21</sup> The effects of the Covid-19 pandemic, namely restrictions on mobility and budget changes during this pandemic, have resulted in the implementation of training not being able to be carried out properly. In carrying out the stunting program the adequacy of officers is an important component in the implementation of a program.<sup>12</sup> The program can run well if the program has sufficient resources, but the program cannot run well if the available resources are not sufficient.

From the results of the interview, it can be seen that the workforce is sufficient in the implementation of the nutrition program, namely at least one, this is in accordance with the minimum requirements for nutritionists in puskesmas in the Regulation of the Minister of Health of the Republic of Indonesia Number 75 of 2014. Although the adequacy of nutrition workers is in accordance with the Regulation The Minister of Health of the Republic of Indonesia Number 75 of 2014 but in its implementation during the pandemic there was an additional responsibility in each unit for the success of the vaccine program at the puskesmas which made the workload increase so that the nutrition program, especially stunting, was not optimal. This is in accordance with Permatasari's research which states that a heavy workload affects the quality of work, which has an impact on the organization.<sup>22</sup>

From the results of the interview, From the results of the interview above, it is known that the source of funds in the implementation of the stunting program during the Covid-19 pandemic is from the BOK and BLUD Puskesmas. BOK is Health Operational Assistance from the State Budget and Expenditure Revenue (APBN), the Ministry of Health and is central government assistance to regional governments which is channeled through the co-administration task mechanism to accelerate the achievement of priority health program targets.<sup>23</sup>

Funding that is hampered due to the absence of technical guidelines for funding during the Covid-19 period is a problem in the implementation of stunting prevention programs because funds have a very important role in stunting prevention programs, so that health costs must be available in sufficient quantities in the sense that they can finance the implementation of all health efforts. needed.<sup>24</sup>

Facilities and infrastructure is one of the supporting factors in addition to human resources and funding. In the stunting prevention program, of course, the availability of adequate facilities and infrastructure along with optimal management and utilization can help achieve the success of a program. This study uses two components in describing the indicators of facilities and infrastructure in the stunting prevention program during the Covid-19 pandemic. The two components are availability and constraints.<sup>25</sup>

All key informants stated that the availability of infrastructure at all puskesmas was complete including body scales (stepping scales for adults and baby scales), measuring instrument for infant body length, microtoise to measure height, measuring tape/metline to measure head circumference, arm circumference, waist and hip circumference. Regarding the availability of infrastructure facilities in the posyandu area, two of the five main informants stated that the availability of infrastructure facilities at the posyandu was not evenly distributed, especially anthropometric tools between one region and another. Meanwhile, the two main informants confirmed by triangulation informants stated that some anthropometric tools were damaged and unfit for use.<sup>13</sup>

This, of course, must be given more attention because the implementation of the nutrition program is determined by the nutritional infrastructure, especially the anthropometric tool used as a measuring tool for the growth and development of children under five.

From the results of the interview, the reason for not being able to check and collect data related to damaged anthropometric tools is due to limited access during the pandemic, especially in August where the city of Semarang carried out PPKM. Checking and calibrating nutritional measuring instruments at the posyandu can minimize calculation errors that have an impact on achieving the objectives of monitoring activities for children under five.<sup>101</sup>

In addition, the use of tools that are not appropriate or according to procedures can cause errors in weighing data that affect the stunting program. This is in accordance with Rusdiarti's research that errors in the use of nutritional measuring tools at the posyandu that are not appropriate, result in incorrect data, which has an impact on errors in making programs and policies related to nutrition programs.<sup>26</sup>

3. Input aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

The implementation of each activity was as follows:

a. Monitoring and tracking activities.

The purposes of monitoring and tracking toddlers were to obtain fast and accurate information on stunting cases, found and treated all stunted toddlers and all stunted toddlers received treatment according to stunting management so that they can suppressed and reduced the stunting prevalence. The target of tracking stunting toddlers was for 100 percent of toddlers in the working area of the puskesmas to track stunted toddlers.

During the Covid-19 pandemic, monitoring and tracking activities are carried out door to door. During the Covid-19 pandemic, tracking of toddlers was carried out by door to door or house-to-house visits of mothers and toddlers by posyandu cadres. Tracking activities are carried out once a week or 3 times a month. After tracking in the form of anthropometric measurements, namely WAZ (Weight for Age Score), HAZ (Height for Age Z-scores), and WHZ (weight for height Z-scores). After monitoring by posyandu cadres, the data is submitted to nutrition workers for checking. If a stunting toddler is found with a z score of less than -2SD, direct monitoring by nutrition workers and posyandu cadres is carried out door to door. If the area is a stunting locus area, then monitoring activities are also assisted by DKK through the Nutrimas program.

While the drawback is that some toddlers are sleeping when visited, so monitoring is difficult to carry out, in addition to the effort and energy spent by posyandu cadres, which has the potential to decrease performance which has an impact on the quality of monitoring and tracking activities.

This was in accordance with Didah's research which states that the heavy workload of posyandu cadres can reduced the achievement result of a program implementation in posyandu.<sup>27</sup>

b. PMT giving activities.

The provision of supplementary food (PMT) for stunted toddlers at the puskesmas used the Recovery PMT and the F100 package with the aim of improving the nutritional status of these toddlers.

The target in giving PMT is the distribution of PMT to all toddlers, especially toddlers with stunting and to have an impact on the community to have the habit of giving toddlers a healthy diet. During the Covid-19 pandemic, only PMT recovery without PMT F100 was given to toddlers who were stunted.

During the Covid-19 pandemic, the provision of PMT for stunting toddlers in the form of recovery PMT and F100 packages was given from the puskesmas, namely nutrition workers to posyandu cadres, to be handed over to mothers with stunting toddlers.

The administration of PMT during the Covid-19 pandemic was the absence of the F100 package for stunted toddlers. According to Kholidah's research, the F100 administration program regularly can reduce.<sup>28</sup>

c. Stunting Counseling

The purpose of health education about stunting was to achieve changes in the behavior of individuals, families and communities related to awareness of stunting prevention, to played an active role in realizing optimal health for infants and toddlers according to healthy living.

During the Covid-19 pandemic, due to the prohibition on access to posyandu, stunting counseling was carried out online. Online stunting counseling is carried out through the WA group with participants from pregnant women, mothers who have toddlers, both stunted and non-stunted. Online counseling is held at least once a month, with nutritionists, health promotion personnel and MCH conducted through group chats or group video calls.

Obstacle in stunting counseling program regularly via online was : participants who do not have quotas and cellphones that meet the minimum specifications cannot participate in counseling activities. This was in line with Fakhriyah's research which states that the problem with online health lectures in WA is that mothers of toddlers do not have quotas and do not have the WA application.<sup>29</sup>

Extension activities are not flexible because one group is filled by several puskesmas officers and have different interests, so that there is the potential that the messages conveyed are conflicting and ineffective.

d. Counseling

The purpose of counseling services was to alleviate the problems experienced by clients. In this case, the client meant pregnant women, mothers who have toddlers, especially mothers who have stunted toddlers. The target to be achieved in nutritional counseling was for mothers to know their nutritional needs and adequacy according to age so that the pattern of giving food was appropriate.

Nutrition counseling is the only activity that has not undergone major changes in the stunting prevention program during the Covid-19 pandemic. This is because the activity is carried out at the puskesmas. A different change from the period before the pandemic was the absence of gifts from posyandu cadres for those who came for consultations.

Although there is no difference before the pandemic and after the pandemic in the stunting program, there are various obstacles that are experienced only during the pandemic, namely the decrease in consultation visits to the puskesmas. One of the causes of the decline in visits to puskesmas is public perception of health services during the Covid-19 period. Public perception affects visits to health care facilities.<sup>30</sup> The Covid-19 pandemic has made the public's negative perception of health services increase.<sup>31</sup> In addition, the absence of a stimulus in the form of PMT made by posyandu cadres makes mothers who have toddlers not visit the puskesmas.

e. Giving Vitamin A

The purpose of vitamin supplementation administration was to make the child's body to be healthy. In particular, the consumption of vitamin A for toddlers has benefits such as: Increasing the body's resistance to diseases and infections such as measles and diarrhea. Assisted the process of vision in adapting light to dark places. Prevented abnormalities in epithelial cells, including the mucous membranes of the eyes.<sup>32</sup>

The target for the provision of vitamins and minerals is that all toddlers get 100 percent at least vitamin A.

During the Covid-19 pandemic, the vitamin and mineral provision which was usually carried out at the posyandu turned into a door-to-door provision of vitamins and minerals due to the prohibition of access to posyandu.

The obstacle experienced during the pandemic was that the administration of vitamin A directly to toddlers was not monitored because it was different from the administration of vitamin A at the posyandu which could be monitored in taking it, the administration of vitamin A during the pandemic was carried out door to door so that it was not possible to carry out further monitoring.

4. Output aspects of the stunting program implementation during the Covid 19 pandemic in Semarang City.

So it can be concluded that the nutritionist as the coordinator of the stunting prevention program conducts regular evaluations once a year. In addition to evaluating, nutrition workers also conduct assessments. Assessment is a process to determine the value or level of success of a program in achieving the goals that have been set or an orderly and systematic process in comparing the results achieved with the benchmark criteria set, followed by drawing conclusions and providing suggestions and input that can be done at each stage. stage of program implementation. Without an evaluation it will be difficult to know how far the planned goals will be achieved.<sup>33</sup>

The main objective of the stunting prevention program during the Covid-19 pandemic was to reduce the stunting rate during the Covid-19 pandemic, which during the current COVID-19 pandemic had the potential for a spike in cases due to limited access and quality of the stunting program itself.<sup>6</sup> Therefore, to find out about the success of the stunting program objectives in general, it can be seen from the status of stunting prevalence in the city of Semarang.

Based on data from the Semarang City Health Office, the prevalence of stunting in the pre-pandemic period was 2.5% in 2018 and 2.57% in 2019 while the prevalence of stunting during the pandemic taken from 2020 data was 3.13% or as many as 3143 infants and toddlers were stunted. It can be concluded that the stunting program during the pandemic has not met the expected target where there is an increase in stunting cases from 2.57% to 3.13% with the total number of toddlers experiencing stunting during the pandemic, an increase of 384 toddlers compared to before the pandemic. This certainly needs special attention, especially in improving the quality of the quality of a program. The success of the stunting prevention program during a pandemic must be in line with the declining prevalence rate during the pandemic.

## CONCLUSION

The stunting prevention program in the work area of the puskesmas during the Covid-19 pandemic has not been able to be implemented well during the Covid-19 pandemic. The input aspect proved this; the process has not run well, thus increasing the stunting prevalence rate from 2.57% to 3.13%. The number of toddlers experiencing stunting during the pandemic increased by 384 toddlers. The suggestion in this study is to increase the innovation of stunting prevention programs by using digital technology during the pandemic.

This research is cannot be separated from the limitations and weaknesses in the data collection process. Limitations and weaknesses in this research include: The limited time of the informants to conduct in-depth interviews due to the busyness of the informants at work, so that the information obtained was not maximized, The limitations of researchers to make observations through observing the available infrastructure at the posyandu (Integrated Healthcare Center) due to restrictions during the pandemic Covid-19.

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## Differences in Development and Diet of Stunting and Non-Stunting Children in the Rowosari Health Center Work Area, Semarang, Indonesia

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### ABSTRACT

**Background:** Stunting in children aged 36-59 months is caused by the intake of energy and protein below the average RDA recommendation. This low consumption has an impact on different growth and development disorders.

**Objectives:** This study aimed to determine the differences in the development and diet of stunted and non-stunted children aged 36-59 months.

**Materials and Methods:** This was an observational study with a cross-sectional approach, which was carried out at the work area of the Rowosari Health Center. The sample population consisted of 67 children aged 36-59 months, which were selected using the simple random sampling technique. The characteristics of the subjects and mothers were then collected using a questionnaire. Meanwhile, data on the diet and child development were obtained with the 24-hour recall method and Developmental Pre-Screening Questionnaire (KPSP), respectively.

**Results:** The results showed that there were differences in the development as well as energy and protein adequacy level of stunted and non-stunted children with a p-value <0.05.

**Conclusion:** There were several deviant developments in non-stunted toddlers due to the lack of nutritional intake, stimulation, interaction with the environment as well as the low knowledge of mothers about child care patterns.

**Keywords:** Stunting, diet, development, Semarang

### BACKGROUND

Stunting is caused by various child development disorders<sup>1</sup> and it has affected 21.3% of children under the age of five years globally with a total of 144 million cases. Several studies showed that the condition is more prevalent in Asian and African countries<sup>2</sup>. The 2018 Basic Health Research (Riskesdas) and the 2019 Indonesian Toddler Nutritional Status Survey (SSGBI) reported that there was a decrease in the stunting rate from 30.8% to 27.7%<sup>3,4</sup>. However, it is still a health problem because its prevalence is above the WHO standard of 20 %<sup>4</sup>.

Adequate nutrition, health conditions, protection, and safety factors play an important role in children's development, especially at an early age<sup>5</sup>. The occurrence of stunting during this period can affect the structure and function of the brain where a reduced number of cells causes growth delays. A survey by the Health Ministry of Indonesia revealed that 16% of children under five years experienced fine and gross motor development disorders, hearing loss, decreased intelligence as well as speech delays with a total of 0.4 million cases<sup>6</sup>. At the age of 36-59 months, only 6-7 toddlers have reached the appropriate growth stage<sup>5</sup>. Furthermore, a previous study showed that faltering growth before birth and 18 months after gestation is associated with poor language and motor development<sup>7</sup>. Stunting children aged 2, 5, and 9 years have lower verbal scores and IQ of 4.6 points compared to others<sup>8</sup>. Several studies also revealed that they have lower scores in all aspects of development<sup>9</sup>. A study in Kalasan showed that stunting children are 3.9 times more at risk of developing suspect than others with normal growth<sup>10</sup>.

Nutrient intake plays an important role in supporting the development of children<sup>11</sup>, hence, low consumption of energy and protein causes growth failure<sup>12</sup>. This was evident in 45.7% of the sample population having an energy intake <70% AKE, while 36.1% were <80% RDA<sup>13</sup>. Furthermore, a previous study revealed that toddlers with low consumption are 7.5 times more at risk of experiencing stunting<sup>14</sup>. A study in Brazil also reported that the intake of protein must meet the nutritional needs of children. Toddlers are 1.59 times at risk of experiencing stunting when their protein intake is below the nutritional adequacy level<sup>15</sup>.

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Semarang is one of the cities in Central Java with the lowest stunting prevalence of 21.0%<sup>16</sup>, but the rate was reduced by 2.7% in 2018 and 2.5% in 2019. However, due to the pandemic, there was a 3.13% increase in the rate with a total of 384 children under the age of five in 2020<sup>17</sup>. Tembalang is one of the affected districts in Semarang City, which had the highest prevalence of 10.11%<sup>18</sup>. During the pandemic, the intervention administered was ineffective<sup>17</sup> and it had a negative impact on the monitoring of children's growth<sup>19</sup>. The diversity of food for stunting children is still lacking, especially during prenatal feeding and exclusive breastfeeding<sup>20</sup>. Therefore, this study aims to determine the differences in the development as well as the diet of stunted and non-stunted toddlers aged 36-59 months in Tembalang District, Semarang City.

**MATERIALS AND METHODS**

This was an observational study with a cross-sectional design, which was carried out in December 2021. The sample population consisted of toddlers aged 36-59 months living in the working area of the Rowisari Health Center, Tembalang District, Semarang City, and the size was calculated using the Lemeshow formula. Furthermore, the study location was in Meteseh Village 3, 4, and 16 where a total number of 67 children was selected using the simple random sampling technique.

The subjects who entered the stunting group as many as 12 children, while those who entered the non-stunting group as many as 55 children. We included children aged 36-59 months living in the working area of the Rowosari health center, living with parents / caregivers, born enough months, agreeing to be respondents by signing *informed consent*. We exclude those who had not in place during the study and had congenital abnormalities.

The free variables in this study were development and diet, while the bound variables were stunting and not stunting. Stunting is determined through the results of measurements of height compared to age in the  $\geq -2$  elementary school assessment standards WHO<sup>3</sup>. The samples' nutritional status was obtained using a stadiometer Seca 213 with TB/U indicators, which were then interpreted according to anthropometric standards<sup>21</sup>. Meanwhile, their development was assessed using the Child Development Pre-screening Questionnaire (KPSP)<sup>22</sup>. The dietary data were collected using the Recall method for 3x24 hours, after which the food ingredient composition was calculated with a nutrisurvey to determine the number of macronutrients consumed<sup>23</sup>. It was then compared with the RDA and all the data were analyzed using Chi-Square statistical test.

**RESULTS**

**Table 1. Distribution of Respondents' Characteristics**

Variable	Stunting		Non-stunting		Total	
	N	%	N	%	N	%
Gender						
Male	6	9.0	40	59.7	46	68.7
Female	6	9.0	15	22.4	21	31.3
Children Age						
36-46 months	6	9.0	22	32.8	28	41.8
47-59 months	6	9.0	33	49.3	39	58.2
Mother's Age						
25-35 years	12	17.9	47	70.1	59	88.1
>36 years	0	0	8	11.9	8	11.9
Mother's Job						
Working	1	1.5	23	34.3	24	35.8
Housewife	11	16.4	32	47.8	43	64.2
Mother's Education Level						
Junior and Senior High School	10	14.9	45	67.2	55	82.1
S1 and Equal	2	3.0	10	14.9	12	17.9

Table 1 shows that 59.2% of the samples were male, and 49.3% were between 47-59 months, which was the most aged group. Furthermore, 70.10% had mothers aged 25-35 years, while 55.2% had housewife mothers. 67.1% of the parent have a junior high and high school education background, and they were all in the non-stunting group.

**Table 2. Differences in the development of stunting and non-stunting children**

Nutritional status	Child development	P-Value*
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	Deviant		Normal		n	%	
	n	%	n	%			
Stunting	11	16.4	1	1.5	12	17.9	0.008
Non-stunting	26	38.8	29	43.3	55	82.1	

A high deviant child development occurred in the non-stunting group where 38.8% of the samples were affected compared to the stunting category with 16.4%, as shown in Table 2. The chi-square test result showed that there were differences in the development in the two groups with  $p < 0.05$ .

**Table 3. Differences in the energy adequacy level of stunting and non-stunting children**

Energy Adequacy Level	Nutritional status						P-Value*
	Stunting		Non-stunting		n	%	
	n	%	n	%			
Lack	12	17.9	33	49.3	45	67.2	0.006
Adequate (appropriate with AKG)	0	0	22	32.8	22	32.8	

Table 3 shows that 46.3% of the children in the non-stunting group had a good energy adequacy level compared to the stunting category with 17.9%. Furthermore, the fisher's exact test results revealed that there were differences in the levels recorded in the two groups ( $p < 0.05$ ).

**Table 4. Differences in protein adequacy levels for stunting and non-stunting children**

Protein Adequacy Level	Nutritional status						P-Value*
	Stunting		Non-stunting		N	%	
	N	%	N	%			
Lack	11	16.4	17	25.4	28	41.8	0.000
Adequate (appropriate with AKG)	1	1.5	38	56.7	39	58.2	

Table 4 revealed that 25.4% of the children in the non-stunted group had good protein adequacy compared to the stunting category with 16.4%. The results of the chi-square test showed that there were differences in the level of energy adequacy in the two groups ( $p < 0.05$ ).

## DISCUSSION

### Subject characteristics

The sample population consists of 59% male and 49.3% were aged 47-59 months. Furthermore, 55.2% of the children had a housewife mother of which 67.1% had junior and senior high school education background. A previous cross-sectional study in Ethiopia identified 410 toddlers in a critical growth and development period between 6-59 months. The results showed that the factors affecting stunting include gender, birth weight  $< 2.5$  kg, low active visits of mothers to integrated service posts, and inappropriate complementary feeding.<sup>24</sup> Mugianti (2018) reported that the growth and development of boys are more influenced by the environment, hence, they can easily experience the condition due to psychological conditions. The growth process is primarily dependent on the ability of the caregivers to meet their nutritional needs.<sup>25</sup> Meanwhile, a study in Ghana showed that stunting was more common in girls than boys aged  $>2-5$  years.<sup>26</sup> This was because the child received an adequate amount of breast milk, but the feeding was improper. Although growth can be achieved after the conditions change, malnourished children never reach optimal level.<sup>26</sup>

The results showed that the mothers' nutritional education and knowledge is one of the factors related to child outcomes. Children with an educated parent are often healthier and well-groomed compared to others. Therefore, the low level of mother's education has an impact on the prevalence of malnutrition among toddlers apart from other factors, such as income.<sup>26</sup> These findings are in line with a study in Laos and Thailand where stunting children have mothers and caregivers without formal education.<sup>27,28</sup>

### Children development

Table 2 shows that abnormal development is prevalent in non-stunted children where 38.8% were affected compared to stunted toddlers with 16.4%. The chi-square test indicated that there were differences in the development based on the incidence of stunting ( $p < 0.05$ ). This finding is in line with Nahar (2020) that there were developmental variations in the cognitive, motor, language, and socio-emotional function of both groups.<sup>9</sup> Putri (2018) also revealed that there were significant differences in the growth of stunted and non-

stunted children in Semarang Regency<sup>29</sup>. Stunting toddlers experience slow and short skeletal growth, hence, good nutrition is needed at an early age. Based on the level of energy and protein adequacy, nutritional intake in this study was still lacking. These nutrients are greatly needed from birth to the age of 2 or 3 years, and the fastest period is the first 6 months of life<sup>30</sup>.

The meta-analysis revealed that stunting children aged 36-59 months in various developing countries experience poor development<sup>31</sup>. This difference causes growth inhibition of the brain cells, fibers, and connectors, thereby leading to overall developmental delays<sup>32</sup>. A previous study reported that the functional connectivity of the brain can function as a neural pathway, where biological difficulties have an impact on cognitive development. These findings provide an understanding of the pathways, which serves as a link between impaired growth and poor cognitive outcomes. Furthermore, this reveals the widespread adverse effects of malnutrition on children's brain development, consequently, more efficient intervention can be developed<sup>33</sup>.

### **Energy Adequacy Level**

Based on energy adequacy levels, the majority of the toddlers were included in the low category, as shown in Table 3. Furthermore, most of the children with deficiency were in the non-stunted group, accounting for 49.3% of the total population. The fisher's exact test showed that there were differences in the energy adequacy level of the stunted and non-stunted groups with a p-value <0.05. This finding is in line with Adani and Nidya (2017) as well as Damayanti that there are variations in the consumption of energy, protein, zinc, iron, exclusive breastfeeding history as well as the development of stunted and non-stunted children<sup>34</sup>. This study is also consistent with Mahfouz et al (2021), which obtained similar results where there were differences between the consumption level of both groups<sup>35</sup>. Three-quarters of the sample population lack energy and the daily intake of stunted toddlers was lower than that of others<sup>36</sup>. Mugianti (2021) reported that children with low consumption are 0.146 times more at risk of experiencing stunting compared to others with sufficient adequacy level<sup>25</sup>. At an early age, sufficient energy and nutrients intake lead to healthy growth and development of the brain, bones, and immune system<sup>37</sup>. Differences in nutritional intake of stunted and non-stunted children are caused by the type of food consumed and irregular eating patterns with fewer portions, which can contribute to growth failure<sup>38,39</sup>.

### **Protein Adequacy Level**

Table 4 shows that 56.7% of the toddlers were included in the category of protein adequacy levels, but the non-stunted group had higher levels compared to the stunting category. The chi-square test results revealed that there were differences in the development of both groups with a p-value <0.05. Furthermore, this finding is in line with Yuristi et al (2019) that there are variations in the protein intake of stunted and non-stunted children<sup>40</sup>. This is also consistent with Sharm S et al (2020) that approximately 85% of children under 5 years have more than 70% of the recommended protein intake<sup>41</sup>. Solihin R et al (2013) reported that every 1% increase in toddlers' protein adequacy level elevates the z-score of BH/A by 0.0024 units<sup>12</sup>.

Protein plays an essential role in the building of new tissues as well as maintaining, repairing, and replacing damaged parts. The intake of nutrients that helps in brain growth and development includes energy, protein, certain types of fat, and iron. Children with long-lasting protein deficiency often experience stunting in height despite the presence of adequate energy<sup>42,36</sup>. However, there are some short children with a good intake of the nutrient. Protein consumption is not directly related to height, but it can serve as an indicator of previous food intake<sup>43</sup>.

### **LIMITATION**

This study was only carried out at Rowosari Health Center, hence, it did not describe the stunting state of Semarang City. Furthermore, some respondents did not understand the child's intake because they were not the main caregiver or the food were not provided by them.

### **CONCLUSION**

The result showed that there were differences in the development as well as the energy and protein adequacy levels of stunted and non-stunted children aged 36-59 months in the Rowosari Health Center's working area. Furthermore, more deviant developments were observed in the non-stunted toddlers due to the

lack of nutritional intake, stimulation, interaction with the environment as well as the mother's low knowledge of parenting patterns.

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# The Association between Sleep Duration, Breakfast Routine and Nutritional Status in Indonesian Adolescents during COVID-19 Pandemic

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## ABSTRACT

**Background:** Adolescents are susceptible to nutritional status issues, both undernutrition, and over-nutrition, becoming a public health concern promptly. There were 912 junior and high-school adolescents who were obese and 249 high-school adolescents who had low body mass index (BMI) in Samarinda City. During the COVID-19 pandemic, adolescents experienced changes in sleep duration, and many adolescents were skipping breakfast. Sleep duration and breakfast can affect the nutritional condition of adolescents.

**Objectives:** The purpose of this study was to determine the association between sleep duration, breakfast routine and BMI in Samarinda, Indonesian adolescents during COVID-19 pandemic.

**Materials and Methods:** A total of 340 adolescents was sampled and assessed using a cross-sectional technique to ascertain their sleep duration, breakfast routine, and nutritional status. Nutritional status was classified based on BMI-for-age and z-value BMI. The amount of sleep duration was calculated by the average wake time and sleep time. Breakfast routine was obtained from seven days of breakfast before 9 am. Then, using multivariate analyses were tested for sleep duration, BMI z-value, breakfast routine, and nutritional status.

**Results:** This study revealed that 68.5% had good nutrition, with an average sleep duration of 8 hours (65.9%) and irregular breakfast (59.1%). Nutritional status was significantly influenced by breakfast routine ( $p=0.044$ ), gender ( $p<0.001$ ), and mother's employment ( $p<0.001$ ). A cubic association was found between sleep duration and BMI ( $p=0.045$ ); and a significant association between breakfast routines and BMI, independent from age, gender, ethnicity, school.

**Conclusion:** Adolescents must consider their sleep duration and the frequency and composition of their breakfast. Future study in the longitudinal study is needed to explore in more detail.

**Keywords :** Sleep Duration; Breakfast; Nutritional Status; Adolescent

## BACKGROUND

Adolescence is a vulnerable period with nutritional status problems, such as malnutrition, including low body weight, overweight, stunting, and micronutrient deficiencies [1, 2]. Overweight and obesity in adolescents can increase the risk of heart disease, atherosclerosis, diabetes mellitus, orthopedic disorders, mental health disorders, and cognitive function [2].

Globally, the prevalence of overweight in adolescents aged 15-19 is 10%, and 2-3% of them are obese. Meanwhile, 88% are underweight in which 29% are girls and 59% are boys [3]. Over 340 million children aged 5-19 years were overweight and obese in 2016 [4]. Overweight or obesity adolescents are public health problems that require immediate attention and it may worsen their health, causing infectious disease [5-7].

According to Basic Health Research in 2018, the proportion of overweight and obese people aged 18 years and over in Indonesia has increased. East Kalimantan, Borneo is in the top three proportions of obese adults aged 18 years and over. Meanwhile, the prevalence of obesity and overweight in the Samarinda area in adolescents aged 13-15 years is 9.03% and 10.42%, respectively. Additionally, the prevalence of obesity and overweight for 16-18 years is 5.50% and 8.17%, respectively. Meanwhile, the prevalence of underweight and fragile nutritional status in Samarinda is 8.34% and 4.66% in 13-15 years and 10.98% and 3.36% in 16-18 years [8].

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Sleep duration, sleep quality, and sleep problems can lead to obesity and overweight. Sleep duration can increase the risk of cardiovascular disease, type 2 diabetes, mental health, hypertension and affect academic performance [9–12]. In addition, adolescent nutritional status is related to short sleep duration, which has the highest risk of obesity or overweight, increased fasting glucose levels, and an unhealthy immune profile [13].

Several studies state an association between short sleep duration and the nutritional status of high school adolescents, which stated that during a pandemic period, adolescents sleep only 4-6 hours in one day [13–15]. The amount of sleep duration is not aligned with the suggestion of the Ministry of Health of the Republic of Indonesia in 2018, which stated that the total sleep duration for adolescents should be 8-9 hours a day.

Another research on the sleep duration in high school students discover that more female students (75.6%) are having a shorter sleep duration compared to male students (69.6%) [16]. The same result is also found in high school students in Brazil, as well as with a sense of sleepiness was excessive [17]. Nonetheless, short sleep duration has a relationship with obesity in adolescents [18].

Apart from sleep duration, meta-analytical studies confirm that skipping breakfast also increases the risk of obesity or overweight [19]. Health behaviors such as the duration of sleep and breakfast consumption in adolescents are associated with chronic disease [13]. Breakfast plays a role in fulfilling nutritional intakes. However, adolescents still skip breakfast [20]. Adolescents who skip breakfast tend to have a poor quality diet and have a higher BMI or have more weight than adolescents who do not skip breakfast. [21, 22]. Another study suggests a positive correlation between skipping breakfast and obesity [23].

In Samarinda, 912 junior high and high school students are obese [24], and 249 high school adolescents have a low BMI [25]. There was also an increase in body weight during the COVID-19 pandemic [26]. In addition, changes in sleep duration in adolescents during the COVID-19 pandemic and their breakfast behavior affect their nutritional status [27, 28]. If those problems do not get enough attention, it will lead to an increasing number of adolescents with high BMI during the COVID-19 pandemic. The result from this study are expected to be used as a reference for further study about the problems and can be another source of knowledge for society. The aim of this study was to identify and predict the relationship between adolescent nutritional status and sleep duration and breakfast routines during the COVID-19 pandemic. This study conducted during COVID-19 pandemic at Samarinda, West Kalimantan, Borneo, Indonesia.

## **MATERIALS AND METHODS**

This study was an observational study with a cross-sectional survey conducted in Samarinda in West Kalimantan in March 2021. The population for this study was 2,943 high school students. Schools were selected based on the ease of access for researchers to reach. The sample was calculated using the Lemeshow formula [29]. The randomized and stratified random sampling technique was used based on geographic location, age, and socio-economic status [30]. The independent variables were sleep duration and breakfast routine, and the dependent variable was nutritional status. Based on self-reports, data on nutritional status, sleep duration, and breakfast routines were collected. Sleep duration was obtained from calculating bed and wake up time during the week. Meanwhile, the breakfast routine is obtained by calculating the time of breakfast during the week and the number of days of breakfast. BMI was calculated by age to determine nutritional status. The instrument used was an online questionnaire that was previously tested for its reliability. The sleep duration question was used to determine the average amount of sleep duration for teenagers in one week, breakfast routine questions were used to see what breakfast time teenagers had breakfast. However, the nutritional status question was asked to see the nutritional status of adolescents based on the z value of BMI. Informed consent was obtained by providing a descriptive at the beginning of the questionnaire and providing questions regarding willingness to fill out the online questionnaire. The study protocol was approved by the ethics committee in Mulawarman University, Samarinda, Indonesia.

Univariate data analysis was used to see the distribution and frequency. The bivariate analysis used was the Spearman test and the chi-square test to find confounding variables. Multivariate analysis was conducted to see whether there was a relationship between sleep duration and breakfast routine on nutritional status. Data analysis using quantitative analysis, namely linear, quadratic, cubic, and logistic regression analysis. If Sig (2-sided) < 0.05 then H<sub>0</sub> is rejected and Sig (2-sided) > 0.05 then H<sub>0</sub> is accepted. This analysis predicted sleep duration and breakfast routine based on nutritional status. A logistic regression test was used to predict the relationship between breakfast routine variables and nutritional status variables by adjusting the four models. The linear test was used to see a straight-line relationship between sleep duration and the z value of BMI as seen from the significant fixed coefficient. Meanwhile, quadratic and cubic tests were used to see the

relationship between sleep duration and the z value of BMI, which was seen from the significant fixed effects results. Linear, quadratic, and cubic tests were adapted to the four models. For all tests, a two-tailed p-value < 0.05 was considered statistically significant.

**RESULTS**

**Table 1. Characteristic of Adolescents**

Variables	Nutritional Status				N (%)	p-value
	Poor (%)	Good (%)	Over (%)	Obese (%)		
<b>Sleep Duration</b>						
<8 Hours	28 (12,5)	158 (70,5)	27 (12,1)	11 (4,9)	224 (100)	0,459
8-9 Hours	8 (12,5)	43 (68,3)	9 (14,3)	3 (4,8)	63 (100)	
>9 hours	5 (9,4)	32 (60,4)	13 (24,5)	3 (5,7)	53 (100)	
<b>Breakfast Routine</b>						
Not Routine	26 (12,9)	131 (65,2)	32 (15,9)	12 (6)	201 (100)	0,420
Routine	15 (10,8)	102 (73,4)	17 (12,2)	5 (3,6)	139 (100)	
<b>Age</b>						
15	1 (6,3)	9 (56,3)	6 (37,5)	0	16 (100)	0,586
16	19 (11,5)	122 (73,9)	18 (10,9)	6 (3,6)	165 (100)	
17	12 (9,6)	85 (68)	20 (16)	8 (6,4)	125 (100)	
18	7 (22,6)	16 (51,6)	5 (16,1)	3 (9,7)	31 (100)	
19	2 (66,7)	1 (33,3)	0	0	3 (100)	
<b>Sex</b>						
Female	20 (9,3)	165 (76,7)	22 (10,2)	8 (3,7)	215 (100)	<b>&lt;0,001</b>
Male	21 (16,8)	68 (54,4)	27 (21,6)	9 (7,2)	125 (100)	
<b>School</b>						
PUBLIC HS 11	14 (11,8)	81 (68,1)	19 (16)	5 (4,2)	119 (100)	0,146
PUBLIC HS 1	5 (5,2)	75 (78,1)	12 (12,5)	4 (4,2)	96 (100)	
<b>Variables</b>						
	<b>Poor (%)</b>	<b>Good (%)</b>	<b>Over (%)</b>	<b>Obese (%)</b>	<b>N (%)</b>	<b>p-value</b>
PRIVATE HS Setia Marga	9 (16,1)	35 (62,5)	7 (12,5)	5 (8,9)	56 (100)	0,146
PRIVATE HS Islam	3 (11,5)	17 (65,4)	6 (23,1)	0	26 (100)	
ISLAMIC HS Granada	10 (23,3)	25 (58,1)	5 (11,6)	3 (7)	43 (100)	
<b>Grade</b>						
X (Ten)	20 (11)	129 (71,3)	25 (13,8)	7 (3,9)	181 (100)	0,498
XI (Eleven)	16 (11,6)	92 (66,7)	22 (15,9)	8 (5,8)	138 (100)	
XII (Twelve)	5 (23,8)	12 (57,1)	2 (9,5)	2 (9,5)	21 (100)	
<b>Tribe</b>						
Kutai	3 (13)	15 (65,2)	4 (17,4)	1 (4,3)	23 (100)	0,197
Banjar	13 (13)	70 (70)	14 (14)	3 (3)	100 (100)	
Dayak	0	2 (40)	2 (40)	1 (20)	5 (100)	
Jawa	13 (11,9)	66 (60,6)	22 (20,2)	8 (7,3)	109 (100)	
Bugis/ Makassar	8 (15,1)	39 (73,6)	3 (5,7)	3 (5,7)	53 (100)	
Others	4 (8)	41 (82)	4 (8)	1 (2)	50 (100)	
<b>Fathers' Occupation</b>						
Government/ private employees	17 (11)	105 (68,2)	23 (14,9)	9 (5,8)	154 (100)	0,565
Army/ Police	0	4 (80)	0	1 (20)	5 (100)	
Laborer	4 (18,2)	17 (77,3)	0	1 (4,5)	22 (100)	
Unemployment	5 (13,5)	21 (56,8)	8 (21,6)	3 (8,1)	37 (100)	
Others	2 (16,7)	9 (75)	1 (8,3)	0	12 (100)	
<b>Mothers' Occupation</b>						
Government/ private employees	9 (12,3)	43 (58,9)	16 (21,9)	5 (6,8)	73 (100)	<b>&lt;0,001</b>
Entrepreneur /trader	6 (19,4)	21 (67,7)	4 (12,9)	0	31 (100)	
Army/ Police	0	0	0	1 (100)	1 (100)	
Laborer	1 (100)	0	0	0	1 (100)	
Housemakers/ Unemployment	24 (10,4)	168 (73)	28 (12,2)	10 (4,3)	230 (100)	
Others	1 (25)	1 (25)	1 (25)	1 (25)	4 (100)	

The p-value of the nutritional status and age variables was based on the Spearman test.

In addition to the Spearman test, the value was obtained from the chi-square test.

The comparison results were obtained from the p-value > 0.05.

Values in bold are significant values.

A total of 340 respondents were obtained from the four public and one private high school in Samarinda. The demographic characteristics of the respondents are depicted in Table 1. The majority of respondents were 16 and 17 years (48.5% and 36.8%, respectively) and predominantly female (63.2%). More than half of the respondents were in class X (ten), as many as 181 (53.2%). Of 340 participants, 63.2% attended public school, and 109 of the respondents (32.1%) were Javanese. Meanwhile, as of parents' occupations, a government/private employee (45.3%) and housewife (67.6%) were the most common for father and mother, respectively.

The group with the highest number of good nutritional status was 16 years. In addition, the number of poor nutrition (undernutrition, overnutrition, and obesity) was only 43 respondents. There are 28 respondents aged 17 years who have more nutritional status and obesity, which makes this age has the highest number compared to other ages. The good nutritional status was predominantly female, while the malnutrition was predominantly male. In addition, respondents whose father is a government/private employee have the best nutritional status, amounting to 105 respondents. At the same time, they also have the highest number of over nutritional status compared to other fathers' occupations, which are 23. Based on the mother's occupation, respondents with a housewife mother have the best nutritional status compared to working mothers.

Based on table 1, the most respondents slept for <8 hours, which amounted to 224 (65.8%). The results of the cross-tabulation showed as many as 158 adolescents had good nutritional status and sleep duration < 8 hours. In addition, respondents with sleep duration < 8 hours had the highest good nutritional status compared to other sleep durations. And, most respondents (59.1%) did not have breakfast regularly. In addition, as many as 131 respondents who do not routinely have breakfast have good nutritional status, while only 26 respondents have poor nutritional status and do not routinely eat breakfast.

**Table 2. Sleep Duration and Body Mass Index**

	BMI Z Score		
	Linear	Quadratic	Cubic
Model 1	0,701	0,135	<b>0,045</b>
Model 2	0,655	0,134	<b>0,042</b>
Model 3	0,553	0,124	0,053
Model 4	0,966	0,355	<b>0,020</b>

Model 1: Age, gender, occupation of mother

Model 2: Age, gender, occupation of father

Model 3: Age, gender, father's occupation, mother's occupation

Model 4: Age, gender, ethnic, school

The value of each model is obtained from linear, quadratic, and cubic tests. The comparison is obtained from the p-value < 0.05. Values in bold are significant values.

**Table 3. Breakfast Routine and BMI-for-age**

Breakfast Routine	BMI-for-age
	p-value
Model 1	<b>0,044</b>
Model 2	0,061
Model 3	<b>0,047</b>
Model 4	<b>0,024</b>

Model 1: Age, gender, occupation of mother

Model 2: Age, gender, occupation of father

Model 3: Age, gender, father's occupation, mother's occupation

Model 4: Age, gender, ethnic, school

The value of each model is obtained from linear, quadratic, and cubic tests. The comparison is obtained from the p-value < 0.05. Values in bold are significant values.

Results of the chi-square test showed that gender (<0,001) and mother's occupation (<0,001) were significant. Meanwhile, other variables were not significant. For the cubic test results displayed in table 2, the significance values obtained in model 1, model 2, and model 4 were 0.045, 0.042, and 0.020, which showed significant results with the Z score BMI. However, for model 3, the results were insignificant with the Z BMI value because the significance value obtained was 0.052. The logistic regression statistical test results in table 3 showed the significance value (p-value) in each model of 0.044, 0.061, 0.047, and 0.024. Because  $p < 0.05$ , this means that model 1, model 3, and model 4 showed a significant value, while model 2 did not show a significant value.

The results of the cubic test were presented in the figure 1 where it can be seen that the line begins to rise at a sleep duration of fewer than 8 hours, then falls back to 8 to 9 hours of sleep duration and again experiences a high increase when sleep duration was 10 hours. These results showed an increase in the Z score BMI when sleep duration was less than 8 hours and a significant increase was more than 10 hours.

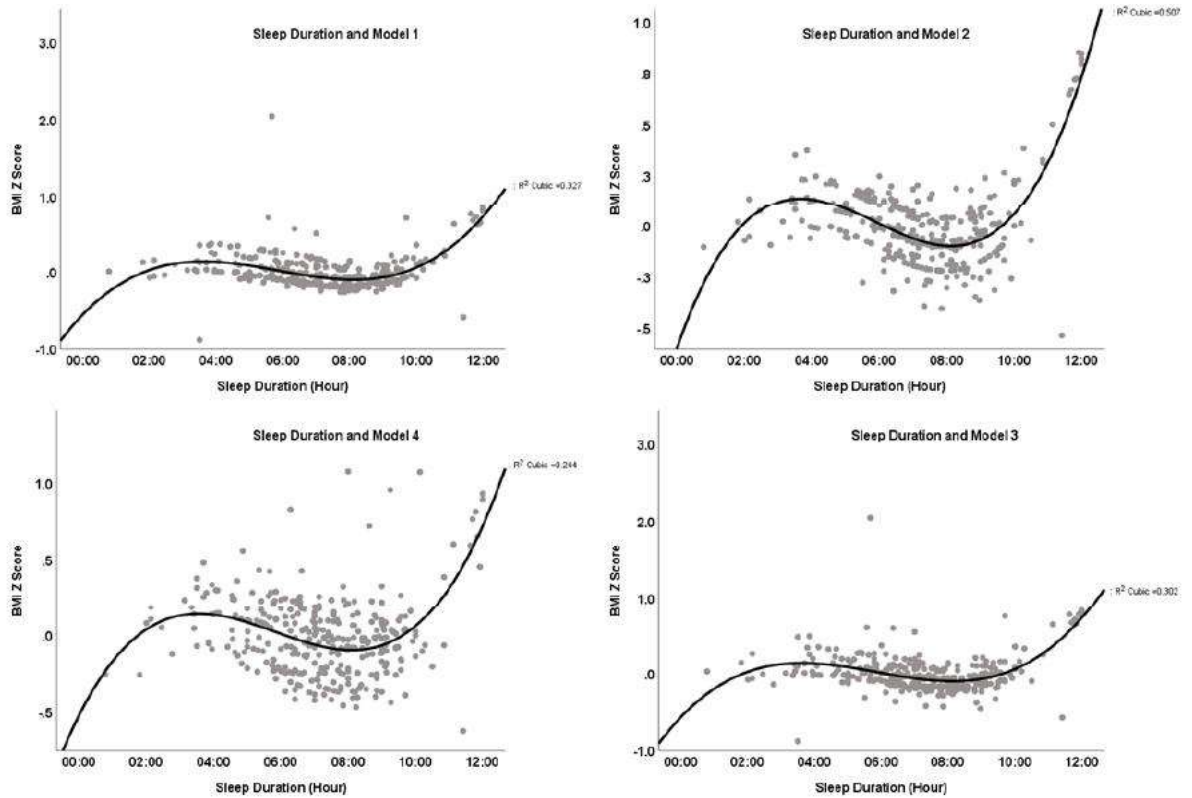


Figure 1. Sleep Duration and Z-Score BMI Each Model

## DISCUSSION

This study's main results indicate a relationship between sleep duration and breakfast routine on the nutritional status of adolescents during the COVID-19 pandemic. However, the relationship found between sleep duration and BMI Z value based on the Multicentre Growth Reference Study (MGRS) for sleep duration [31]. In addition, there is also a relationship between gender and mother's occupation with the nutritional status of adolescents.

In term of age, Salmela-Aro (2011) categorized adolescents into three, namely, early adolescents (11-13 years), middle adolescents (14-17 years), and late adolescents (17-19 years) [32]. Therefore, based on the results of this study, 90% of adolescents were included in the category of middle adolescents, and 10% were late adolescents. Drastic growth and development occur at that age, so the need for energy, vitamins, protein, and minerals increase significantly [20]

In the current study, the prevalence of overweight and obesity was 22.6% in adolescents aged 17-19 years. These results are very high compared to the results of previous studies, which found the prevalence of overweight and obesity in adolescents is 2.3% [33]. In the same age group, the prevalence of malnutrition was 13.2%, while the study by Roba et al. (2016) reports that 29.5% of adolescents have poor nutritional status [34]. These different results may be caused by different socio-economic backgrounds or ethnic differences in dietary behaviour [34, 35]. Strict diet patterns and over snack consumption can also make their nutritional intake unfulfilled and result in malnutrition [36]. While the reason why adolescents with overweight or obesity caused too much consuming fat and carbohydrate food and lack in physical activity [36].

Nutritional issues in adolescents might started during infant period and they also suffer from malnutrition during infant periods. Furthermore, the adolescent environment influences their nutritional status [37]. Nutritional issues in adolescents, such as undernutrition or obesity, can also be induced by an imbalanced adolescent nutritional intake [38]. Food consumption and weight gain in the 10 - 19 years age group are rising during the COVID-19 pandemic, potentially affecting their nutritional condition [39]. One can assume that this might be caused by a shift in behavior related to weight increase in the school-age group during the ongoing pandemic [40].

The respondents in this study were predominantly female, with the sex ratio between female and male being 2:1. Adolescents experience different sexual maturity between girls and boys, influencing their

nutritional needs [20]. Adolescent sexual maturity is related to hormonal changes, body composition, weight, and linear growth [20]. Gender determines a person's nutritional needs, where male adolescents have higher nutritional needs due to their higher physical activity than female adolescents [41]. Nutritional status in adolescents was found to have an association with gender on this study. This finding is in line with the results of a study conducted by Darling et al. (2020), which found a relationship between adolescent girls with a reduced risk of being underweight, but a high risk of being overweight [42]. Meanwhile, adolescent boys are associated with low body weight [42]. The difference between girls and boys is because girls have about twice as much fat as boys. After all, girls are prone to fat accumulation [43]. Research conducted by Maltoni et al. (2021) stated weight gain in adolescent boys during the COVID-19 pandemic [44].

Women from young to old, married or unmarried, have children or do not have children at this time have the ambition to work, so it is not uncommon to find a mother who has a dual role in a family [45]. However, during the COVID-19 pandemic, many mothers between the ages of 25 and 44 lost their jobs due to demands to care for their families [46]. This study found a relationship between a mother's work and adolescent nutritional status. However, the results of this study were different from previous studies, which reported no relationship between the mother's work and the nutritional status of students [47]. Adolescents with mothers who have employment status as homemakers are the most likely to have good adolescent nutritional status based on this study. Because homemakers have time to meet their children more often, mothers can pay more attention to their children's health [47].

This study found no significant association between father's occupation and adolescent nutritional status. This may be due to the status of mothers who are mostly housewives and the finding of a relationship between mother's occupation status and adolescent nutritional status, so that father's occupation does not show significant results. Meanwhile, a previous study states a significant relationship between fathers' work and adolescent nutritional status [48]. The type of father's occupation affects his income in which will affect the amount and food selection at home [48]. Income that only comes from one parent can hinder overweight in adolescents [49]. Family with low income might have some difficulties to provide and choose nutritious and diverse foods [50].

Sleep duration usually refers to the total amount of sleep gained, either during episodes of nocturnal sleep or over 24 hours [51]. Sleep is defined as a behavioral state characterized by rest, reduced environmental awareness, and immobility [52]. Different sleep times result from different lifestyles and jobs for each individual [52]. When sleep is of insufficient duration, it can disturb consciousness during the day and cause excessive experience sleepiness [52]. Adolescents often experience insufficient sleep duration can be caused by the adolescents deliberately reducing the duration of their sleep for other activities, such as attending parties, working, studying at night for exams [53]. Lack of sleep duration can cause individuals to experience hallucinations, mood swings, fatigue, irritability, impaired perception & orientation, and declining attention [52].

Based on this study, most adolescents had a total sleep duration of less than 8 hours, so this finding was in line with the results of the study by Sinha et al. (2020), which reported that the amount of sleep duration for adolescents during the COVID-19 pandemic is only 4-6 hours in a day [54]. It can be caused by adolescents who deliberately reduce their sleep duration, such as doing activities at night, studying, partying, or working [53]. These results did not meet the sleep needs of adolescents recommended by the Indonesian Ministry of Health in 2018, which is 8-9 hours of sleep duration in one day.

Previous research on sleep duration during the COVID-19 pandemic conducted in five cities (Seoul, Stockholm, London, Los Angeles, and New York) found that the average sleep duration of respondents is less than 8 hours [55]. This short sleep duration is due to increased stress during the COVID-19 pandemic [56]. During the COVID-19 pandemic, many adolescents experienced stress, making it hard for them to sleep at night. Stress and sleep quantity can also reduce sleep duration because during the COVID-19 pandemic, they rarely sleep at night, even though their sleep duration is only about 6 to 8 hours [57].

In addition, poor health can cause adolescents to sleep less than eight hours. Evidence by Panel et al. (2015) states that adolescent sleep duration of fewer than seven hours tends to have poor and low health and low physical and mental quality [58]. Likewise, Guo et al. (2021) state that an unhealthy lifestyle occurred during the COVID-19 pandemic among students at a high level of education [59]. Health problems such as obesity in adolescents, hypertension, diabetes, and cardiovascular disease can cause sleep duration shorter than eight hours [60]. Individuals who lack sleep can affect their long and medium-term performance (58). Short sleep duration can affect changes in sleep quality during the COVID-19 pandemic [61].

Research on sleep duration in America states that, on average, an adolescent sleep for 7.3 hours in one day [62]. This result is similar to the studies conducted in European and North American states, where the average adolescent sleep duration ranges from 7 to 9 hours on school days [63]. In addition, these results are also supported by research conducted in Africa, Asia, Central and South America, the Middle East, the Caribbean, and Oceania, which found that the sleep duration in 16-year-old adolescents is 7 hours [64].

This study found that 15.6% of adolescents had a sleep duration of more than 9 hours, while research conducted by AL-Haifi (2016) found that 24.85% of adolescents have more than 9 hours sleep duration, others found that almost 90% of adolescents have more than 7 hours sleep duration in one day [65, 66]. Adolescents with longer sleep duration can increase the risk of coronary heart disease and affect their mental health [67, 68].

This study showed that only 18.5% of adolescents met the adequacy of sleep duration, namely for 8-9 hours, while the majority (81.5%) did not meet the adequacy of sleep duration. As a comparison, previous research showed that 82.7% of adolescents met the adequacy of their sleep duration, while 17.2% did not meet the adequacy of their sleep duration [69]. Because other study were conducted before the COVID-19 pandemic while this study was conducted during the pandemic, so that makes results are different. Another reason is adolescents having a tough time maintaining and initiating sleep [70].

The bivariate analysis results showed no significant relationship between sleep duration and adolescent nutritional status during the COVID-19 pandemic. It is in line with the results of a previous study, which stated that there was no association between BMI and sleep duration in adolescence [71]. A study by Schneider et al. (2020) also found that there is no association between BMI and sleep duration in adolescent boys [72]. These results show that short sleep duration does not affect their nutritional status [73].

Sleep duration and nutritional status are not related because when adolescents stay up late, they do not always consume food or drink; it could also be that they are busy doing school assignments [73]. In addition, factors that directly affect nutritional status are food intake and infection, while sleep duration is an indirect factor affecting nutritional status [74]. The absence of this relationship can also be explained that sleep duration is not an independent factor. It can also be caused by other factors such as genetic factors and environmental factors [75].

The results of the cubic test analysis in this study found that adolescents whose sleep duration was more than 9 hours experienced a high increase in their BMI Z value, which was inversely proportional to the findings of Grandner et al. (2015) [76]. They found that a short sleep duration of less or equal to four hours is associated with high BMI Z values. This difference is because a non-linear relationship was found in the current study, while Grandner et al. (2015) found a linear relationship [76]. Lack of sleep duration is associated with unhealthy eating habits, such as more significant portions, increased hunger, increased appetite in high-calorie foods, and increased intake of sugary foods and drinks [77]. Children who experience sleep deprivation and lack healthy food have a high BMI z value [77].

Research from Italy states that adolescents with low or average weight tend to have longer sleep durations compared to adolescents who are overweight and obese [78]. The results of this study are in line with the results of this study, in which 70% of adolescents with low or normal nutritional status had a total sleep duration of more than nine hours compared to adolescents with overweight and obese status. Covariates effect such as lifestyle, diet, and physical activity on BMI can influence these outcomes, as can sample size, age group differences, and geographic and ethnic variations [79].

For breakfast, can be characterised as the first meal before or starting the activity two hours after waking up, usually, less than 10 am, with a calorie content of about 20% to 35% of the total daily energy adequacy [19]. This study found that 59.1% of adolescents did not regularly eat breakfast. These results align with Hermanto et al.'s (2020) research, which found that 70.4% of adolescents rarely eat breakfast [70]. Skipping breakfast is often done by adolescents and can reduce their nutrient intake [20].

Adolescents skip breakfast because there is no food available in their homes [22]. Husain & Ashkanani (2020) reported that during the COVID-19 pandemic, breakfast is often missed. Staying up late makes someone snack in the middle of the night, and excessive sleep is the reason for skipping breakfast [80]. Other reasons adolescents skip breakfast are lack of appetite, no time, difficult to make a food, and religious reasons [81]. These results are inversely proportional to the research conducted by Sidor & Rzymiski (2020), who stated that 65.5% of respondents had breakfast every day [82].

A total of 131 adolescents who did not regularly take breakfast has good nutritional status, while adolescents who regularly eat breakfast with good nutritional status are 102 respondents. Based on this study,

adolescents who did not regularly eat breakfast tend to have good nutritional status during the COVID-19 pandemic. It can be due to other factors related to good nutritional status, such as physical activity. Adolescents who are physically active during the COVID-19 pandemic tend to have normal nutritional status [83]. In addition, the intake of energy, carbohydrates, and protein also affects the nutritional status of adolescents [84]. Therefore, there is a possibility that adolescents have good nutritional status but do not regularly eat breakfast.

The bivariate analysis results in this study showed no correlation between breakfast routine and nutritional status. A previous study by Kurniawan (2020) show no relationship between breakfast routines and nutritional status [85]. A typical breakfast cannot determine a person's nutritional status because the total energy requirement obtained from breakfast food is only 25% [38]. So, a balance breakfast menu is needed to fulfill the daily nutritional intake [86]. Previous studies demonstrated that there is no association between breakfast habits and the nutritional status in high school students [85, 87]. Food quality and quantity such as large portions, nutritional value, and food varieties affect a person's nutritional status rather than solely breakfast behavior [88].

This study found a linear relationship between breakfast routine and nutritional status in adolescents. Nutritional status is a balance between nutrient intake from food and the nutritional needs needed for body metabolism [2]. Data analysis using logistic regression tests found an association between breakfast routines and nutritional status in adolescents. This finding aligns with Amalia & Adriani (2019), which found an association between breakfast routines and nutritional status [89]. Research conducted on European and Brazilian adolescents found that skipping breakfast leads to obesity in adolescents [90]. Similarly, a study in Bangladesh and India demonstrated that skipping breakfast significantly correlates with being overweight [91]. However, research from Zagreb, Croatia, states that adolescent girls who eat breakfast have a higher incidence of obesity [92].

Adolescents who skip breakfast tend to have increased blood sugar levels, fatigue, declined concentration, and experience a decrease in physical and mental conditions [93]. Breakfast can improve cognitive performance, as the adolescents will not be disturbed by hunger and affect memory [94]. A previous study have reported that skipping breakfast is associated with an increased risk of obesity by 1.75 times than eating breakfast regularly [19].

During the COVID-19 pandemic, adolescents increase their breakfast and unhealthy food/drinks consumption, resulting in weight gain that affects their nutritional status [95]. Beside excessive breakfast, skipping breakfast can also increase the energy intake obtained when adolescents consume snacks to replace breakfast [96]. Another explanation is that adolescents who skip breakfast during the COVID-19 pandemic are caused by waking up at night, leading to snacking in the middle of the night and also excessive sleep the next day, which can lead to overweight and obesity [80]. Another study conducted in South Korea stated that in general breakfast consumption in adolescent during the pandemic COVID-19 is higher than before the pandemic. During the pandemic period, adolescents have a lot of free time to eat at home, the ban on going out causes adolescents to have a lot of time to eating or snacking at home [97]. Also, a study showed that during a pandemic there are some people who skip breakfast, which can affect their quality of life [98].

## **CONCLUSION**

In a nutshell, there was an association between sleep duration and breakfast routine with adolescent nutritional status. The findings indicated that many adolescents had less than 8 hours of sleep duration and a lack of breakfast routines. However, more than half of adolescents had good nutritional status. Adolescents are advised to get enough sleep duration as recommended and to have breakfast every day and maintain it during the COVID-19 pandemic.

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## Effects of Sorghum Cookies (*Sorghum Bicolor L. Moench*) on Fasting Glucose, Triglyceride, High-Density Lipoprotein level, and Body Fat Percentage in Adolescent Obesity

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### ABSTRACT

**Background:** Adolescent obesity is related to the risk of metabolic syndrome. Several studies have proven the effect of dietary interventions on metabolic parameters in obese individuals. A source of complex carbohydrates that is still rarely developed in the obese diet is sorghum which contains resistant starch.

**Objective:** The study was to reveal the effect of sorghum cookies on Fasting Glucose (FG), Triglycerides (TG), High-Density Lipoprotein (HDL), and Body Fat Percentage (BFP) in obese adolescents.

**Materials and Methods:** This quasi-experiment with the pre-post control-group design was conducted on 20 boys and 20 girls (divided into 10-boy control group, 10-girl control group, 10-girl intervention group, and 10-girls intervention group) with the age range of 13–15 years who attended Junior High School 14 Semarang chosen by consecutive sampling. Weight, Height, and BFP were measured directly by BIA. Metabolic parameters (FG, TG, and HDL levels) were taken through venous and 10-hour fasting. Energy intake and physical activity were taken by interview using the food recall questionnaire for 6 days randomly and IPAQ. The intervention of sorghum cookies was given in 90 grams/day with 473 kcal/day for 28 days. The analysis of the effect of the intervention was conducted by a paired t-test and independent t-test.

**Results:** At 28-days sorghum cookies intervention resulted in lower levels of FG, TG, and BFP in the intervention boy group ( $p < 0.05$ ) and BFP in the girl group ( $p < 0.05$ ). The intervention of sorghum cookies showed no effect on HDL levels in boys, and it did not affect FG, TG, or HDL levels of the girl subjects ( $p > 0.05$ ).

**Conclusion:** Obese adolescents who had been receiving intervention of 90 grams of sorghum cookies for 28 days appeared to have lower levels of fasting glucose, triglycerides, and body fat percentage.

**Keywords:** Sorghum, Fasting Glucose, Triglycerides, HDL, Body Fat Percentage

### BACKGROUND

Adolescents are particularly susceptible to obesity due to various factors. The body's rapid growth and development necessitates more energy and nutrients. Changes in lifestyle and eating habits will have an impact on nutritional intakes, such as lack of fruits and vegetable intake and frequent intake of fatty and high sugar foods<sup>1</sup>. According to the data of Riskesdas 2018, the prevalence of obese adolescents in Indonesia has reached 16%. Central Java Province has a prevalence of obese adolescents of 11.19%, and Semarang City has a prevalence of obese adolescents of 11.09%.<sup>2</sup>

One type of Cerealia in intervention therapy for obesity is sorghum. Furthermore, sorghum is an alternative local food as it has a low glycemic index of 43 which is much lower than that of white rice of 82.<sup>3</sup> The low glycemic index is due to the contribution of high fiber content. Fiber can slow down the rate of food in the gastrointestinal tract and inhibit the activity of digestive enzymes so that it can control blood glucose.<sup>4</sup> Meanwhile, the mechanism of fiber in reducing fat absorption is by binding to fatty acids, cholesterol, and bile salt in the gastrointestinal tract. Fatty acids and cholesterol that are bound to fibers cannot form micelle which is needed for fat absorption to pass through unstirred water layers into enterocytes. As a result, the fat that binds to the fiber cannot be absorbed and will go to the large intestine to be removed with faeces or degraded

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by intestinal bacteria. In addition, fiber is also able to slow down gastric emptying and change gastric peristalsis, causing longer satiety so that appetite can be controlled.<sup>5</sup>

The food product that was administrated is sorghum cookies. The main ingredient of cookies is 60 g of sorghum flour processed with egg yolks, palm oil, glucose, flour, and skim milk. After it was baked, the total weight of the cookies was 90 g. Cookies were distributed in the morning, afternoon, and evening (3 times a day). Daily serving could replace 473 calories per day or 25% of total calories for boy adolescents and 30.5% for girl adolescents.<sup>6</sup>

Polysaccharides in sorghum are resistant starches that function as prebiotics. In 90 g of sorghum cookies, there is 2.43% of resistant starch. Processing cookies with heating and cooling can enhance resistant starch levels by up to 9%.<sup>7</sup> This starch is difficult to digest in the small intestine and to be fermented by bacteria in the large intestine. The fermentation results in the form of SCFA (Short-Chain Fatty Acid) act as a key regulator to modulate intestinal integrity, energy homeostasis, anti-inflammatory, control glycemic and insulin response, and improve blood lipid profile.<sup>8</sup> In the previous study, Olawole *et al.* showed that giving sorghum flour concentration to a cake could inhibit the activity of  $\alpha$ -amylase and  $\alpha$ -glucosidase which could reduce glucose levels.<sup>9</sup> According to Shen *et al.*, Sorghum resistant starch can inhibit the increase in triglycerides, cholesterol, LDL, and increase HDL levels in someone with metabolic fat disorders. This resistant starch cannot be digested in the small intestine and then fermented by bacteria in the large intestine. The fermentation product in the form of SCFA (Short Chain Fatty Acid) plays a role in reducing blood cholesterol and increasing the volume of faeces and changing the number of bacterial microbiota populations.<sup>10</sup> Therefore, the researchers examined the effect of sorghum cookies on fasting glucose, TG, HDL, and body fat percentage in obese adolescents.

## MATERIALS AND METHODS

The design of this study is a quasi-experiment with a pre-post control-group design. The study was conducted in October 2021 in Semarang City and has received ethical clearance from the Semarang State University (UNNES) Health Research Ethics Committee No. 153/EC/KEPK/2021. Sampling was carried out by non-probability sampling with a purposive sampling technique.<sup>11</sup> The minimum sample size was calculated by  $X1-X2 = 10.5$ ;  $Z\alpha + Z\beta = 2.92$ ;  $\alpha = 0.05$ , so the total subject in a group was 10, and the total in 4 groups was 40. The groups were divided into a 10-boy control group, 10-girl control group, 10-girl intervention group, and 10-girls intervention group. Inclusion criteria included adolescents aged 13–15 years, having Z-score BMI/Age  $\geq 2SD$ , not consuming diet supplements or drugs, having no history of degenerative diseases, and being willing to fill in informed consent. Exclusion criteria included quitting during the study.

Data retrieval was conducted during the Covid-19 pandemic so that it obeyed the health protocol. The researchers and enumerators in charge of data retrieval wore masks and always washed their hands with soap before and after collecting the data from each subject. The subjects were also required to wear masks and use hand sanitisers. Anthropometry tools were cleaned using 70% alcohol at each subject change. Height data were measured using GEA microtoice with 0.1 cm accuracy, body weight was measured using Omron digital scale with 0.01 kg accuracy, and per cent body fat was measured using Bioimpedance Analysis (BIA, *Omron Karada HBF-375*) with 0.1% accuracy. The independent variable in this study was the intervention of sorghum cookies as much as 90 grams per day given as morning, afternoon, and evening snacks. The nutrient contents of sorghum cookies are listed in Table 1.

Table 1. Nutrient Content of Sorghum Cookies

Ingredient	Total (gr)	Energy (ca	Protein (gr	Fat (gr)	Carbohydrate (g	Fiber (gr)
Sorghum flour	60	199.2	6.2	1.8	44.2	7.6
Wheat flour	10	36.4	1.0	0.1	7.6	0.3
Palm oil	12	103.4	0	12	0	0
Egg yolk	10	27.8	1.9	2.1	0.2	0
Skimmed milk powder	10	36.8	3.6	0.2	5.2	0
Sugar	18	69.7	0	0	18	0
Total		<b>473</b>	12.7	16.2	75.2	7.9

Source: Center for Food and Nutrition Laboratory Gajah Mada University

Metabolic parameters were taken through vein blood vessels with 10-hour fasting. The blood specimen analysis was conducted at Diponegoro National Hospital Laboratory. FG levels are high if they are  $\geq 110$  mg/dl.<sup>12</sup> Triglyceride levels are high when they are  $\geq 150$  mg/dl, and HDL levels are low for boys when they

are < 45mg/dl; whereas, HDL levels are low for girls if they are < 50 mg/dl.<sup>12</sup> Percent of body fat was measured by the position of the subject rising to the top of the foot unit (without any footwear) attached to the leg electrodes. The hands were stretched forward to form an angle of 90° standing upright holding the hand electrode using the BIA Omron Karada HBF-375. The high BFP category for boys is ≥ 25%, for girls ≥ 30%.<sup>12</sup> The confounding variables in this study included gender, energy intake, and physical activity. Gender is a biological difference between boys and girls. Energy intake is the number of calories consumed from all types of food and drinks. Intake data were taken through 6-time interviews in 6 intermittent days with a food recall questionnaire and processed with Nutrisurvey using Windows software. Physical activity is a body movement that results in energy expenditure. The intervention of physical activity was jogging and skipping 5 times a week. Data on physical activity were taken through interviews on physical activity during the last 7 days using the International Physical Activity Questionnaire (IPAQ) instrument. IPAQ consists of 7 questions including the type, frequency, and duration.<sup>13</sup>

The data analysis using SPSS 23.0 computer software included univariate analysis, paired test (paired t-test), and unpaired different test (independent t-test). The univariate analysis looked at the distribution and normality of the data using the Shapiro Wilk test. Paired difference test aims to see the difference before and after intervention in each group on FG, TG, HDL, and BFP using paired t-test if the data are normally distributed, and the Wilcoxon test is used if the data are not normally distributed. Unpaired difference test aims to see differences in the results of FG, TG, HDL, and BFP between groups using the independent t-test if the data are normally distributed, and the Mann Whitney test is used if the data are not normally distributed.<sup>14</sup>

## RESULTS

### Subject Characteristics

A total of 40 subjects who met the inclusion criteria in the age range of 13–15 years were evenly divided into 4 groups, namely the boy and girl in the control group, boy and girl in the intervention group. The mean values (±SD) of the subjects was shown in Table 2.

Table 2. The Baseline Characteristics of Subjects

Variables	Boys		Girls	
	Control (n=10)	Intervention (n=10)	Control (n=10)	Intervention (n=10)
Body Weight (kg)	85.21±12.87	85.83±13.76	75.86±8.87	76.15±9.12
Z-score (SD)	2.96±0.44	2.98±0.47	2.45±0.29	2.48±0.24
Energy Intake (kcal)	2,454.50±39.90	2,460.50±35.31	2,092±308.58	2,147.50±27,40
Physical Activity (METs)	367.60±80.64	362.40±91.50	435.20±52.53	443.20±61.66
Fasting Glucose (mg/dl)	87.30±6.21	88.40±7.47	86.70±9.60	89.50±10.90
Triglyceride (mg/dl)	133.60±33.96	130.50±38.75	151.30±26.83	148.00±27.83
HDL (mg/dl)	38.20±7.44	38.60±10.07	39.90±4.36	42.10±5.94
Body Fat Percentage (%)	33.43±2.92	32.96±3.09	33.43±1.86	32.90±3.00

Table 2 showed the overall characteristics of the subjects by gender. Body weights in the boy group were higher than in the girl group. Z-Score increased simultaneously with energy intake. Low physical activity was found in both groups. Although the participants were mildly obese, they did not have impaired fasting glucose and TG but were low in HDL levels. A high body fat percentage was found in boys and girls.

### Differences in Body Weight (BW) between Pre- and Post-Interventions

Based on the Wilcoxon test, the boy control group showed no difference in the results of pre- and post-interventions (p = 0.443). In the boy intervention group, there was a significant difference (p= 0.005) with a decrease in BW (Δ) of 2.47±1.03 kg. Mann-Whitney test in the boy control and intervention groups showed no differences (p = 0.450) as shown in Table 3.

Table 3. Body Weights of Boy and Girl Groups

Groups	Boys			Girls		
	Pre(Mean±SD)	Post(Mean±SD)	p	Pre (Mean±SD)	Post(Mean±SD)	p
Control	80.05±13.57	80.05±13.23	0.443	75.86±9.35	75.71±9.17	0.288
Intervention	80.60±14.50	77.70±14.01	0.005*	76.15±9.61	73.68±9.82	0.001*
p <sup>1</sup>		0.450			0.639	

$p$  = Analyzed by Wilcoxon test

$p^1$  = Analyzed by Mann-Whitney test

\* =  $p < 0.05$  (significant)

Changes in body weight in the girl control group based on the paired test showed no different results between pre- and post-interventions ( $p = 0.288$ ). Meanwhile, the intervention group showed a significant difference ( $p = 0.001$ ) with a decrease in BW ( $\Delta$ ) of  $2.47 \pm 0.77$  kg. The Mann-Whitney test showed no significant BW difference between the girl control and intervention groups ( $p = 0.639$ ).

### Differences in Z-scores of BMI/Ages between Pre- and Post-Interventions

The Wilcoxon test results for the Z-score BMI/Age value in the boy control group showed no difference between pre- and post-intervention ( $p = 0.234$ ). Meanwhile, the intervention group showed a significant difference ( $p = 0.005$ ) with a decrease of ( $\Delta$ ) Z-Score BMI/Age of  $0.13 \text{ SD} \pm 0.04 \text{ kg/m}^2$ . According to the Mann-Whitney test, there was no difference in the BMI/Age Z-scores between the boy control and intervention groups ( $p = 0.496$ ) as shown in Table 4.

**Table 4. Changes of Z-Score in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre(Mean $\pm$ SD)	Post(Mean $\pm$ SD)	$p$	Pre (Mean $\pm$ SD)	Post(Mean $\pm$ SD)	$p$
Control	2,845 $\pm$ 0.46	2.840 $\pm$ 0.45	0.234	2.45 $\pm$ 0.30	2.44 $\pm$ 0.31	0.247
Intervention	2.76 $\pm$ 0.49	2.65 $\pm$ 0.48	0.005*	2.48 $\pm$ 0.25	2.36 $\pm$ 0.27	0.001*
$p^1$		0.496			0.546	

$p$  = Analyzed by Wilcoxon test

$p^1$  = Analyzed by Mann-Whitney test

\* =  $p$  value  $< 0.05$  (significant)

The results of the Wilcoxon test in the girl control group showed no difference between pre- and post-interventions ( $p = 0.247$ ). The girl intervention group showed a significant difference ( $p = 0.001$ ) with a decrease in Z-Score of BMI/Age of  $0.12 \pm 0.05 \text{ kg/m}^2$ . Based on the Mann-Whitney test, there was no difference in the Z-scores between the girl control and intervention groups ( $p = 0.546$ ) as shown in Table 4.

### Differences in Energy Intakes (EI) between Pre- and Post-Interventions

Wilcoxon test results in the boy control group showed significant differences between pre- and post-interventions ( $p = 0.007$ ). For the intervention group, there was a significant difference ( $p = 0.005$ ) with a decrease ( $\Delta$ ) of per day energy of  $558 \pm 76.41$  kcal. According to the Mann-Whitney test, there were significant differences between the boy control and intervention groups ( $p = 0.001$ ) as contained in Table 5.

**Table 5. Changes in Energy Intake in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre(Mean $\pm$ SD)	Post(Mean $\pm$ SD)	$p$	Pre(Mean $\pm$ SD)	Post (Mean $\pm$ SD)	$p$
Control	2450,00 $\pm$ 42,00	2325,00 $\pm$ 100.50	0.007*	2167.50 $\pm$ 325,00	2150,00 $\pm$ 127.64	0.332
Intervention	2460,00 $\pm$ 37.22	1910,00 $\pm$ 79.38	0.005*	2150,00 $\pm$ 28.89	1562.50 $\pm$ 35.74	0.005*
$p^1$		0.001*			0,001*	

$p$  = Analyzed by Wilcoxon test

$p^1$  = Analyzed by Mann-Whitney test

\* =  $p$  value  $< 0.05$  (significant)

The girl group, based on the results of the control group's Wilcoxon test, showed no difference between pre- and post-interventions ( $p = 0.332$ ). The intervention group showed a significant difference ( $p = 0.005$ ) with a decrease ( $\Delta$ ) of per day energy of  $587.5 \pm 52.45$  kcal. Based on the Mann-Whitney test, there were significant differences between the girl control and intervention groups ( $p = 0.001$ ) as contained in Table 5.

### Differences in Physical Activities (PA) between Pre- and Post-Interventions

Wilcoxon test results in the boy control group showed no difference between pre- and post-interventions ( $p = 0.284$ ). The boy intervention group showed a significant difference ( $p = 0.005$ ) with an increase in IPAQ scores ( $\Delta$ ) of  $271.1 \pm 81.63$  METs. Based on the Mann-Whitney test, there were significant differences between the boy control and intervention groups ( $p = 0.001$ ) contained in Table 6.

**Table 6. Changes in Physical Activity in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean $\pm$ SD)	Post (Mean $\pm$ SD)	$p$	Pre (Mean $\pm$ SD)	Post (Mean $\pm$ SD)	$p$
Control	372.50 $\pm$ 85.00	390,00 $\pm$ 87.36	0.284	420,00 $\pm$ 55.36	457.50 $\pm$ 70.31	0.066
Intervention	360.50 $\pm$ 96.45	631.50 $\pm$ 25.17	0.005*	446.50 $\pm$ 65.00	651.50 $\pm$ 25.92	0.005*
$p^1$		0.001*			0,001*	

$p$  = Analyzed by Wilcoxon test



$p^l$  = Analyzed by Mann-Whitney test  
 \* =  $p$  value < 0.05 (significant)

The results of the Wilcoxon test in the girl control group showed no difference between pre- and post-interventions ( $p = 0.066$ ). The girl intervention group showed a significant difference ( $p = 0.005$ ) with an increase in AF ( $\Delta$ ) scores of  $203.7 \pm 44.46$  METs. Based on the Mann-Whitney test, there was a significant difference in the AF values between the girl control and intervention groups ( $p = 0.001$ ) as shown in Table 6.

**Differences in Fasting Glucose (FG) between Pre- and Post-Interventions**

The results of the paired t-test test in the boy control group showed no difference between pre- and post-interventions ( $p = 0.84$ ). This is in contrast with the intervention group that had a significant difference ( $p = 0.004$ ). Based on the independent t-test, there were significant differences in FG levels between the boy control and intervention groups ( $p = 0.045$ ) as shown in Table 7.

**Table 7. Changes in Fasting Glucose (FG) in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SD)	$p$	Pre (Mean±SD)	Post (Mean±SD)	$p$
Control	87.30±6.54	87.10±5.52	0.840	86.70±10.13	85.90±8.19	0.380
Intervention	88.40±7.87	82.40±4.03	0.004*	89.50±11.49	81.70±5.01	0.008*
$p^l$		0.045*			0.187	

$p$  = Analyzed by Paired T-Test  
 $p^l$  = Analyzed by Independent T-Test  
 \* =  $p$  value < 0.05 (significant)

The results of the paired t-test test on the girl control group showed no difference between pre- and post-interventions ( $p = 0.38$ ). It is different from the girl intervention group which showed a significant difference ( $p = 0.008$ ). Based on the independent t-test analysis, there was no significant difference in FG levels between the girl control and intervention groups ( $p = 0.187$ ) as shown in Table 7.

**Differences in TG Levels between Pre- and Post-Interventions**

The results of the paired t-test test in the boy control group showed no difference between pre- and post-interventions ( $p = 0.052$ ). This is in contrast with the intervention group that had a significant difference ( $p = 0.005$ ). Based on the independent t-test, there were significant differences in TG levels between the boy control and intervention groups ( $p = 0.013$ ) as shown in Table 8.

**Table 8. Changes in Triglyceride Levels in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SD)	$p$	Pre (Mean±SD)	Post (Mean±SD)	$p$
Control	121.50±35.79	127.50±30.37	0.052	151.30±28.28	150.20±22.99	0.682
Intervention	114.50±40.85	91.00±41.90	0.005*	148.00±29.33	126.20±30.78	0.001*
$p^l$		0.013*			0.064	

$p$  = Analyzed by Wilcoxon test  
 $p^l$  = Analyzed by Mann-Whitney test  
 \* =  $p$  value < 0.05 (significant)

Based on the paired t-test analysis, the girl control group showed no difference between pre- and post-interventions ( $p = 0.682$ ). It is different from the girl intervention group which showed a significant difference ( $p = 0.001$ ). Based on the independent t-test, there was no significant difference in TG levels between the girl control and intervention groups ( $p = 0.064$ ) as shown in Table 8.

**Differences in HDL Levels of Pre- and Post-Intervention**

The results of the paired t-test analysis on the boy control and intervention groups showed no difference between pre- and post-interventions ( $p = 0.664$ ;  $p = 0.089$ ). Based on the independent t-test, there was no difference between the two boy groups ( $p = 0.505$ ) as shown in Table 9.

**Table 9. Changes in HDL Levels in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SD)	$p$	Pre (Mean±SD)	Post (Mean±SD)	$p$
Control	38.20±7.84	37.90±6.50	0.664	39.90±4.60	37.90±4.09	0.060
Intervention	38.60±10.61	35.90±6.64	0.089	42.10±6.26	38.40±3.34	0.012*
$p^l$		0.505			0.768	

$p$  = Analyzed by Paired T-Test  
 $p^l$  = Analyzed by Independent T-Test  
 \* =  $p$  value < 0.05 (significant)

The girl control group, based on the paired t-test analysis, showed no difference between pre- and post-interventions ( $p = 0.060$ ). Meanwhile, the girl intervention group showed a significant difference ( $p = 0.012$ ). Based on the independent t-test analysis, there was no difference in HDL levels between the girl control and intervention groups ( $p = 0.768$ ) as shown in Table 9.

### Differences in Body Fat Percentage (BFP) between Pre- and Post-Interventions

Paired t-test analysis results in the boy control group showed no difference between pre- and post-interventions ( $p = 0.882$ ). The intervention group showed a significant difference ( $p = 0.001$ ). Based on the independent t-test analysis, there were significant differences in BFP between the boy control and intervention groups after the intervention of sorghum cookies ( $p = 0.001$ ) as shown in Table 10.

**Table 10. Changes in Body Fat Percentage (BFP) in Boy and Girl Groups**

Groups	Boys			Girls		
	Pre (Mean±SD)	Post (Mean±SI)	<i>p</i>	Pre (Mean±SD)	Post (Mean±SD)	<i>p</i>
Control	33.43±3.08	33.37±2.41	0.882	33.43±1.96	33.17±1.96	0.166
Intervention	32.96±3.26	27.31±3.19	0.001*	32.90±3.17	28.52±2.70	0.001*
<i>p</i> <sup>1</sup>		0.001*			0.001*	

*p* = Analyzed by Paired T-Test

*p*<sup>1</sup> = Analyzed by Independent T-Test

\* = *p* value < 0.05 (significant)

The girl control group, based on the paired t-test analysis, had no difference between pre- and post-interventions ( $p = 0.166$ ). It is different from the girl intervention group which showed a significant difference ( $p = 0.001$ ). The independent t-test analysis showed a significant difference in the values of BFP between the girl control and intervention groups ( $p = 0.001$ ) as shown in Table 10.

## DISCUSSION

This study observed the effect of the difference in the intervention of 90 grams of sorghum cookies for consecutive 28 days on fasting glucose (FG), Triglyceride (TG), HDL, and Body Fat Percentage (BFP) on obese adolescents. It was found that the intervention of sorghum cookies could reduce FG, TG, and BFP in the boy group, and it reduced BFP in the girl group ( $p < 0.05$ ). Before the treatment, both groups were homogeneous, so the change in all parameters values was due to the sorghum intervention.

The intervention of sorghum cookies could decrease the bodyweight of both intervention groups because sorghum cookies contain 7.9 g of fiber and 2.43 g of resistant starch. They are used as a snack with low calories but contain soluble and insoluble fibers with a longer satiety effect so that weight loss can slowly be achieved. Fiber cannot be absorbed in the small intestine and would absorb water and form a gel in the stomach. Fiber could prolong transit time in the stomach and felt full longer.<sup>10</sup> In addition, the influencing factor was the addition of physical activity with jogging and skipping.

Z-scores of BMI/age parameter decreased after intervention in the treatment group. It was because the Z-scores decreased simultaneously with weight loss. It caused decreasing body fat and more energy expenditure. There were significant differences in energy intakes in both boy and girl groups ( $p = 0.001$ ;  $p = 0.001$ ) to reduce energy in the intervention group by 500 calories/day. This is under the recommendation of a maximum weight loss of 2 kg/month or 500 g/week by reducing energy intake to 500 kcal/day.<sup>15</sup>

Differences were observed in the physical activity of the intervention group derived from the physical activity program for 150 minutes/week. Jogging for 25 minutes and skipping for 5 minutes were done regularly 5 times a week. The physical activity aims to create a balance between the energy obtained and the energy released by the body. For obese adolescents, this creates a negative energy balance that can lose weight.<sup>16</sup> Physical activity that could increase energy export meets the criteria of frequency, intensity, type, and duration. Physical activity has a frequency in how often the activity is conducted. Usually, the frequency of training in the week ranges from 3 to 5 times and depends on the individual condition. The intensity was how hard an activity was conducted. It was usually classified into low, medium, and high intensity. In the initial stages, it should be done with moderate intensity (64–76% of the maximal heart rate) and increased as time goes by. Time refers to how long activity was conducted in one meeting. Usually, the intensity was 30–60 minutes for each exercise. Types of activities refer to the types of physical activities carried out such as walking, jogging, biking, swimming, and so on.<sup>17</sup>

Differences in FG levels after intervention in the boy group were influenced by the content of sorghum including soluble fiber and resistant starch. Resistance starch makes a lower sorghum glycemic index than

rice. Resistant starch cannot be absorbed by digestive enzymes, and resistant starch metabolic processes occur 5–7 hours after consumption. Hence, the water-soluble fiber contained in sorghum will absorb water and form a gel in the stomach that can extend gastric emptying.<sup>7</sup> Fermentation occurs in the large intestine that produces Short-Chain Fatty Acid (SCFA). As a result, these fatty acids will return to the bloodstream and could inhibit the use of glucose by body tissues for a long time, thereby increasing peripheral insulin sensitivity. It causes a decrease in blood glucose levels and improvement of insulin resistance. This finding is in line with previous research that sorghum flour can reduce fasting glucose and improve insulin sensitivity ( $p \leq 0.05$ ).<sup>4</sup>

There was a difference in TG levels between the boy control and intervention groups after the intervention ( $p = 0.013$ ), but there was no difference in the girl groups ( $p = 0.064$ ). The decrement in TG levels due to the presence of starch content in sorghum acts as a prebiotic that induces changes in intestinal microbiota. Resistant starch that cannot be digested in the colon will be fermented to produce SCFA. SCFA production will encourage the expression of pro-glucagon and increase the production of Glucagon Like Peptide-1 (GLP 1). GLP 1 was known as an intestinal hormone secreted by L ileum cells and suppresses hepatic lipogenesis through activation of the Adenosine Monophosphate Protein Kinase (AMPK) pathway.<sup>18</sup> AMPK is an energy metabolism regulatory enzyme that works by inhibiting the pathway of anabolism and stimulating the path of catabolism (metabolic homeostasis). Activation of the AMPK pathway that can reduce hepatic lipogenesis can reduce serum triglyceride levels. Based on previous studies, sorghum flour can reduce the number of adipose cells that express Peroxisome Proliferators-Activated Receptors (PPAR- $\gamma$ ). PPAR- $\gamma$  plays a role in the storage of fatty acids in adipose cells.<sup>19</sup>

There are no differences in HDL levels between the control and intervention groups in boys and girls after the intervention ( $p = 0.505$ ;  $p = 0.768$ ). This is estimated because the effects of dietary foods can affect HDL levels requiring 6–8 weeks.<sup>20</sup> The importance of increasing HDL-c cholesterol in a person with obesity is because HDL-c cholesterol functions to bring excess cholesterol into blood vessels and transport it to the liver for further metabolism. Improved HDL-c can be done by increasing physical exercise with the principle of FITT (frequency, intensity, type, time). Improved HDL-c by increasing physical exercise with the FITT principle requires 3 to 6 months.<sup>20</sup>

Differences in BFP changes based on the independent t-test between the control and intervention groups of boy and girl adolescents ( $p = 0.001$ ). A decrease in BFP caused by the consumption of sorghum cookies for 28 days can increase the intake of complex carbohydrates and fibers and reduce body fat in someone with obesity. This is similar to previous studies of the correlation of intervention of 40 grams of sorghum per day in 8 weeks to decrease body fat ( $p \leq 0.05$ ).<sup>21</sup> Another study found that a low-calorie diet in the second week could decrease fat by 50–70% due to fatty acid oxidation.<sup>22</sup>

## CONCLUSION

The intervention of 90 g/day of sorghum cookies for 28 days reduces fasting blood glucose, triglycerides, and percent body fat in the boy group, and it reduces percent body fat in the girl group ( $p < 0.05$ ).

## SUGGESTION

Additional duration of dietary intervention and physical activity is needed as it will affect HDL level changes which need 3–6 months.

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## Improvement of Students and Snack Vendors Behavior After Received Health Promotion Program from UKS's Cadres

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### ABSTRACT

**Background:** School Health Program or UKS aims to improve students learning achievement by improving their health status including the fulfillment of nutrition so that they can grow and develop optimally. The nutritional problems of school-age children in Indonesia, according to Riskesdas 2018 data, are children with the short/stunting category reaching 30.7%, while those who are obese are 8% and anemic 26%. Nutritional problems in school children will affect the quality of human resources in the future.

**Objectives:** This study examined the effect of promoting healthy and safe snacks by UKS's cadres on increasing knowledge, attitudes, behavior of students and snack sellers.

**Materials and Methods:** The first stage of research was training elementary school students UKS's cadres who will become educators on promoting healthy and safe food consumption behavior. The second stage was assessed to 360 randomly selected students and 94 school vendors in 12 different schools. The intervention schools received a package of promotions delivered by UKS's cadres while the comparison group received the poster. Data on knowledge, attitudes, behavior of students and food sellers were collected using a questionnaire instrument. The data were collected by the researchers assisted by 12 enumerators, 6 research field assistants and 12 teachers in charge of the research field. Bivariate analysis using t-test, Wilcoxon test, and Mann Whitney test were used to assess the differences between the groups.

**Results:** After intervention by UKS's cadres, there was a change in students' knowledge of 51.1% for knowledge of healthy snacks, 52.8% about safe snacks, 82.8% about formalin, 62.8% about borax, and 75.6% about Rhodamine B. Changes in the behavior of snack sellers, the highest percentage of changes in holding food with tools is 62.5% and not holding food after holding money is 54.2%. Increased change were significantly higher in the intervention groups than the comparison group ( $p < 0.05$ ).

**Conclusion:** The UKS's cadres as trained peer-educators could significantly improve safe and healthy food behavior of students as well as knowledge of snack school vendors. UKS's cadres as promoters of healthy and safe snacks can be used as a mandatory UKS program in school to achieve food safety for school children

**Keywords:** School health program; elementary school; trained students; street vendors; food safety; peer educators

### BACKGROUND

The nutritional problems of school-age children in Indonesia, according to Riskesdas 2018 data, are children with the short/stunting category reaching 30.7%, while those who are obese are 8% and anemic 26%. Nutritional problems in school children will affect the quality of human resources in the future [1]. Quality human resources in the school environment can be realized by providing food that will be consumed by the school community in safe, quality, and nutritious conditions. The food consumed by the school community can be in the form of snack food available in the school environment or snack food outside the school environment. The food currently circulating, including food sold in school canteens and/or in the school environment, is food produced by the food industry, including the food home industry and food produced by catering services which are called ready-to-eat food. The safety and quality of food products circulating in the

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school environment are determined by school policies, the level of knowledge and concern of school canteen managers and food vendors around the school environment [2].

Law No. 36 of 2009 concerning health has mandated efforts to improve nutrition to improve the nutritional quality of individuals and communities. Fulfilling the nutritional adequacy of children can be through breakfast and snacks for children who have not had breakfast. In 2017 there were 53 extraordinary incidents of food poisoning reported by BPOM throughout Indonesia. The use of hazardous food additives (BTP) that is often used is the use of preservatives, dyes, and sweeteners [3].

The provision of energy and other nutrients for school-aged children is partially supplied by snacks. Snack consumption, and is beneficial for the growth of children [4]–[8]. The family environment exercises a strong influence on the child's diet. On reaching school-age, however, the child's diet may change because of the increased time spent by children in school and away from parental supervision. Many children acquire new habits of 'what to eat' and 'how to eat' from outside the home [9]–[12].

Among all age groups and social classes, including school-age children and adolescents, snacking is part of daily life [13], [14]. Many school-age children buy snacks in accordance with their preferences, without any knowledge or understanding of the ingredients contained in the snacks, which may adversely affect their health [15]–[18]. Many snacks still sold in schools have not met the basic health requirements, such as hygiene and use of harmful chemical additives, increasing the risk for students to consume unhealthy snacks [19].

The Food & Drug Control National Agency (BPOM) has found many cases from the research on street food snacks for school children. But ironically, until now there are still many dangerous school snacks sold in the school environment. These unhealthy snacks contain at least one or more the harmful substances, namely formalin, borax, rhodamine B, and methanyl yellow. All four are carcinogenic or trigger cancer. Borax and formalin are commonly used as preservatives, while Rhodamine B and methanyl yellow are used as dyes. Napitupulu and Abadi, 2018 examined roasted meatballs sold by vendors in several elementary schools in Medan and found that three samples of roasted meatballs contained Borax and four samples of sauces on roasted meatballs that were examined contained Rhodamine B [20]. These problems indicated the low level of awareness concerning the food safety of the community, including both sellers and buyers.

School health programmes are an important component of public health. Children spend more time at school than anywhere else, except at home. Schools can play a significant role in influencing school-age children by, teaching them, for instance, healthy behaviours for children. Without education, children are not prepared to get the correct information, proper knowledge, and skills about nutrition. Some studies have showed that a peer-based model of nutritional education has a positive impact on students' nutritional behaviour. Peers can positively influence students' knowledge, awareness and self-reliance [14], [21]–[23]. A study on the efficacy of training students as peer educators to provide information on healthy and safe consumption behaviour in schools is necessary. We aimed to assess the changes in knowledge, attitude and behaviour of UKS's cadres after being trained; students' knowledge, attitudes and behaviour during the intervention and compare it after the student group had received the promotion from UKS's cadres and snack vendors' knowledge during the intervention and compare it after the group had received the promotion from UKS's cadres.

## MATERIALS AND METHODS

The quasi-experimental approach using a pre–post-test control group was assigned in this study. The study conducted in Deli Serdang District, Sumatera Utara Province, Indonesia. The selection of research locations in Deli Serdang Regency was carried out purposively. Researchers chose two sub-districts based on geographical location and based on the number of primary schools that were most abundant in the sub-district. The selected sub-districts are Pantai Labu District representing the coastal area and Tanjung Morawa. District representing the mainland area based on purposive. The selection of schools in the district was also chosen purposively, namely schools that had UKS activities and many food vendors around the school.

Researchers set six primary schools as controls and six primary schools as intervention sites for UKS's cadres selected in each sub-district of Pantai Labuh and sub-district of Tanjung Morawa so that the total number of primary schools used as research locations was 12 elementary schools. Pantai Labu sub-district, three primary schools were selected as intervention and three primary schools as controls. In the Tanjung Morawa sub-district, three primary schools were intervention and three primary schools were controls. The selection of schools in the district was also chosen purposively.

The population in this study was all 3rd grade, 4th grade, 5th-grade elementary school students, and all school children snack sellers in the school environment. The population in this study was to assess the effect of giving promotions by trained *UKS's* cadres to elementary school students in the intervention group and the effect of pasting posters on the control group. Using a level of significance of 5%, and a test power of 90%, we anticipated the proportion of the population in the twelve selected schools to be 0.44 (P1) and 0.25 (P2) while the drop-out rate to be 30%. We enrolled 360 students in two groups. The sample of students in the intervention group of *UKS's* cadres was 180 and the sample in the control was 180. The sample selection was carried out by systematic sampling for the student sample by considering the number of students in each class. Sample for snack sellers, all snack sellers around the school were used as respondents in this study (48 for intervention and 46 for control).

Data analysis was carried out univariate and bivariate. Univariate analysis was conducted to determine the frequency distribution of the data. Bivariate analysis to analyze the effect of treatment on the intervention group by *UKS's* cadres and the control group. Before the bivariate analysis was carried out, the data normality test was carried out using the Kolmogorov Smirnov test. In this study, all data were not normally distributed, so the Wilcoxon statistical test and the Mann-Whitney test were carried out to analyze the effect of treatment between groups. The paired-sample t-test statistical test was used to analyze the effect of *UKS's* cadre training on the knowledge, attitudes, and behavior of *UKS's* cadres because after the normality test the data with Kolmogorov-Smirnov showed a normal data distribution ( $p > 0.05$ ).

### **Study instrument**

We assessed the knowledge, attitudes and behaviours of the students using structured questionnaires. We asked questions relating to 22 items of knowledge, 15 items of attitude and 15 items of behaviour to identify the students' understanding concerning the healthy snacks, potential bacteria, chemical and physical hazards in snacks, characteristics of foods containing chemical hazards, as well as the impact of the consumption of contaminated food on health. We also asked the vendors questions concerning 24 items of knowledge using structured questionnaires while we observed their behaviours using a structured check list. We kept the sentence structure and format of the questionnaires for an easier understanding. An expert panel of nutritionists determined the validity of the content while we used a group of students ( $n = 30$ ) and a group of vendors ( $n = 10$ ) to assess the content validity prior to data collection. We tested the internal consistency (Cronbach's alpha) for the students' knowledge, attitude and behaviour sections, with results of 0.666, 0.654 and 0.632, respectively. Cronbach's alpha for the snacks vendors' knowledge question was 0.714.

We scored each positive or correct response to the students and vendors questionnaires as 1 point. The maximum score obtained for a student's knowledge was 22, that for a student's attitude was 15, and that for a student's behaviour was 15. The maximum score for a snacks vendor's knowledge was 24. We evaluated the differences in the scores for knowledge, attitude and behaviour of students before and after intervention, as well as between intervention and comparison groups using the Mann Whitney test with a significance level of 5%.

### **Data Collection**

The data was collected by 12 enumerators, namely nutrition students from the Health Polytechnic of the Medan Ministry of Health who have passed the food safety and nutritional status assessment courses. This data collection was also accompanied by researchers and 6 field research officers. The field officers are three nutrition laboratory officers from the Health Ministry of Health Medan and three nutrition workers at the *puskesmas* or community health center. In addition to researchers and field assistants, this data collection was also accompanied by one teacher from each school who became the research locus as the person in charge of the field. Data were collected using questionnaire instruments and observation sheets.

### **Intervention**

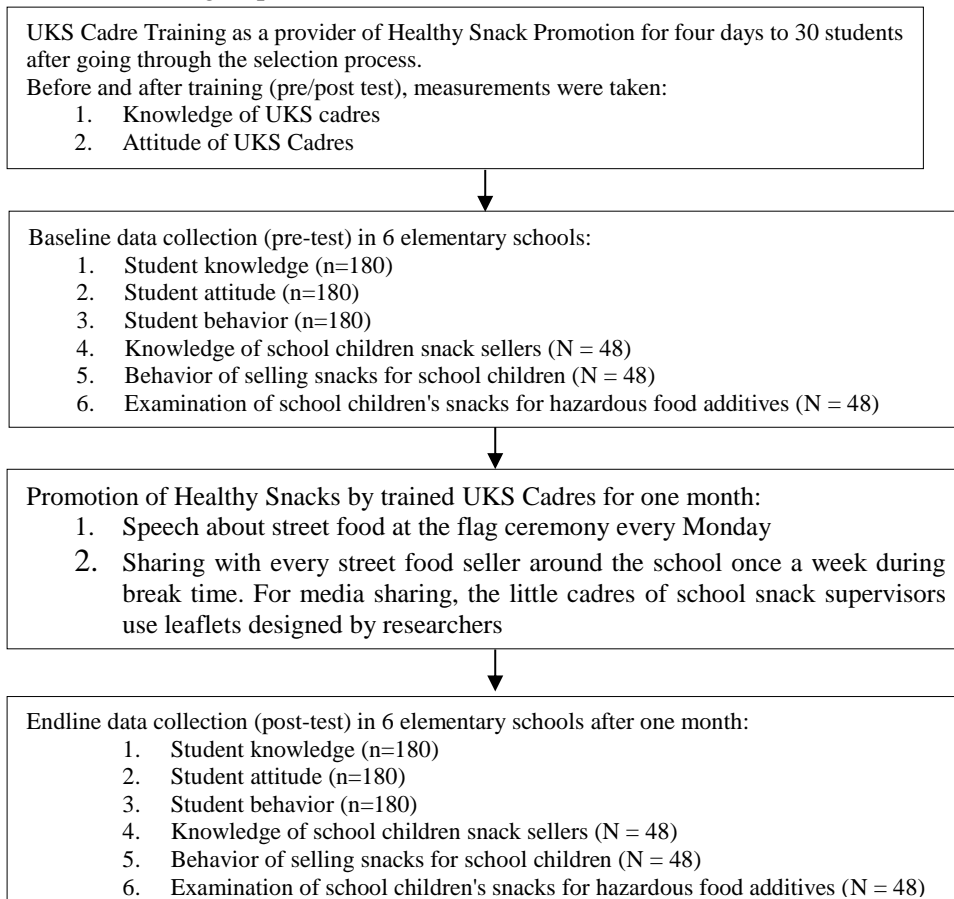
The initial phase of the research involved the training of the students as *UKS's* cadres, to act as educators in the selected schools. We selected and trained five students from each of 12 different elementary schools located in selected districts using the inclusion criteria of students in grades 3, 4 and 5, academically ranked from 1<sup>st</sup> to 5<sup>th</sup> in their class, and with good public speaking skills. The cadres were trained for four days, after which they were recruited based on the results of the test. For the first day, we provided training material involving snacks that contain chemicals harmful to human health. The material for the second day included

promotion methods to the vendor (speech). In the third day, we trained the students on the borax, formalin and rhodamine B assessments while in the fourth day, we focused on speech and sharing information practices.

In the second phase of our research, we assessed 360 randomly selected students and 94 school vendors in 12 different schools. We performed this phase after the intervention of the UKS's cadres every Monday and the sharing of information with street food vendors once a week for one month. We provided the intervention schools with packaged activities, such as a speech to peers, interpersonal communication with snack vendors and poster distribution. We displayed posters promoting the consumption of healthy and safe snacks, developed by the National Agency of Food and Drug Control (BPOM) in comparison schools. The posters distributed to both groups included information about healthy snacks, potential bacteria, chemical and physical hazards in snacks, characteristics of foods containing chemical hazards, as well as the impact of the consumption of contaminated food on health. Prior to the intervention activities, we conducted a baseline survey to assess the knowledge, attitudes and behaviours of students, the knowledge of snacks vendors and an assessment of the foods potentially containing dangerous additives, such as formalin, borax and rhodamine B. Then, the UKS's cadres and laboratory research staff subjected the foods suspected of contamination with harmful additives to laboratory tests using touch formalin tests, touch borax tests and touch rhodamine B tests.

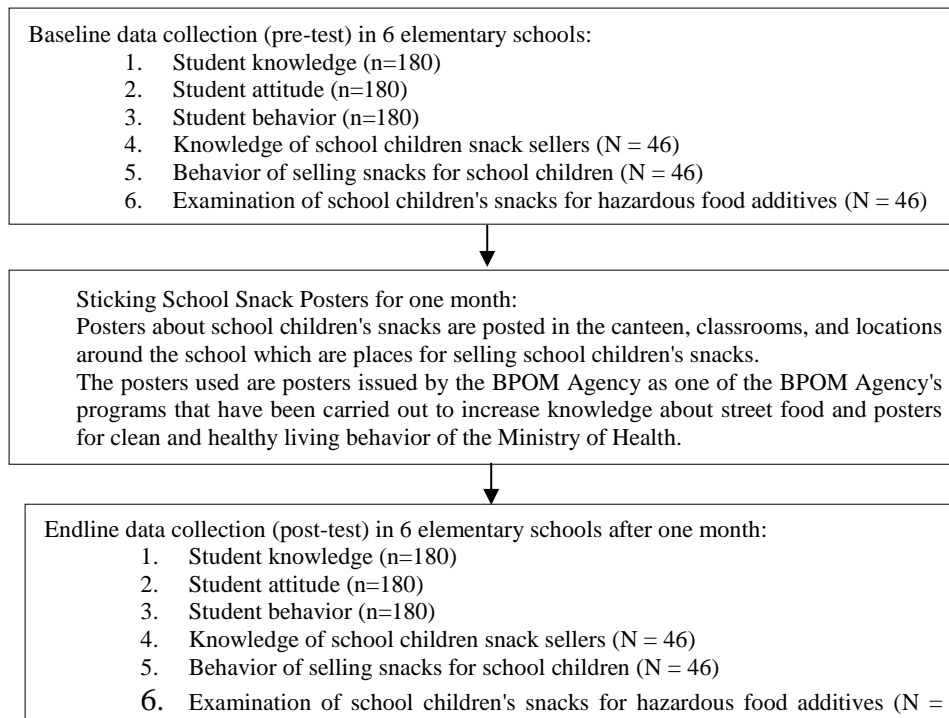
## Research Scheme

### Treatment in the intervention group





### Comparison group



We obtained permission and administrative approvals from the Education Office of Deli Serdang District to conduct this study. The ethical clearance was obtained from the Nursing Faculty of the University Sumatera Utara, with number: 1206/V/SP/2018. We informed all respondents about the purpose of the study and obtained their consent prior to data collection.

### RESULTS

This research was started by training UKS students as a provider of snack promotions to students and snack sellers for school children. To assess the success of the training, researchers measured the knowledge, attitudes, and behaviour of students about school children's snacks, with the following results:

**Table 1. Change In Knowledge, Attitudes and Behaviour Scores of UKS's Cadres Before and After Training (N = 30)**

Variables	Average ± SD	Average change ± SD	<i>p value</i> *
knowledge before training	12.77 ± 3.58		
knowledge after training	19.77 ± 2.11	7.00 ± 2.98	0.001
attitude before training	8.20 ± 2.16		
attitude after training	13.37 ± 1.88	5.17 ± 1.91	0.001
behaviour before training	7.93 ± 1.89		
behaviour after training	13.0 ± 1.88	5.07 ± 1.64	0.001

\*difference within the group (before and after) using paired t-test, at significant level of 5%

Table 1 summarises the scores for knowledge, attitude and behaviour. An increase of these scores, with significant average differences of  $7.00 \pm 2.98$ ,  $5.17 \pm 1.91$  and  $5.07 \pm 1.64$ , respectively can be observed. After being analyzed with the paired t-test statistical test, it showed that there were differences in the mean knowledge, attitudes, and behavior of UKS cadres before and after the training. UKS cadre training as a promotion provider for school children snacks affects increasing the knowledge, attitudes, and behavior of UKS's cadres.

### The effect of intervention to student and snack school vendors

The method of promoting healthy and safe snacks for school children carried out by trained UKS cadres is a speech every Monday during the flag ceremony and sharing with school children snack sellers. Respondents in this study were all students in grades 3, 4, and 5 from each school that became the research location which was randomly selected, and all street vendors selling snacks for school children around the school. The characteristics of the respondents can be seen in table 2 and table 3 below.

**Table 2. Characteristics of Student Respondents**

Variabels	Control		Intervention	
	n	%	n	%
Age				
8 - 9	57	31.7	52	28.9
10 - 11	115	63.9	120	66.7
12 - 13	8	4.4	8	4.4
<b>Kelas</b>				
Grade 3	60	33.3	62	34.4
Grade 4	61	33.9	66	36.7
Grade 5	59	32.8	52	28.9
Total	180	100	180	100

**Table 3 Characteristics of Snack Sellers Around School**

Variabels	Control		Intervention	
	n	%	n	%
Age				
25 - 35	9	19.57	11	22.92
36 - 46	19	41.30	17	35.42
47 - 57	13	28.26	16	33.33
57 - 70	5	10.87	4	8.33
<b>Jenis Kelamin</b>				
Male	17	36.96	21	43.75
Female	29	63.04	27	56.25
Total	46	100	48	100

**Table 4. Knowledge, Attitude and Behaviour Scores Before and After the Interventions**

Variables	Comparison (N1 = 180) (N2 = 46)*	Intervention (N1 = 180) (N2 = 48)*	p value <sup>b)</sup> between groups
<b>Student's knowledge</b>			
before	12.00 (10.00–16.00)	12.00 (9.00–15.00)	0.096
after	13.00 (11.00–16.00)	19.00 (16.00–21.00)	0.001
change	1.00 (0–1.00)	6.00 (4.00–9.00)	0.001
p value <sup>a)</sup> within group	0.001 <sup>a)</sup>	0.001 <sup>a)</sup>	
<b>Student's attitude</b>			
before	8.00 (7.00–10.00)	8.00 (7.00–10.00)	0.758
after	9.00 (8.00–11.00)	13.00 (11.00–14.00)	0.001
change	1.00 (0–3.00)	4.00 (2.00–6.00)	0.001
p value <sup>a)</sup> within group	0.001 <sup>a)</sup>	0.001 <sup>a)</sup>	
<b>Student's behaviour</b>			
before	7.00 (7.00–10.00)	7.00 (6.00–9.00)	0.287
after	9.00 (7.00–11.00)	12.00 (10.00–14.00)	0.001
change	2.00 (0–3.00)	4.00 (2.00–5.00)	0.001
p value <sup>a)</sup> within group	0.001 <sup>a)</sup>	0.001 <sup>a)</sup>	
<b>Vendor's knowledge</b>			
before	17.00 (13.75–19.00)	17.00 (14.25–18.75)	0.854
after	16.50 (14.00–19.00)	21.00 (19.00–22.00)	0.001
change	0.50 (0–2.00)	4.00 (2.00–5.75)	0.001
p value <sup>a)</sup> within group	0.042 <sup>a)</sup>	0.001 <sup>a)</sup>	

<sup>a)</sup> difference within groups (before and after) using Wilcoxon test, at significance level of 5%

<sup>b)</sup> difference between groups (intervention and comparison) using Mann Whitney test, at significant level of 5%

<sup>1)</sup> expressed as average (25<sup>th</sup>–75<sup>th</sup> percentile)

\* N1: number of students

N2: number of snacks vendors

Table 4 shows that the condition of both groups of students and vendors in the baseline were similar in term of knowledge, attitude and behaviour. However, after the given intervention, there was an increase

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change in the score of knowledge, attitudes and behaviour of students as well as vendor's knowledge. It is seen that the increase in the intervention groups were significantly higher than that for the comparison group. The average values of knowledge, attitude and behaviour of students before and after intervention showed significant differences ( $p < 0.05$ ).

It can be seen in Table 5 that the increasing percentage of students who gained knowledge is the highest for the topic 'characteristics, form and function of formalin' (43.9%) and the lowest for the topic 'healthy snack' (17.8%).

**Table 5. Student's Knowledge About the Specific Topics Related on Healthy and Safe Snacks Before and After the Interventions**

Topics	Comparison (N=180)				Intervention (N = 180)				Difference <sup>b)</sup>	
	Before		After		Before		After		n	%
	n	%	n	%	n	%	n	%		
1. Healthy snack change <sup>a)</sup>	92	51.1	152	84.4	88	48.9	180	100		
	60	33.3			92	51.1			32	17.8
2. Snack safety (bacteria, chemical, and physical) change <sup>a)</sup>	70	38.9	122	67.8	82	45.6	177	98.3		
	52	28.9			95	52.8			43	23.9
3. The characteristics, form, and function of formalin change <sup>a)</sup>	18	10.0	88	48.9	14	07.8	163	90.6		
	70	38.9			149	82.8			79	43.9
4. The characteristics, form, and function of borax change <sup>a)</sup>	24	13.3	79	43.9	21	11.7	134	74.4		
	55	30.6			113	62.8			58	32.2
5. The characteristics, form, and function of rhodamine B change <sup>a)</sup>	22	12.3	86	47.8	25	23.9	161	89.4		
	64	35.6			136	75.6			72	40

<sup>a)</sup> change within groups

<sup>b)</sup> change between groups

**Table 6. Behaviour of Snack Vendors Based on Cadres' Observations**

Behaviour	Comparison (N=46)				Intervention (N = 48)				Differences <sup>b)</sup>	
	before		After		before		after		N	%
	N	%	N	%	N	%	N	%		
1. Holding food without tools change <sup>a)</sup>	46	100	46	100	48	100	18	37.5		
	0	100			30	62.5			3	31.9
2. Holding snacks after holding money change <sup>a)</sup>	46	100	46	100	48	100	22	60.4		
	0	100			26	54.2			2	27.7
3. Long nails, dirty clothes change <sup>a)</sup>	30	65.2	21	45.7	31	64.6	10	20.8		
	9		19.6		21	34.8			1	12.7
4. Dirty tools change <sup>a)</sup>	35	76.1	32	69.6	36	75	19	39.6		
	3		6.5		17	35.4			1	14.9
5. Opened snacks change <sup>a)</sup>	39	84.8	35	76.1	37	77.1	6	12.5		
	4		8.7		31	64.6			2	28.7
6. Waste disposal unavailable change <sup>a)</sup>	44	95.7	43	93.5	41	85.4	2	4.2		
	1		2.2		39	81.3			3	40.4

<sup>a)</sup> change within groups

<sup>b)</sup> change between groups

Table 6 shows the behaviour of snack vendors based on cadres' observations. The lowest percentage of change belongs to vendors' behaviour in the topic of personal hygiene, such as long nails and dirty clothes (12.7%). Snack vendors find it difficult to change their behavior in terms of personal hygiene, especially cleanliness of nails and cleanliness of clothes used when selling.

Table 7 summarises the results of the vendor inspections conducted by cadres and supervised by laboratory workers. It was found that both the control and the intervention groups used unsafe food ingredients.

**Table 7. Snacks Containing Harmful Chemical Additives Before and After the Interventions**

Comparison (N=6)				Intervention (N=6)			
Location	Snacks	before contains	after contains	Location	Snacks	before contains	after contains
SD A, public school	noodles	formalin	formalin	SD I.1, Islamic private school	rice cake	borax	-
SD B, Islamic private school	nugget	borax	borax	SD I.2, public school	chicken nugget	borax, rhodamine B	food not sold anymore
SD C, public school	meat ball	borax	borax	SD I.2, private school	jam	rhodamine B	food not sold anymore
SD D, private school	noodles	formalin	formalin	SD I.3, public school	noodles	formalin	formalin
SD E, public school	ice candle	rhodamine B	rhodamine B	SD I.4, public school	ice candle	rhodamine B	-

## DISCUSSION

Our study shows that prior to the intervention, most of the students had poor knowledge about healthy and safe snacks, as reflected in the score before intervention. In the comparison group, we considered the average score of knowledge to be low even after the intervention. In general, respondents were ignorant about the harmful ingredients found in snacks. Neither students nor snack vendors knew the characteristics of snacks that may contain formalin, borax and rhodamine B, nor their impact on human health. This lack of knowledge is reflected in the low scores of the respondents in terms of attitudes and behaviour. Because the information about safe and healthy snacks is not yet available in the school curriculum, it is very difficult for students to get the correct information about healthy and safe snacks for school children, with severely limited access for students. The only source of information for students is often their parents while every day at school, the children are exposed to various types of snacks without any form of supervision regarding food quality and safety.

We found that vendors were aware of the need for students to consume safe and healthy snacks. However, our research showed that the vendors mostly had poor practices and sold unsafe and unhealthy snacks to school children. We also noted their poor personal hygiene, such as not using tools when holding snacks, not washing hands after holding money and leaving the snacks they sold uncovered and consequently, in contact with flies. The results of the chemical tests showed that some snacks contained harmful chemical additives.

After the intervention, we observed an increase in the average scores for knowledge, attitudes and behaviour of students and vendors, both in the intervention and the comparison groups. This increase in mean score was evident in the group given interventions which received a combination of poster distribution and promotion activities implemented by UKS's cadres ( $p < 0.05$ ). Posters and promotions conducted by school health programme cadres provided a stimulus in the form of healthy and safe vendor's information, prompting the change in knowledge, attitudes and behaviour of respondents. Poster distribution and speech are both methods of mass health education.

Our study showed that a combination of both methods namely, poster distribution and monthly speeches by trained students to their fellow students during gathering events, such as the flag raising ceremony, proved to be more effective than poster distribution alone to improve the knowledge, attitude and behaviour of respondents ( $p < 0.05$ ). Educational media in the form of posters requires a high reading interest from the target audience. Attractively designed posters are more likely to rouse curiosity and attract interest in reading and thereby to achieve the goals for which they were designed. In this study, we used posters that had been designed and used by the BPOM. In this field, however, when conducting in-depth interviews with students at the comparison site, the researchers found the interest of school children in reading this poster is lacking. Generally, the children read posters only when they were attached due to the curiosity.

The change in knowledge, attitude and behaviour of students who received the combination of the poster and group speech by UKS's cadre was greater. This was because the frequency at which the students received the stimulus in the form of information about healthy and safe snacks was more intensive and regular than that in the comparison group, when generally, the students read posters only once while some of them never even read the poster. Judging by the observations of the research team, the students who attended the

ceremony carefully listened the cadres' speeches, which they found compelling. During their speeches, the cadres wore white uniforms, which gave them a sense of pride and confidence to give speeches in front of their friends and teachers.

The pride of each school health programme cadre motivated them to always be passionate about promoting healthy and safe snacks. We observed this from the changes in speech and sharing skills, which improved every week. The growing interest among students to emulate the cadres motivated them to pay attention to the speeches delivered by their friends. Children need nutritional education to access the right nutritional knowledge and skills. Peer-based nutritional education models have a positive impact on students' nutritional behaviour. Peers can influence the knowledge and awareness of their fellow students and improve student self-reliance [24], [25].

The ideal and common places to provide health promotional interventions for children aged 6 to 12 years are educational institutions. Food marketing impacts children's food knowledge, behaviour and health. Understanding food marketing in children's everyday settings is necessary to protect children [26], [27]. Children's nutritional knowledge has shown an improvement with the increase of nutritional education programmes in schools [16], [28]. As previously shown, the nutritional education using the peer education model influences children's behaviour [22], [23], [29] and how they will select the food [30]. Nutritional education will increase the children's knowledge. Therefore, the children with higher knowledge scores are more likely to choose healthy snacks [11], [30].

Our research also found that pasting posters affected increasing the knowledge of street food vendors. However, when compared with the sharing and lecture methods given by *UKS's* cadres, the average change in knowledge of street food vendors who were intervened by *UKS's* cadres was higher than the knowledge of street food vendors given by posters. In our study, the promotion of healthy and safe snacks by *UKS's* cadres was more effective than the affixing of posters. From interviews with several school snack vendors who were given posters, they stated that they did not have time to read the posters because they were busy selling. Several sellers stated that they were not interested in reading the poster.

Sharing the information with the vendors has proved to be the most effective way of increasing their knowledge and skills. Apparently, the vendors took the information provided by the cadres of the school health programme about the personal hygiene and snacks. The vendors would have been embarrassed if they were caught by the school health programme cadres and in consequence, they always paid attention to cleanliness when engaged in selling. Vendors who sold snacks that are harmful to health were also approached by the school, but only after they were reported to the counsellor and principal by the school health programme cadres.

As most children attend school regularly and consume at least one meal and a number of snacks at school each day, the school-based programmes represent an ideal setting to enhance healthy eating. However, the current research suggests that the elementary school teachers often display low levels of nutritional knowledge, self-reliance and necessary skills to deliver effective nutritional education [31], [32]. By empowering the school health programme's cadres, the school-based programmes are effectively used as nutritional education programmes in schools.

Several studies showed that a peer approach to school-based health promotion is very effective in changing the healthy life behaviour of children. These improvements were achieved in parallel with progresses in diet quality, self-reliance and knowledge concerning healthy living [33]–[35]. The use of peer-to-peer approaches in health promotion interventions targeting youth seems to be a strategy with great potential. Peer leadership initiatives can increase physical activity for youth and children [36]. Darise, Deby Sinta (2021) in their research suggest that peer education can be used as an approach by schools for students to reduce the number of snack consumption habits in adolescents. In their research, they found that the peer education method affected increasing knowledge and attitudes related to snack consumption [37].

## **CONCLUSIONS**

*UKS's* cadres as promotion providers of healthy and safe snacks are more effective when compared to the method of providing posters on the knowledge, attitudes, and behavior of students and snack sellers at school. *UKS's* cadres as promoters of healthy and safe snacks can be used as a mandatory *UKS* program in every school to achieve food safety for school children. This study did not analyze other factors that may also influence changes in the knowledge, attitudes, and behavior of respondents such as age, gender, parental education level, and other factors.

## ACKNOWLEDGEMENT

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## CONFLICT OF INTEREST

The authors have no conflict of interests to declare.

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## The Evaluation Study of Nutritional Knowledge from Sports Practitioners in The Quadrennial National Sports Competition 2021

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### ABSTRACT

**Background:** Nutritional program is another influencing factor of athletic performance after the physical training program, and psychological training program. However, Indonesian sports practitioners somehow still neglect the important role of sports nutrition to achieve the best athletic performance.

**Objectives:** To examine the level of basic nutritional and sports nutritional knowledge among the sport's practitioners who participated in the quadrennial national sports competition 2021.

**Materials and Methods:** This evaluation study has conducted with a descriptive quantitative approach. Thirty-eight sports practitioners (24 males and 14 females), were represented from five provinces such as Central Java, Western Java, Eastern Java, Southern Sumatera, and Bali. Their status during the sports events are athletes, referees, officials, coaches, and judges. The incidental technique sampling was used to attract the respondents. Nutritional Knowledge Questionnaires (NKQ) developed by Rosi et al, was used in this study. Data was analyzed with the frequencies distribution technique, and displayed using the percentage.

**Results:** More than half of the total respondents (81%) have good, very good, and excellent knowledge in general nutrition (21%, 34%, 26%) respectively. Similarly, it is also happened in the evaluation of their knowledge for basic nutrition good (5%), very good (29%), excellent (40%), as well as in their knowledge levels for sports nutrition, good 18% and excellent 53%. However, based on the evaluation of their sports nutritional knowledge, we found that there are 8% (n=3) of the respondent were failed as the score <50 points.

**Conclusion:** Overall, the nutritional knowledge for general, basic and sports in sports practitioners evaluated good. However, the sports nutritional knowledge is not well understood evenly by them. At last, this study can be used as a reference to make a better decision on how sports nutrition must be promoted to maximize the athletic performance.

**Keywords:** Sports Nutrition; Sports Event; Elite Sports

### BACKGROUND

The proper physical training program, diet program, and psychological training are believed to be the key factors which affecting the best sports performance for any athlete. Further, social support, family, coach, teammates, athletic ability, athletic experience, and athletic achievements are considered as the contributing factors to either good or poor performance.<sup>1</sup> Aspects involved in a training program such as performance prediction, periodization, training methods and monitoring, techniques, injury prevention and its management.<sup>2</sup> Meanwhile, adequacy, balance, calorie (energy) control, nutrient density, moderation, variety, and consumption time are the aspects involved in the diet program.<sup>3</sup> Last, the psychological aspects such as

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attention, self-confidence, stress control, anxiety, motivation, cohesion, self-control or emotional self-regulation, moods, and interpersonal skills can influence the athlete's performance.<sup>4</sup>

Educational factors such as formal education and informal education in some ways could be one of many determinant factors on human behavior. A study found that there were not any differences on nutritional knowledge and attitudes among elite athletes, amateur athletes, and recreational athletes.<sup>5</sup> Interestingly, there are two scientific evidences about the correlation between nutritional knowledge and sports that were not in line with each other. The first study stated that having a good nutritional knowledge or its practice did not directly determine the athletic performance, and the other study stated that body fat percentage (BF%) was found higher in athletes who have a low level of sports nutrition knowledge.<sup>6,7</sup>

In elite sports, a study analyzed the tennis players' knowledge and attitudes on sports nutrition and doping revealed that coach (teacher, mentor) becomes their main source of any information related to doping and nutrition.<sup>8</sup> Hence, consistent long-term educational intervention is able to change the knowledge, attitudes, and athletes' behavior on sports nutrition. Athletes are motivated to learn, improve diet behaviors, and benefit from team-based nutrition interventions.<sup>9</sup> Both basic nutritional concepts and the understanding of specific effects of nutrients on sports performance still needed to be consistently taught to the athlete by the sports nutrition practitioners. Unclear understanding of nutritional guidelines interpreted into absolute food portions or combinations may found in the athlete. Nutritional interventions by promoting adequate energy intake, lowering BF%, appropriately gaining muscle mass, and the body lean is still needed.<sup>6,7</sup>

Based on the elucidation above, the levels of nutritional knowledge in sports practitioners either athlete, coach, official, or other stakeholders is remains unclear. Therefore, this study aims to evaluate the level of sports practitioners' knowledge on both basic nutrition and sports nutrition.

## **MATERIALS AND METHODS**

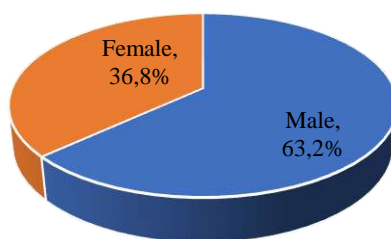
This evaluation study has conducted with a descriptive quantitative approach. The inclusion criteria in this study is all the individuals who were actively participating in the quadrennial national sports competition 2021, Papua. Their status during the sports events are athletes, referees, officials, coaches, and judges. Meanwhile, total respondents in this study are 38 sports practitioners (24 males and 14 females), they were represented from five provinces such as Central Java, Western Java, Eastern Java, Southern Sumatera, and Bali. The incidental technique sampling was used to attract the response.

Nutritional Knowledge Questionnaires (NKQ) developed by Rosi et al, which published in 2020 was used in this study, it was translated into Bahasa Indonesia, with some adjustments on its statements and then it was transferred into Google Forms to make easier distribution and data collection. The NKQ consisted of 16 questions evaluating basic nutrition, and 10 questions evaluating sports nutrition. The NKQ was chosen because it provides a brief, feasible, and validated questionnaire or evaluates the efficacy of education on basic and sports nutrition in both the general population and athletes.<sup>10</sup>

NKQ using the modified Goodman Scales which provides three optional answers (true/false/I do not know). The six-teen questions related to basic nutritional knowledge are: 1) Protein intake and body fat, 2) Carbohydrate content of banana, 3) Carbohydrate content of rice, 4) Fat requirements, 5) Fat content of low-fat cheese, 6) Fat content of butter, 7) Fat content of honey, 8) Daily recommended intake of water, 9) Protein content of hard cheese, 10) Protein content of beans, 11) Protein content of corn, 12) Protein quality of eggs, 13) Energy from vitamins, 14) Daily recommended calcium intake, 15) Alcohol and body fat, and 16) Alcohol intake and recovery from injuries. Meanwhile, the ten questions related to sports nutritional knowledge are: 1) The best meal for increasing muscle mass, 2) Protein needs of vegetarian athletes, 3) Vitamin and mineral supplements and sports performance, 4) Water consumption during training, 5) Dehydration and sports performance, 6) Snacking during training, 7) Carbohydrate intake during training, 8) Label and claims on food supplements, 9) Safety of supplements, and 10) Doping substances.

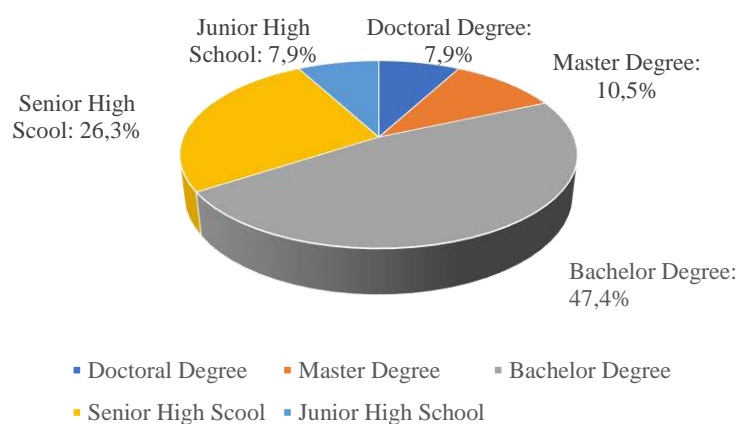
The answers of NKQ were scored. Then it was categorized into eight categories such as Failed <50, Less 51-55, Less than enough 56-60, Enough 61-65, More than enough 66-70, Good 71-80, Very good 81-85, and excellent 86-100.<sup>10</sup> Data were analyzed with the frequencies distribution technique, and displayed using the percentage in the tables and figures.

## RESULTS



**Figure 1. Respondent's Sex**

A total of 38 respondents participated in this study which consists of 24 (63.2%) males and 14 (36.8%) females (Figure 1). The educational backgrounds of respondents were varied starting from Junior High School 3 (7.9%), Senior High School 10 (26.30%), Bachelor Degree 18 (47.40%), Master Degree 4 (10.50%), and Doctoral Degree 3 (7.9%), for the visualization can be seen on Figure 2.



**Figure 2. Educational Degree of Respondent**

**Table 1. Participants Delegation**

Category	n	%
<b>Province</b>		
Central Java	21	55.28
Western Java	8	21.05
Eastern Java	3	7.89
Southern Sumatera	3	7.89
Bali	1	2.63
Unknown	2	5.26
<b>Sports</b>		
Gymnastics	18	47.40
Handball	4	10.52
Softball	3	7.89
Wrestling	2	5.26
6t5 Skates	2	5.26
Sepak Takraw	2	5.26
Wushu	2	5.26
Cricket	1	2.63
Indoor Hockey	1	2.63
Hapkido	1	2.63
Archery	1	2.63
Unknown	1	2.63
<b>Status</b>		
Athlete	28	73.70
Referee	5	13.15
Official	3	7.89
Coach	1	2.63
Judge	1	2.63

There are five identified provinces that have participated in this study: Central Java (55.28%), Western Java (21.05%), Eastern Java (7.89%), Southern Sumatera (7.89%), Bali (2.69%), and 2 respondents (5.26%) were not identified. Further, from those 5 provinces, the respondents were identified actively involved in 11 sports, they are: gymnastics (47.40%), handball (10.52%), 3 softball (7.89%), wrestling (5.26%), skates (5.26%), sepak takraw (5.26%), wushu (5.26%), cricket (2.63%), indoor hockey (2.63%), hapkido (2.63%), archery (2.63%), and one respondent (2.63%) was not identified. At last, from 38 respondents their role in the quadrennial national sports competition 2021 were as athlete (73.70%), referee (13.15%), official (7.89%), coach (2.63%), and judge (2.63%) see Table 1.

Nutritional knowledge is the overall knowledge, both about basic and sports nutrition. The data from sports practitioners can be seen in Table 2. Eight categories were made up based on the common judgmental value for the educational sector. Based on the analysis, regarding the nutritional knowledge found that 10 (26%) respondents are classified into excellent category, 13 (34%) very good, 8 (21%) good, 3 (8%) more than enough, 1 (3%) enough, less than enough 2 (5%) and less 1 (3%). Meanwhile, the understanding data of basic nutrition from respondents found that 15 (40%) were classified into excellent category, 11 (29%) very good, 2 (5%) good, 2 (5%) more than enough, 6 (16%) enough, and 2 (5%) less than enough. Lastly, the nutritional knowledge data of respondents showed that 20 (53%) were classified into excellent category, 7 (18%) good, 5 (13%) more than enough, 3 (8%) less than enough, and unfortunately 3 (8%) of respondents were failed.

**Table 2. Distribution Frequency of Nutritional Knowledge**

Category	Score Range	General Nutrition (n= 38)	Percentage (%)	Basic Nutriti (n= 38)	Percentage (%)	Sports Nutrition (n= 38)	Percentage (%)
<b>Excellent</b>	86-100	10	26	15	40	20	53
<b>Very Good</b>	81-85	13	34	11	29	0	0
<b>Good</b>	71-80	8	21	2	5	7	18
<b>More than enough</b>	66-70	3	8	2	5	5	13
<b>Enough</b>	61-65	1	3	6	16	0	0
<b>Less than enough</b>	56-60	2	5	2	5	3	8
<b>Less</b>	51-55	1	3	0	0	0	0
<b>Failed</b>	<50	0	0	0	0	3	8
<b>Total</b>		<b>38</b>	<b>100%</b>	<b>38</b>	<b>100%</b>	<b>38</b>	<b>100%</b>

Regarding to the sports nutritional data in table 2, although more than half of respondents were categorized into good (18%) and excellent (53%), surprisingly we found that there were three of the respondents failed as their score <50. These respondents backgrounds are three males; senior high school, senior high school, bachelor degree; one from eastern java, and two from western java; one sepak takraw athlete, and two gymnasts; one of them has been participating in sports for more than sixteen years, while the other two over than six years.

## DISCUSSION

Based on this research, the majority of the respondent was male athletes. The gender gap in sports performance has been stable since years ago. These suggest that women's performances at the high level will never match those of men, even when performances still improve, these progressions are proportional for each gender.<sup>11</sup> In general, males have longer limb levers, stronger bones, greater muscle mass and strength, and greater aerobic capacity. Females exhibit less muscle fatigability and faster recovery during endurance exercise.<sup>12</sup>

The educational backgrounds of the respondent also varied from Junior High School to Doctoral Degree. Educational factors such as formal education and informal education in some ways could be one of many determinant factors on human behavior.<sup>5</sup> A systematic literature review found that most nutrition education programs administered to athletes lead to significant improvements in nutrition knowledge (NK).<sup>13</sup>

The sports practitioner that become our respondents were from 5 different provinces in Indonesia. The quadrennial national sports competition is a multi-sport event held every four years in Indonesia. The

participants of this event are athletes from all provinces of Indonesia. It is organized by the National Sports Committee of Indonesia (KONI). The characteristic of the respondent was varied either the type of sports or the status of the sport's practitioners. Social support, family, coach, teammates, athletic ability, athletic experience, and athletic achievements are considered as the contributing factors to either good or poor performance.<sup>1</sup>

In this research, general nutrition is the overall knowledge, both about basic and sports nutrition. Subjects who have a good knowledge were from higher educational background. Higher levels of nutrition knowledge have been reported in those with higher education or socio-economic status and greater levels of nutrition knowledge have been typically found in middle-aged as opposed to younger or older persons.<sup>14</sup> Good nutritional knowledge has been recognized as the key factor that play a critical role in improving athletic performance in terms of improved quality of training and a speedy recovery from exercise. Athletes need sufficient knowledge of this subject to understand the importance of food choices for their athletic performance, recovery, and overall health.<sup>15</sup>

The question about basic nutrition is mostly about the source of macronutrients in food. From the result, we have found that the nutrition knowledge of our respondents was satisfactory as more than half of the participants had good nutritional knowledge. Magazines, parents, coaches, and teammates were the commonly cited sources for nutrition revealed by another study.<sup>7</sup> Athletes are understanding the important role that nutrition has in performance. One thing athletes often forget is that their dietary needs are much higher than those of the general population. Individual dietary requirements vary depending on the type of sport, the athlete's goals, body composition, training schedule, environment, and metabolism.<sup>16</sup>

Most of sports practitioner have scored above 71 for the sports nutrition questions which are categorized as good, very good, and excellent. Sports nutrition is a complex area of nutrition science and has emerged as an entire medical sub-specialty of its own.<sup>17</sup> Sports nutrition focused on meeting the nutritional requirements for physical activity, optimizing the refueling process after physical exercise, and improving athletic performance in training and competitions, as well as promoting general health and well-being.<sup>18</sup>

Surprisingly we found that some sports practitioners were failed (score <50) in sports nutrition knowledge. These respondents backgrounds are three males; 2 of them are senior high school and bachelor degree; one from eastern java, and two from western java; one sepak takraw athlete, and two gymnasts; one of them has been participating in sports more than sixteen years, while the other two over than six years. This finding, however, was similar to findings of other studies in which researchers found female athletes to have significantly higher NK scores than their male counterparts.<sup>19</sup> Adolescent athletes often rely on their coaches for nutrition guidance despite gaining brief information from their regular textbooks. Dependence on the internet search for proper diet and nutrition is growing, however, it's difficult to separate authentic information. Lack of proper training on diet and nutrition creates potential harm if the coaches and athletes are misinformed.<sup>20</sup> Proper nutrition knowledge and healthy dietary practices are important for adolescent athletes as well as for coaches.<sup>7</sup>

## CONCLUSIONS

We conclude that the sport's practitioners have well understanding of basic and sports nutrition, but this phenomenon especially the sports nutrition is still not understood by the whole practitioners. From this point, we suggest that sustainable education both formal and informal related to sports nutrition must be conducted as endless efforts to support the national sports development by the whole practitioners (athletes, referees, officials, coaches, and judges).

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