

RESEARCH STUDY

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## Association of Ultra-Processed Food Consumption and Body Mass Index for Age among Elementary Students in Surabaya

### Hubungan Konsumsi Ultra-Processed Food dengan Indeks Massa Tubuh menurut Usia pada Siswa Sekolah Dasar di Surabaya

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#### ABSTRACT

**Background:** Childhood obesity became a major nutritional problem in the last decades and growing rapidly in many countries, including Indonesia. Processed food especially ultra-processed food (UPF) as part of NOVA classification had known to contain obesogenic nutrients which were high energy-dense, fatty, sugary, and salty may lead to higher body mass index-for-age (BAZ).

**Objective:** The study aimed to assess the correlation between UPF and BAZ among school-age children 10-12 years old in Surabaya.

**Methods:** A cross-sectional study and data collection were conducted in three public and private schools in Surabaya, East Java Indonesia from March-April 2020. Elementary students in the 4<sup>th</sup> and 5<sup>th</sup> grades were enrolled and 136 students were randomly selected as respondents. Weight and height measurements were obtained for calculating the BAZ, and UPF consumption was obtained by food frequency questionnaire. Structured questionnaires and physical activity questionnaires for children (PAQ-C) were used to assess socio-demographic status, physical activity level, energy intake, and sedentary screen time. ANOVA test was done for bivariate analysis and linear regression for multivariate analysis, all data analyzed used SPSS version 20.

**Results:** The result found a mean of BAZ was 0.31 SD; 35.3% of respondents were in the 1<sup>st</sup> tertile of UPF consumption. Most of the respondents had inadequate TEI and low PAL. No significant association was found between UPF consumption and BAZ ( $p=0.217$ ). Only physical activity that significant in multivariate analysis ( $p=0.032$ )

**Conclusion:** It was necessary to distinguish the type of obesogenic and non-obesogenic UPF to get a clear correlation between UPF consumption and BAZ among school-age children.

#### ABSTRAK

**Latar Belakang:** Obesitas pada anak menjadi masalah gizi utama dalam beberapa dekade terakhir dan berkembang pesat di banyak negara, termasuk Indonesia. Pangan olahan khususnya Ultra-Processed Food (UPF) sebagai bagian dari klasifikasi NOVA diketahui mengandung nutrisi "obesogenic" yang padat energi, berlemak, manis dan asin dapat menyebabkan peningkatan indeks massa tubuh menurut usia (BAZ).

**Tujuan:** Penelitian ini bertujuan untuk mengetahui hubungan antara UPF dan BAZ pada anak usia sekolah 10-12 tahun di Surabaya.

**Metode:** Studi potong lintang dan melibatkan tiga sekolah dasar negeri-swasta di Surabaya, Jawa Timur Indonesia selama Maret-April 2020. Siswa SD kelas 4 dan 5 sebanyak 136 orang dipilih secara acak sebagai responden. Pengukuran berat badan dan tinggi badan dilakukan untuk menghitung BAZ, sedangkan konsumsi UPF diperoleh dengan Food Frequency Questionnaire (FFQ). Kuesioner terstruktur dan kuesioner aktivitas fisik untuk anak (PAQ-C) digunakan untuk menilai status sosiodemografi, tingkat aktivitas fisik, asupan energi, dan waktu di depan layar. Uji ANOVA dilakukan untuk analisis bivariat dan regresi linier untuk analisis multivariat, data analisis menggunakan SPSS versi 20.

**Hasil:** Hasil penelitian didapatkan rata-rata BAZ 0,31 SD; 35,3% responden berada pada tersil pertama konsumsi UPF dan median energi dari UPF 247 kkal/hari. Sebagian besar responden memiliki total asupan energi yang tidak adekuat dan tingkat

aktivitas fisik rendah. Tidak ada hubungan signifikan yang ditemukan antara konsumsi UPF dan BAZ ( $p = 0,217$ ). Hanya aktivitas fisik yang signifikan dalam analisis multivariat ( $p = 0,032$ ).

**Kesimpulan:** Perlu dibedakan tipe UPF "obesogenic" dan "non-obesogenic" untuk mendapatkan hubungan yang jelas antara konsumsi UPF dan BAZ pada anak usia sekolah.

**Kata Kunci:** Ultra-processed Food, Anak Usia Sekolah, Gizi Lebih-Obesitas.

## INTRODUCTION

Childhood obesity especially in school-age children in the last 40 years has risen more than 10 times, from 11 million to 124 million.<sup>1</sup> The epidemic has been growing rapidly in low and middle-income countries-likewise Indonesia. The recent Basic Health Survey (BHS) 2018 stated that 9.2% of children 5-12 years were obese, this prevalence was higher compared to the 13-15 age group (4.8%) and 16-18 age group (4%).<sup>2</sup> It showed that obesity was higher in school-age children rather than in adolescents. Obesity is identical with the condition of excess fat. The difficulty of body fat measurement without sophisticated tools promotes a role for using body mass index (BMI) for age to assess health risk by considering gender and age to indicate adiposity.<sup>3</sup>

Nowadays global food system has shifted from conventional foods to multiplied consumption of highly processed foods.<sup>4</sup> Processed food was formerly dominant in high-income countries, and currently in middle-income countries. Many types of food processing are advantageous. However what is identified and defined in this study as ultra-processing, one of the food classifications in the NOVA food system,<sup>5</sup> this type of process is generally obesogenic because of its energy-dense, fatty, sugary, or salty characteristics.<sup>6-9</sup> The product is made attractive, cheap, hyper-palatable, and ready to consume. In addition, the high palatability of ultra-processed food (UPF), which is associated with their convenience and aggressive advertising are the factors that increased their consumption.<sup>10</sup> This food category is also high in refined carbohydrates that may lead to addictive-like eating behaviors and overconsumption, which causes excess fat and higher BMI.<sup>9,11,12</sup>

Regarding the association between UPF consumption and BMI, there was a study in adults and adolescents stated that Brazilians in the top quintile of UPF consumption had 0.94 kg/m<sup>2</sup> higher BMI and 26% more likely to be obese compared with those in the lowest quintile.<sup>13</sup> But the recent study in 2019 among subjects 10-18 years old stated that UPF consumption has not been shown as a factor associated with excess weight.<sup>8</sup> Most of the studies also assessed the general population or adults, not much attention has been given to children's consumption of UPF. In Indonesia, research in Jakarta highlighted the contribution of energy from UPF (15.7%) among adults was still lower compared with Brazil (30%).<sup>8,14</sup> No study was found that assesses the UPF consumption among school children in Indonesia.

The study was conducted in Surabaya, the capital city of East Java. East Java has the second largest population of school-aged children in Indonesia, around 2 million children are students in public or private elementary schools and Surabaya has the largest population of school-aged children in the province.<sup>15</sup>

Most UPF are representative of the global food system delivered by the food and beverage industry. The presence of the food and beverage industry in Indonesia rise from 8.46% in 2016 to 9.23% in 2017.<sup>16</sup> Most of the food and beverage industry is located in Java with 7 industries in Jakarta, 39 industries in West Java, 10 industries in Central Java, and 42 industries in East Java.<sup>17,18</sup> The data showed that most of the food industry located in East Java and Surabaya as the capital city become the center of product distribution. Therefore, the possibility of UPF consumption among Surabaya citizens is greater than in other regions.

The importance of assessing UPF consumption among school-age children regarding BMI for age-related to obesity is urgent. Data from a lower-middle-income country in South East Asia specifically in Indonesia related to UPF consumption is sparse, especially in school-aged children. It is needed to research to assess the association of UPF consumption with BMI for age among school-aged children in Surabaya.

## METHODS

This observational cross-sectional study was part of a bigger study entitled "The Challenge of Z Generation in Realizing a Healthy Life to Prevent Childhood Obesity". This study was done in three randomly selected public and private schools in Surabaya, East Java Indonesia from March-April 2020. Elementary students in the 4<sup>th</sup> and 5<sup>th</sup> grades were enrolled 136 students randomly selected as respondents. The inclusion criteria were children 10-12 years, agreed to involve in this study by parent informed consent, heard healthy. The subject with special needs (unable to give normal communication during an interview), physical disability, and special diet was excluded from the study. Sample size calculation was defined using coefficient correlation from the previous study 0.3,<sup>19</sup> with  $\alpha = 5\%$ , power of study 90%, and DEFF 1.5.

Weight and height measurements were obtained for calculating the BAZ, stadiometer, and SECA weight scale was used for anthropometric measurement. A structured questionnaire and physical activity questionnaire for children (PAQ-C) were used to assess socio-demographic status, physical activity level (PAL), sedentary screen time, and child morbidity. Repeated 2x24-hour recall used to assess energy intake.

Socio-demographic status was defined as parent education level (low, moderate, high) and parent occupation (formal and informal sector for father, working and not working for mother). Sedentary screen time was categorized into  $\leq 2$  hours/day and  $> 2$  hours/day, categorization of child morbidity were "never", "1-2x", ">2x", while the PAQ-C score  $> 2.75$  was considered as active. Total energy intake was categorized

into <80% of RDA, ≥ 80% of RDA, and >100% of RDA.

Ultra-processed food in this study was defined as food processed in food industries by the addition of many ingredients, and most of these foods are ready-to-eat or only require simple preparation before consumption. Ultra-processed food consumption was obtained by a pre-developed food frequency questionnaire for the last month. Construction of the food list using data of 1-day 24-hour recall form from the bigger study. The food list was constructed from randomly selected 30 subjects. The food that was classified as UPF was included in the food list. Food items eaten by fewer than 10 subjects were excluded from the UPF food list. We identified 127 items that belong to UPF which consist of 82 food items and 45 items of beverages. Next step, we combined the same brand and type of food but had various flavors into one item, i.e. strawberry UHT milk and chocolate UHT milk were defined as UHT milk. To enrich food items of FFQ according to the available food surrounding the environment of school-aged children, a market survey by listing the available food and beverages was conducted in each school area consisting of the school canteen and food store. In the end, we got 78 food items and 35 items of beverages.

The NOVA food classification was used as a reference for grouping foods based on processing type, with adjustment with Indonesian terms.<sup>14</sup> Food and beverage are categorized into twelve broad groups "Milk and milk powder product" (2 items), "Milk" (2 items), "Confectionary/ candy & chocolate" (3 items), "Cereals" (7 items), "Bakery" (7 items), "Meat and poultry" (4 items), "Fish" (1 item), "Sauce, dressing & powder flavoring" (10 items), "Powder drink & concentrate" (3 items), "Drinks" (7 items), "Snacks" (6 items), "Fast food" (3 items). There were seven options in the category for frequency of intake, which was "never", "<1x/month", "1-3x/month", "1x/week", "2-4x/week", "1x/day", ">1x/day". The frequency was scored from 1-7 to then sum up to get the total score of UPF frequency. The total score of UPF consumption was categorized based on tertile data distribution.

Data analysis using SPSS version 20. Independent t-test was used for categorical data in bivariate analysis with normal distribution, while Pearson and spearman correlation tests were used for numerical data. ANOVA was done to find out a compare of the mean for more than two variable categories. Linear regression was done in multivariate analysis, variable which has a p-value <0.20 in the bivariate analysis was included in multivariate analysis. The ethical clearance was obtained from the Ethical Committee of the Faculty of Nursing, Universitas Airlangga with permit number 1757-KEPK. In addition, a permit letter was issued to the school. Signed informed consent was obtained from the respondent's parent. This consent informed them regarding the purpose of the study. It was ensured that each respondent participates voluntarily and had the autonomy to refuse to join the study. Any data obtained from this study was confidential and used only for research purposes.

## RESULTS

In this study, the age of respondents was a range of 10-12 years old. The median age of respondents was 11 years old. Additionally, the proportion of girls involved in this study was higher than boys, 54.4% and 45.6% respectively. Based on the level of education and occupation, most of the fathers and mothers of respondents had graduated from senior high school. Most of their fathers were working in the formal sector, while most of the mothers were not working. Most of the students had sedentary screen time for more than 2 hours on weekdays (64%) and 55.9% of the respondents never got sick for the last two weeks. While based on the physical activity level characteristic of respondents, ¼ of total respondents were inactive. Also, the total energy intake per day was 1591 kcal from food and beverages, with a standard deviation of 382 kcal. In addition, the result was compared to recommended dietary allowance (RDA) of Indonesia for ages 10-12 years old in 2019 which was 2000 kcal/day for boys and 1900 kcal/day for girls.<sup>20</sup> It showed that 5 out of 10 respondents had inadequate energy intake every day (<80% of RDA). Only 4 of 10 respondents had adequate intake (80-100% of RDA), and 2 of 10 respondents exceeded the RDA.

This study attained UPF consumption data based on the median UPF frequency score and energy from UPF intake, 125.50 and 247 kcal/day, respectively. UPF consumption was not significantly correlated with BAZ ( $p>0.05$ ). Two socio-demographic statuses showed significant association with BAZ ( $p<0.05$ ), child sex ( $p=0.018$ ), and mother's education level ( $p=0.014$ ). Total energy intake and physical activity level were not significantly associated with BAZ. In multivariate analysis after adjusting to other several confounders, only physical activity level was significantly correlated with BAZ ( $p=0.032$ ). The school-aged children that were physically active were significantly decreased BAZ to 0.195.

Child sex has a significant association with BAZ based on statistical analysis. This finding was linear with a study in China, boys had a higher OR of being overweight/obese compared to girls (OR = 2.30).<sup>21</sup> The background of this situation was the girls might pay more attention to foods and were more likely to eat healthy food (having breakfast, fruits, and vegetables), while the boys were more likely to consume less healthy food such as high energy food (western fast food, fried food, carbohydrate drinks, and sugar-sweetened drinks).<sup>21</sup>

Parents' education, in this study mother's education, showed an association with BAZ among school-aged children. Children with high education of mothers showed a higher mean of BAZ compared to mothers with moderate and low education. This study also revealed higher BAZ among children with working moms, even though it was not significantly associated. This was consistent with a previous study that stated that highly educated mothers doubled the risk of overweight children (OR = 2.07).<sup>22</sup> Highly educated parents can easily gain better jobs to get high incomes;

thus, they could purchase foods outside the home rather than homemade food. Highly educated mothers seem to strongly influence their role as decision-makers for daily food purchasing and affecting the food availability at home. Besides, a mother with high education will influence their children's BMI by protecting her children from being underweight and leading to a higher risk of being overweight.

Physical activity level was the only predictor of BAZ in this study, in which inactive school-aged children tend to have higher BAZ. The reduction of many physical

activities in children's lifestyles was the impact of some environmental factors such as less active transportation and the changing nature of school ground facilities, leading to a higher risk of childhood obesity.<sup>22</sup> Beside environmental factors, physical activity has been proven can reduce the level of leptin and insulin, decrease circulating leptin and insulin concentration will result in satiety, represents feeding so it will maintain the body of weight school-aged children.<sup>23</sup>

**Table 1.** General characteristics of respondents based on age, sex, education, occupation, sedentary screen time, child morbidity, physical activity, energy intake, food consumption and antropometric measurements

Characteristics	n (%)	Mean±SD or median(min-max)	p-value
Child age (years)		11 (10-12)	0.634
Child sex			0.018*
Boys	62 (45.6)		
Girls	74 (54.4)		
Father's education level			0.463
Low	25 (18.4)		
Moderate	75 (55.1)		
High	36 (26.5)		
Mother's education level			0.014*
Low	25 (18.4)		
Moderate	70 (51.5)		
High	41 (30.1)		
Father's occupation			0.461
Formal sector	77 (56.6)		
Informal sector	59 (43.4)		
Mother's occupation			0.142
Not working	88 (64.7)		
Working	48 (35.3)		
Sedentary screen time		3 (0-8)	0.569
> 2 hours/day	87 (64.0)		
≤ 2 hours/day	49 (36.0)		
Child morbidity			0.320
Never	76 (55.9)		
1-2x	57 (41.9)		
>2x	3 (2.2)		
Physical activity			0.136
Inactive	96 (70.6)		
Active	40 (29.4)		
Total energy intake (kcal/day)		1591 ± 382	0.595
<80% of RDA	63 (46.3%)		
≥80% of RDA	49 (36.0%)		
>100% of RDA	24 (17.6%)		
Food Group Consumption			
Ultra-processed food (kcal/day)		247 (0-884)	
Unprocessed/ minimally processed (kcal/day)		532 ± 209	
Processed culinary ingredient (kcal/day)		186 (0-841)	
Processed food (kcal/day)		178 (0-1079)	
Anthropometric			
Weight (kg)		36.32 (20.60-77.90)	
Height (cm)		140.45 ± 7.45	
BAZ (kg/m <sup>2</sup> )		0.31 ± 1.79	

From the type of UPF (**Table 2**), several foods and beverages are frequently consumed by more than half of the respondents. soy sauce, candy/gum, meatball, seasoned flour, wafer & astor, tea, biscuit, chocolate powder, instant noodle, and tomato. The sauce was the

most consumed UPF. This finding was similar to other studies in Brazil that showed candies and gum were a type of UPF that are mostly consumed by children.<sup>24,8</sup> A study by Ferreira that compares UPF consumption among students from public and private schools shows that

more than 50% of the students consume candies, this type of food was the most consumed in the UPF group.<sup>24</sup>

**Table 2.** Food and drink reported in the UPF FFQ (Ultra-Processed Food, Food Frequency Questionnaire)

Food and Drinks	Intake			
	Seldom		Often	
	n	%	n	%
<b>Milk and Milk Powder Product</b>				
Low-fat milk powder	130	95.6	6	4.4
Full cream milk powder	81	59.6	55	40.4
<b>Milk</b>				
UHT milk	72	52.9	64	47.1
Yogurt	114	83.8	22	16.2
Sweetened condensed milk	74	54.4	62	45.6
Ice cream	64	47.1	72	52.9
Pudding	109	80.1	27	19.9
<b>Confectionery/ Candy &amp; Chocolate</b>				
Candy and gum	45	33.1	91	66.9
Chocolate and meises	66	48.5	70	51.5
Marshmallow	120	88.2	16	11.8
<b>Cereals</b>				
Instant noodle	58	42.6	78	57.4
Instant porridge	130	95.6	6	4.4
Instant soup	134	98.5	2	1.5
Ready to eat cereal	97	71.3	39	28.7
Oatmeal	123	90.4	13	9.6
Seasoned flour	47	34.6	89	65.4
Cereal powder	83	61.0	53	39.0
<b>Bakery</b>				
White bread	63	46.3	73	53.7
Bagelen	127	93.4	9	6.6
Biscuit	55	40.4	81	59.6
Wafers & Astor	49	36.0	87	64.0
Cookie	62	45.6	74	54.4
Packaged bread	70	51.5	66	48.5
Cake	104	76.5	32	23.5
<b>Meat and Poultry</b>				
Sausage	47	34.6	89	65.4
Meatball	46	33.8	90	66.2
Chicken nugget	94	69.1	42	30.9
Corned and smoked beef	113	83.1	23	16.9
<b>Fish</b>				
Fishball and processed fish	96	70.6	40	29.4
<b>Sauce, Dressing &amp; Powder Flavoring</b>				
Tomato sauce	58	42.6	78	57.4
Chili sauce	59	43.4	77	56.6
Cheese sauce	109	80.1	27	19.9
Instant spaghetti sauce	127	93.4	9	6.6
Soy sauce	35	25.7	101	74.3
Salad dressing	122	89.7	14	10.3
Mayonnaise	94	69.1	42	30.9
Ready to use seasoning	69	50.7	67	49.3
Jam	88	64.7	48	35.3
Margarine and butter	81	59.6	55	40.4

Food and Drinks	Intake			
	Seldom		Often	
	n	%	n	%
<b>Powder Drink &amp; Concentrate</b>				
Chocolate powder	56	41.2	80	58.8
Fruit concentrate	77	56.6	59	43.4
Milk Shake	67	49.3	69	50.7
<b>Drinks</b>				
Electrolyte drinks	109	80.1	27	19.9
Carbonated drinks	117	86.0	19	14.0
Fruit juice drinks	105	77.2	31	22.8
Jelly drinks	98	72.1	38	27.9
Tea	52	38.2	84	61.8
Coffee	107	78.7	29	21.3
Syrup	108	79.4	28	20.6
<b>Snacks</b>				
Potato chips	64	47.1	72	52.9
Cassava chips	90	66.2	46	33.8
Pilus	81	59.6	55	40.4
Peanuts	108	79.4	28	20.6
Extrudate snacks	79	58.1	57	41.9
Corn chips	77	56.6	59	43.4
<b>Fast Food</b>				
Fried chicken	94	69.1	42	30.9
Fried fries	101	74.3	35	25.7
Burger	113	83.1	23	16.9

Seldom (not consumed and 1-3x/ month); Often (1x/ week - >1x/ day)

In this study, soy sauce became the most frequently consumed food by 74% of respondents. It could happen because most of the children's snacks that are available in the school area used soy sauce as a condiment. *Batagor, siomay, cilok, otak-otak, cilor*, and fried quail eggs were examples of available snacks in 1 school area. Besides, the main course in Surabaya also used soy sauce as a condiment, such as *soto, fried rice, sate, and bakso*.

The list of the most frequent UPF consumption was dominated by sweet food and beverage like candy, *wafel & astor*, tea, biscuit, and chocolate powder drink. These kinds of food were common food consumers used by school children and available at the school canteen. Tea and chocolate powder drink were types of drinks that can easily be consumed by the children in their spare time, these kinds of drinks are also known as high in calories and may contribute to higher calorie intake.

Ultra-processed foods were found to contain 'obesogenic' nutrients which are known more energy-dense, sugary or salty, and contribute to overweight-obesity by excessing caloric intake.<sup>5</sup> ANOVA test found no significant correlations between BAZ and UPF consumption ( $p > 0.05$ ), which is in contrast with a study by Louzada, et. al in the Brazilian population which found a positive association between UPF consumption and

higher BMI.<sup>13</sup> Mean BMI was 0.94 kg/m<sup>2</sup> higher among those in the highest quintile, with adjusted OR of being obese or excess weight, were, respectively, 1.98 and 1.26 in the highest quintile of UPF intake.<sup>13</sup> In the Louzada study, the population was varied from children 10 years old until elderly age 60 years or more, bigger than this study population which only focusing on school-aged children.

This study finding was consistent with a previous study by Enes, et. al<sup>8</sup> (2019) among adolescents 10-18 years old and Sparrenberger, et. al (2015)<sup>25</sup> among children 2-10 years old. From Sparrenberger, et. al's study, the association of percentage contribution of UPF and nutritional status based on BMI for age was not significant. This result is due to the similar mean percentage of UPF contribution in both groups, normal weight (48.2%) and excess weight (49.0%).<sup>25</sup> In Enes, et. al's study which use the Simplified Food Frequency Questionnaire for Adolescents (SFFQA) to measure food intake and UPF consumption, no significant association was found between the contribution of UPF in the diet and mean BMI. This study found a higher prevalence of overweight and obesity in the first quartile of UPF intake.<sup>8</sup> Similar to Enes, et. al study, our study also found a higher mean BMI among those in the 1<sup>st</sup> tercile of UPF consumption (**Table 3**).

**Table 3.** Association between ultra-processed food (UPF) consumption and body mass index-for-age (BAZ)

UPF Consumption	BMI for Age	
	Mean±SD	p-value
1 <sup>st</sup> tercile	0.54 ± 1.89	0.217
2 <sup>nd</sup> tercile	0.44 ± 1.66	
3 <sup>rd</sup> tercile	-0.08 ± 1.77	

**Table 4.** Multivariate Analysis between ultra-processed food (UPF) Consumption and body mass index-for-age (BAZ), adjusting for other potential Factors

Variable	Adjusted			
	β	95% CI	p-value	Adj R <sup>2</sup>
UPF consumption	0.049	-0.493-0.282	0.591	0.120
Mother's education level	0.116	-0.128-0.731	0.167	
Low				
Moderate				
High				
Mother's occupation	0.137	-0.112-1.128	0.107	
Not working				
Working				
Physical activity level	-0.195	-1.452(-0.067)	0.032*	
Inactive				
Active				
Total energy intake (kcal/day)	-0.007	-0.001-0.001	0.939	

The insignificant results regarding UPF and BAZ could be due to the relative homogeneity of the study population. The energy from unprocessed/ minimally processed food consumption was still the highest compared to other food groups. It showed that most of the respondents still depend on the consumption of single-ingredient food with no or very slight modification, in this case, the amount of staple food (rice) and other fresh ingredients (i.e. egg, fresh vegetables, chicken) dominate the daily intake of the respondent. However, the energy from UPF was the second higher after unprocessed/ minimally processed food, therefore we should be aware to prevent the increase of UPF consumption in the future.

Besides relative homogeneity, diet quantity and quality were the factors that can influence the BAZ among children. UPF was known to contain the obesogenic nutrient which had "low quality" nutrient.<sup>5</sup> A recent study in 2020 by Bleiweiss-Sande, et. al.<sup>26</sup> stated that processed food consumption had no association with weight status but was associated with the diet quality of elementary school children. This study also stated that the overall dietary quality, as well as nutritional status of the children, will improve by limiting highly processed foods in children's diets.<sup>26</sup> And it might be another reason there was no significant association between the consumption of UPF and BAZ among children since the diet quality factor was not assessed in this study.

In this study, UPF was defined as food processed in food industries with the addition of many ingredients, and most of these foods were ready to eat or take simple preparation before consumption. The researcher did not differentiate the UPF based on nutrient content, which most of the UPF generally contain obesogenic nutrients (high energy-dense, high atrium, fatty, and sugary). On the other hand, from the FFQ list, we found out that some UPFs were not obesogenic. Yogurt, oatmeal, UHT milk,

and white bread are an example of UPF in this study that do not contain the obesogenic nutrient. Those types of foods mostly contain beneficial nutrients such as vitamins, minerals, and fiber that became protective against higher BAZ and obesity.

Most of the respondents in this study came from the middle up socioeconomic status and it might influence the food choice among respondents and their families. Regarding the price, non-obesogenic UPF such as yogurt, oatmeal, and UHT milk tends to be more expensive than obesogenic UPF (sugary drinks, salty and fatty snacks). Thus, purchasing food that is considered non-obesogenic UPF is more frequent among respondents in this study.

This study had some limitations especially due to the COVID-19 pandemic. Direct offline data collection was not possible in the field, the researcher decided to analyze the existing data taken before the pandemic and social distancing to keep the data quality and minimize bias. The correlation between UPF and BAZ could not be detected due to this study didn't distinguish the type of obesogenic and non-obesogenic UPF.

## CONCLUSION

There was no association between BMI for age z-score and UPF consumption. After adjusting with other potential factors, physical activity level was significantly correlated with BAZ. Considering the relatively high prevalence of lack of physical activity among students, it is necessary to conduct socialization in terms of being inactive to all parties in school such as students, teachers, and headmasters. For maximizing the school facility to support students to be more physically active, the school also needs to make a policy of daily or weekly physical exercise in addition to sports subjects. It's also necessary to differentiate the obesogenic and non-obesogenic UPF

to define the clear association between UPF consumption and BAZ.

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#### CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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