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Relationship between ultra-processed food consumption with body fat percentage and blood pressure in adolescence

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ABSTRAK

Latar Belakang: *Makanan ultra proses mengandung kadar gula, lemak, dan garam yang tinggi sehingga mengkonsumsinya secara sering dapat meningkatkan lemak tubuh dan berat badan serta dapat menyebabkan hipertensi. Jenis makanan ini banyak dikonsumsi remaja.*
Tujuan: *Penelitian ini bertujuan untuk mengetahui hubungan antara konsumsi makanan ultra proses dengan persen lemak tubuh dan tekanan darah pada remaja di Surakarta.*
Metode: *Penelitian ini merupakan penelitian observasional analitik dengan pendekatan cross-sectional. Penelitian dilakukan di lima Sekolah Menengan Atas (SMA) di Surakarta, Indonesia, di lima kecamatan berbeda. Sebanyak 114 siswa diseleksi melalui proportionate random sampling. Data yang diambil pada penelitian ini adalah konsumsi makanan ultra proses, persen lemak tubuh, dan tekanan darah. Konsumsi makanan ultra proses diukur menggunakan Food Frequency Questionnaire (FFQ). Persen lemak tubuh diukur menggunakan Bio Impedance Analysis (BIA) Omron BF-375. Tekanan darah diukur menggunakan sphygmomanometer digital. Hubungan konsumsi makanan ultra proses dengan persen lemak tubuh dan hubungan konsumsi makanan ultra proses dengan tekanan darah dianalisis menggunakan Kendall's τb..*
Hasil: *Makanan ultra proses yang paling sering dikonsumsi oleh responden adalah kerupuk. Hasil penelitian menunjukkan bahwa sebagian besar responden mengkonsumsi makanan ultra proses pada kuartil ke-3 (50%). Secara statistik terdapat hubungan yang signifikan antara konsumsi makanan ultra proses dengan persen lemak tubuh (p-value 0,008). Nilai koefisien korelasi antar variabel dalam analisis tersebut diperoleh 0,216, artinya tingkat keeratan hubungan antar variabel sangat lemah dan memiliki arah hubungan yang positif. Sedangkan hasil analisis antara konsumsi makanan ultra proses dengan tekanan darah pada remaja tidak ditemukan adanya hubungan (p-value 0,135).*
Kesimpulan: *Terdapat hubungan antara konsumsi makanan ultra proses dengan persen lemak tubuh dan tidak terdapat hubungan antara konsumsi makanan ultra proses dengan tekanan darah pada remaja.*

KATA KUNCI*: lemak tubuh, makanan ultra proses, remaja, tekanan darah*

ABSTRACT

Background: *Ultra-processed foods (UPFs) are high in sugar, fat, and salt, so consuming them frequently can increase body fat and weight and may also lead to hypertension. This type of food is widely consumed by adolescents.*

Objectives: *The objective of this study was to examine the relationship between the consumption of UPFs, body fat percentage, and blood pressure among adolescents in Surakarta.*

Methods: *This study employed an analytical observational research design utilizing a cross-sectional approach. The research was conducted in five senior high schools located in five distinct subdistricts of Surakarta City, Indonesia. A total of 114 students were selected using proportionate random sampling. The data collected in this study included UPFs consumption, body fat percentage, and blood pressure. Data on the consumption of UPFs were gathered using the Food Frequency Questionnaire (FFQ). Bioelectrical Impedance Analysis (BIA) using the Omron HBF-375 device was employed to assess body fat percentage, while a digital sphygmomanometer was used to measure blood pressure. The relationships between the frequency of UPFs food consumption and blood pressure were analyzed using Kendall's τb.*

Results: *The UPF's food that respondents most often consume is crackers. The result showed that most respondents consumed UPFs in the third quartile (50%). Statistically, there was a significant relationship between consumption of UPFs and percent body fat (p-value 0.008). The correlation coefficient value between variables in this analysis was obtained at 0.216, which means that the level of correlation closeness between variables is very weak and has a positive correlation direction. Meanwhile, the results of the analysis between consumption of UPFs and blood pressure in adolescents found no correlation (p-value 0.135).*

Conclusions: *An association was found between the consumption of UPFs and body fat percentage in adolescents. However, no correlation was observed between the consumption of UPFs and blood pressure in this group.*

KEYWORD*: adolescence; blood pressure; body fat; ultra-processed food (UPF)*

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INTRODUCTION

Currently, changes are taking place in the global food system. The consumption of ultra-processed foods has increased in many parts of the world, both in variety and quantity (1). Researchers in São Paulo, Brazil, have developed the NOVA classification system (a name, not an acronym), which categorizes foods into four types (2). Ultra-processed foods (UPFs) can lead to food addiction because they contain high levels of sugar and refined carbohydrates, which can trigger increases in body fat and body weight (3). Ultra-processed foods (UPFs) are high in fat, sugar, and salt content, and are energy-dense, making them obesogenic. (4)(5). UPFs can cause food addiction because they contain high levels of sugar and refined carbohydrates, which can trigger an increase in body fat levels and body weight (6)(7)(8). The relationship between UPFs food consumption and body fat percentage remains inconsistent (9)(10)(11)(12). Several studies have proven that high consumption of UPFs contributes to increased body fat and obesity (9)(10)(11). However, other studies indicate that there was no association between the consumption of UPFs and body mass index or body fat percentage. Although the average BMI and body fat percentage in that study were classified as overweight, the percentage of UPFs consumption was lower than that of unprocessed food, minimally processed food, and culinary ingredients (12).

Consumption of UPFs is also associated with an increased risk of hypertension. However, the link between ultra-processed foods and hypertension is also unclear. (13)(14). A study conducted in China found that excessive intake of UPF meals increased the incidence of hypertension in Chinese adults, particularly

among younger groups (14). Meanwhile, research on Canadian and Lebanese people has found no association between UPF foods and systolic blood pressure and diastolic blood pressure (13).

High consumption of UPFs in the long term causes various health problems, including hypertension and obesity (15). This research was conducted in Surakarta City. Based on the previous study, adolescents in Surakarta still consume some types of food and drinks that are included in the UPFs (16)(17)(18). Apart from that, based on data from the Statistics of Surakarta Municipality in 2018, expenditure on prepared food and drinks for residents of the city of Surakarta was the highest compared to expenditure on other food categories, such as fruit, vegetables, eggs, meat, and fish. This suggests a possibility of high consumption of UPFs (19). Based on the 2018 Central Java Province Basic Health Research data, the city of Surakarta has the highest prevalence of obesity in the 16–18 years age group, namely 11.47%. This prevalence is far above the obesity prevalence in the province and the nation (20). Research regarding the consumption of UPFs in adolescents and its relationship with body fat percentage as an indicator of obesity in Indonesia is still difficult to find. Based on the aforementioned background, this research aims to investigate the relationship between the consumption of UPFs, body fat percentage, and blood pressure among adolescents in Surakarta.

MATERIALS AND METHODS

This research was an observational analytical study with a cross-sectional approach. The research was conducted at five senior high schools in Surakarta City, Indonesia, located in five different sub-districts based on multistage cluster sampling from January-February 2024. The number of samples in this study was 114 students which was calculated based on proportionate random sampling. Samples were chosen based on inclusion and exclusion criteria. This study's inclusion criteria were students aged 15 to 18, who were willing to participate in the research and were in good health. Meanwhile, the exclusion criteria in this study were students who were not present throughout data collection and were following a specific diet.

The data taken in this study were UPFs consumption, body fat percentage, blood pressure, nutritional status and physical activity. Ultra-processed food consumption data was measured using the Food Frequency Questionnaire (FFQ). The Food Frequency Questionnaire measures the UPF that respondents consumed during the last three months. Food items in the FFQ were obtained from a preliminary study on 30 students at each school by conducting 24-hour recall interviews and surveys in canteens and food stores around the school so that they could represent the food usually consumed by students. Each FFQ question was declared valid ($p<0.005$) and reliable (Cronbach's alpha=0.78). The total number of UPFs items that were declared valid was 52 foods. Frequency was scored from 1 to 7, then summed to obtain a total UPFs frequency score (21). The total score for UPFs consumption was classified based on the quartile data distribution.

Bio Impedance Analysis (BIA) Omron HBF-375was used to determine body fat percentage. The results were categorized into four groups: very high (>35% for male, >25% for female), high (20% - 25% for male, 30% - 35% for female), normal (10% - 20% for male, 20% - 30% for female), and low (<10% for male, and <20% for female) (22). The blood pressure was measured using a digital sphygmomanometer. The blood pressure was divided into three categorize: normal (<120/80 mmHg), pre-hypertension (120/<80 mmHg – 129/<80mmHg), hypertension stage 1 (130/80mmHg– 138/89 mmHg), hypertension stage 2 (≥140/90 mmHg) (23). Nutritional status data was obtained from the results of calculating body mass index according to age. The results were categorized into underweight (-3 SD - <-2SD), normal (-2 SD - +1 SD), overweight (>+1 SD - +2 SD), and obesity (>+2 SD) (24). Meanwhile, physical activity data was obtained from interviews using the PAQ-A questionnaire. The results were categorized into mild (1 – 2.3), moderate (2.4 – 3.7), and heavy (≥3.8) (25).

SPSS version 23 was used to conduct data analysis. The frequencies of respondents' traits were determined using univariate analysis. Bivariate analysis was used to examine the association between frequency of UPFs food consumption and body fat percentage, as well as

the relationship between frequency of UPFs consumption and blood pressure using Kendall's τb. This research has passed ethical due diligence based on the letter 03/UN27.06.11/KEP/EC/2024 issued by the Ethics Commission of Sebelas Maret University on 8th January 2024. Informed consent was signed by respondents and their parents. It was ensured that respondents participated voluntarily.

RESULTS AND DISCUSSIONS

Based on the result of data collection, the characteristics of the respondents can be seen in **Table 1**. below:

Table 1. Characteristics of Respondents

Characteristics	Cases (n=114)	
	(f)	(%)
Age (year)		
15	10	8.8
16	65	57
17	35	30.7
18	4	3.5
Sex		
Male	45	39.5
Female	69	60.5
Nutritional Status		
Underweight (-3 SD - <-2 SD)	3	26
Normal (-2 SD - +1 SD)	90	78.9
Overweight (>+1 SD - +2 SD)	15	13.2
Obesity (>+2 SD)	6	5.3
Body Fat Percentage		
Low (male <10%, female <20%)	39	34.2
Normal (male 10% – <20%, female 20% – <30%)	34	29.8
High (male 20% – 25%, female 30% – 35%)	23	20.2
Very high (male >25%, female >35%)	18	15.8
Blood Pressure		
Normal (<120/80 mmHg)	60	52.6
Increased blood pressure (120/<80 mmHg – 129/<80 mmHg)	30	26.3
Hypertension stage 1 (130/80 mmHg – 138/89 mmHg)	18	15.8
Hypertension stage 2 (≥140/90 mmHg)	6	5.3
Physical Activity		
Mild (1 – 2.3 point)	94	82.5
Moderate (2.4 – 3.7 point)	19	16.7
Heavy (≥3.8 point)	1	0.9
Ultra-processed Food Consumption		
1st quartile (score ≤127.75)	28	24.6
2nd quartile (score >127.75 –score ≤140)	28	24.6
3rd quartile (score >140 –score≤167)	57	50
4th quartile (score >167)	1	0.9

Source: Primary Data (2024)

Based on **Table 1** as many as 114 respondents found that the majority aged 16 years old (57%). The proportion of girls engaged in this study was larger than boys, at 60.5% and 39.5%, respectively. Most of the respondents were classified normal nutrition status (78.9%) based on their BAZ and based on body fat percentage were classified low (34.2%). Meanwhile, most respondents had normal blood pressure (52.6%). The participants in this study exhibited UPFs consumption in the 3rd quartile (50%) and had mild physical activity (82.5%).The type of UPFs most frequently consumed based on Figure 1 were crackers. It could happen because eating crackers is a common eating habit among Indonesians. Most of the students stated that they often consume crackers as a complement to their main meal or as a snack. Some of them also consume crackers in the form of 'seblak', a familiar spicy food among Indonesian adolescent.

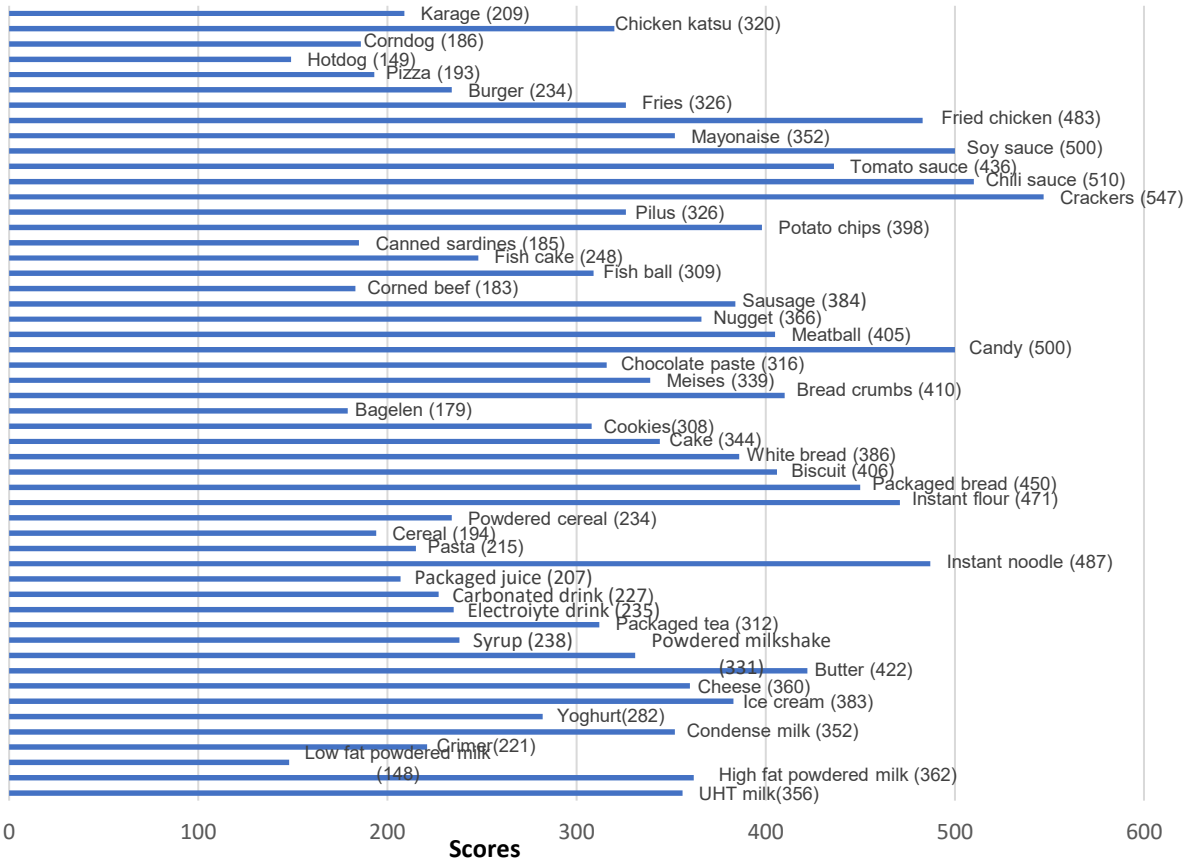

Figure 1. Frequency scores of ultra-processed foods consumption distribution

Three other foods that were also widely consumed were soy sauce, chili sauce, and candy. Based on **Table 2** above the relationship between UPFs consumption with body fat percentage shows a significant value (p-value 0.008), so statistically, there was a significant relationship between UPFs consumption and body fat percentage. The correlation coefficient value between variables in this analysis was obtained at 0.216, which means that the level of correlation closeness between variables is very weak and has a positive correlation direction.

Table 2. Bivariate analysis of the relationship between ultra-processed food consumption with body fat percentage

UPF consumption	Body Fat Percentage								Correlation coefficient	p-value
	Low		Normal		High		Very High			
	n	%	n	%	n	%	n	%		
1st quartile	11	28.2	11	32.4	6	26.1	0	0	0.216	0.008*
2nd quartile	11	28.2	11	32.4	4	17.4	2	11.1		
3rd quartile	17	43.6	11	32.4	13	56.5	16	88.9		
4th quartile	0	0	1	2.9	0	0	0	0		

Source: Primary Data (2024)
**) There is a significant relationship (p<0.05) based on Kendall's tau test*

These findings were consistent with previous research that found that UPFs was associated with increasing body fat in children (26). These findings were also in line with Taslim et al that found eating patterns with higher UPFs consumption promote the increase in body mass index, waist circumference, and fat mass (27). A systematic review proves that several published

studies show a positive relationship between the consumption of UPFs and increases in body fat during childhood and adolescence (28).

The risk of being overweight can be elevated by consuming UPFs, since they increase the overall intake of calories, carbohydrates, and fats, potentially leading to an inadequate ratio of nutrients involved in forming body fat accumulation (29). The more calories consumed, the more fat that the body does not require is stored as fat, elevating body fat mass (30). Monosodium Glutamate (MSG), an additive found in UPFs, could also be the reason. Consuming MSG can cause changes in leptin hormone signalling, thereby triggering overeating and resulting in obesity (31). Weak correlation between UPFs consumption with body fat percentage can be caused by other factors that influence body fat percentage. Based on **Table 1** it was known that the majority of respondents have mild physical activity. Insufficient activity can increase body fat (32). Another cause related to the comparison of the amounts of UPFs, unprocessed food, minimally processed food, and culinary ingredients needs to be investigated further.

Table 3. Bivariate analysis of the relationship between ultra-processed food consumption with blood pressure

UPF consumption	Blood Pressure								Correlation coefficient	p-value
	Normal		Increased blood pressure		Hypertension stage 1		Hypertension stage 2			
	f	%	f	%	f	%	f	%		
1st quartile	16	28.3	4	13.3	7	38.9	0	0	0.090	0.284
2nd quartile	17	26.7	8	26.7	3	16.7	1	16.7		
3rd quartile	26	60	18	60	8	44.4	5	83.3		
4th quartile	1	1.7	0	0	0	0	0	0		

Source: Primary Data (2024)

According to the data presented in **Table 3**. there is no statistically significant correlation between the consumption of UPFs and blood pressure (p-value 0.284). The negative association between UPFs with blood pressure in this study corroborates a previous study (33). This finding was in contrast to other studies which say that there was a relationship between consumption of UPFs and blood pressure. Cortes et al said that diastole blood pressure increased by 0.28 mmHg for every 100 g increase in UPF (p-value=0.01) (34).

Ultra-processed foods usually contain high levels of sodium. Although hypertension can be caused by high sodium intake, it cannot be obtained solely from UPF consumption (35) (36). The lack of a relationship between UPFs consumption and blood pressure in this study could be related to the young age of the participants, who have not consumed UPFs for enough time to lead to metabolic and/or cardiovascular abnormalities. Besides that, high blood pressure can be influenced by several other factors not examined in this study.

This study has several limitations. First, this study used an FFQ with a period of the last three months so it was limited to respondents' memories. The second limitation of this preliminary study was don't use SQ-FFQ to analyze UPFs food consumption, so it cannot be known how many calories are consumed from UPFs in the questionnaire's food list. Longitudinal studies are needed to know the effect of UPFs consumption on blood pressure in adolescents

CONCLUSIONS AND RECOMMENDATIONS

There was no significant difference in viscosity values between formulations A, B, C, and D. However, the combination with skim milk caused the product to be thicker than formulations without skim milk. All formulations met the standard physical characteristics of pudding as they included high viscosity. In addition, there was a significant difference in energy density between formulations A, B, C, and D. Formulations B and C have an energy density of 0.88 kcal/g and 0.83 kcal/g, so that formulations that meet the standards and can be recommended for hypoalbuminemia patients.

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