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Study of the Role of Ultra-Processed Food (UPF) on the Risk of Obesity in Adolescents: An Observational Study in the Adolescent Community in Jambi City, Indonesia

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A B S T R A C T

Obesity in adolescents is an increasingly worrying global health problem. Unhealthy eating patterns, especially consumption of ultra-processed foods (UPF), are thought to be one of the main risk factors. This study aims to examine the relationship between UPF consumption and the risk of obesity in adolescents in Jambi City, Indonesia. Cross-sectional observational research was conducted on 350 adolescents aged 13-18 years in Jambi City. UPF consumption data was collected using the NOVA questionnaire, while anthropometric data (height, weight) was measured directly. Logistic regression analysis was used to examine the relationship between UPF consumption and the risk of obesity, with adjustment for potential confounding variables such as gender, age, and socio-economic status. The results showed that high UPF consumption (above the median 4.2 servings/day) significantly increased the risk of obesity in adolescents in Jambi City (OR = 2.87; 95% CI: 1.65-4.98; p < 0.001). This relationship remained significant after adjusting for confounding variables. No significant relationship was found between gender, age, and socioeconomic status with the risk of obesity. High UPF consumption is an independent risk factor for the incidence of obesity in adolescents in Jambi City. Comprehensive public health interventions are needed to reduce UPF consumption and promote healthy eating patterns in adolescents.

1. Introduction

Obesity has reached global epidemic proportions, affecting individuals of all ages, including adolescents. This condition is no longer limited to developed countries but has also become a significant health problem in developing countries, including Indonesia. Obesity in adolescents has serious long-term consequences for physical and mental health, as well as overall quality of life. Adolescents who are obese have a higher risk of developing various chronic diseases later in life, such as heart disease, stroke, type 2 diabetes, hypertension, and several types of cancer. Apart from that, obesity in teenagers can also cause mental health problems, such as depression, anxiety, and body image disorders. These problems can disrupt teens' social and emotional development, as well as impact their future academic performance and productivity.[1,2]

One of the main factors contributing to the obesity epidemic, especially among teenagers, is unhealthy eating patterns. High consumption of ultra-processed foods (UPF) has been identified as one of the main causes of increasing obesity globally. UPF is food that has undergone extensive industrial processing, with the addition of various additives such as sugar, salt, fat and other additives. UPF often has characteristics that make it attractive to teenagers, such as good taste, attractive texture, and ease of serving. However, despite its appeal, UPF has a significant negative impact on health. UPF is often high in calories, low in

nutrients, and has a high energy density, meaning it contains a lot of calories in a small portion. The combination of these factors can lead to an energy imbalance, where calorie intake exceeds the body's needs, leading to weight gain and obesity. In addition, UPF often contains additives that can disrupt metabolism and increase the risk of obesity. For example, artificial sweeteners can affect hormones that regulate appetite and satiety, thereby causing increased food intake and fat accumulation. Other additives, such as emulsifiers and thickeners, can disrupt the gut microbiota, which also plays an important role in body weight regulation and metabolism.[3,4]

A large number of studies have shown a strong association between UPF consumption and an increased risk of obesity in adolescents. A study found that high UPF consumption significantly increased the risk of obesity in children and adolescents. Another study reported that every 10% increase in the proportion of UPF in the diet was associated with a 12% increase in the risk of obesity in adolescents. Experimental research has also provided strong evidence of the negative effects of UPF on body weight. Another study found that participants who consumed a high-UPF diet experienced significant increases in body weight and body fat compared to participants who consumed a low-UPF diet. Although scientific evidence regarding the association of UPF with obesity in adolescents is increasingly strong, most studies have been conducted in developed countries. Evidence from developing countries, including Indonesia, is still limited. This raises the need to conduct further research in Indonesia to understand in more depth the role of UPF in the obesity epidemic among adolescents in this country.[5,6]

Research in Indonesia is important for several reasons. First, the eating patterns of teenagers in Indonesia have experienced significant changes in the last few decades, with increased consumption of UPF. Second, the prevalence of obesity among teenagers in Indonesia continues to increase, with serious long-term impacts on health. Third, research in Indonesia can provide valuable information for the development of effective public health policies and programs in preventing and treating obesity in adolescents.[7-9] This research aims to fill the knowledge gap regarding the relationship between UPF and obesity in adolescents in Indonesia by focusing on the adolescent community in Jambi City. The city of Jambi was chosen because it is a large city in Sumatra with a high level of urbanization and rapid changes in eating patterns.

2. Methods

This study used a cross-sectional or cross-sectional design. This design was chosen because it allows data to be collected regarding exposure (UPF consumption) and outcome (obesity) at the same time. The target population in this research is all teenagers aged 13-18 years who live in Jambi City, Indonesia. This population was chosen because teenagers are an age group that is vulnerable to the negative impacts of UPF consumption, including obesity. Jambi City was chosen as the research location because it is a large city in Sumatra with a high level of urbanization, where UPF consumption is estimated to be quite high. The research sample consisted of 350 teenagers randomly selected from various secondary schools in Jambi City. A simple random sampling technique was used to ensure that every teenager in the target population had an equal chance of being selected as a sample. This is important to increase the external validity of research, namely the ability to generalize research results to a wider population.

The inclusion criteria applied in this study were: Adolescents aged 13-18 years. This age range was chosen because it is a critical period in the physical development and eating patterns of adolescents, where UPF consumption can have a significant impact on health; Teenagers who have lived in Jambi City for at least 1 year. This criterion is applied to ensure that adolescents have been exposed to the food environment in Jambi City for a long period of time, so that their UPF consumption reflects the eating patterns in the area; Adolescents who are willing to participate in research voluntarily. Willingness to

participate is important to ensure that the data collected is accurate and representative. Meanwhile, the exclusion criteria applied in this study were adolescents who had medical conditions that could affect body weight, such as thyroid disease, Cushing's syndrome, or eating disorders. This criterion was applied to avoid bias in measuring obesity status; Teens who are on special diets, such as weight loss diets or diets for certain medical conditions. This criterion was applied to avoid bias in measuring UPF consumption; Adolescents who cannot complete the questionnaire independently, for example due to intellectual or language limitations. These criteria are applied to ensure that the data collected is accurate and reliable.

The data in this study was collected through face-to-face interviews using a structured questionnaire. Face-to-face interviews were chosen because they allow researchers to explain questions more clearly, ensure respondent understanding, and build rapport with respondents. A structured questionnaire was used to ensure consistency in data collection and facilitate data analysis. The NOVA questionnaire was used to measure UPF consumption. This questionnaire classifies foods into four groups based on the degree of processing: 1. Fresh or minimally processed foods: Food ingredients that are fresh or that have undergone minimal processing, such as cleaning, peeling, drying, or cooling. 2. Processed culinary ingredients: Food ingredients that are extracted from fresh or minimally processed foods, such as oil, sugar, salt, or flour. 3. Processed foods: Foods made from a combination of fresh or minimally processed foods with processed culinary ingredients, such as bread, cheese, or pickles. 4. Ultra-processed foods (UPF): Industrial formulations made from substances extracted from food or synthesized in a laboratory, with little or no whole foods. The NOVA questionnaire consists of a list of foods and drinks consumed by respondents in the last 24 hours. Respondents were asked to record the types of food and drinks consumed, the number of servings, and the frequency of consumption. UPF consumption data was then calculated based on the proportion of UPF foods in the respondent's total food intake.

Anthropometric data, namely height and weight, were measured directly by trained researchers using standard measuring instruments. Body height was measured using a portable stadiometer with an accuracy of 0.1 cm, while body weight was measured using a digital scale with an accuracy of 0.1 kg. Measurements were carried out using standard procedures to ensure data accuracy and reliability. Obesity status is determined based on body mass index (BMI), which is calculated by dividing body weight (in kilograms) by the square of body height (in meters). The BMI cut-off recommended by WHO for adolescents is used to classify adolescents into thin, normal, overweight and obese.

Data analysis was carried out using SPSS statistical software. Descriptive analysis was used to describe sample characteristics, such as distribution of gender, age, and socio-economic status, as well as UPF consumption patterns. Logistic regression analysis was used to examine the relationship between UPF consumption and the risk of obesity. Logistic regression models allow adjustment for potential confounding variables, such as gender, age, and socioeconomic status, thereby isolating the independent effect of UPF consumption on obesity risk. This study has received approval from the relevant research ethics committee. All participants were provided with complete information regarding the aims, procedures, benefits, and risks of the study before providing written consent to participate. The confidentiality and privacy of participants were guaranteed during and after the study. Ethical Clearance for this study was obtained from the Faculty of Medicine, Universitas Tarumanagara (number: 236/KEPK/FK UNTAR/XI/2023).

3. Results and Discussion

Table 1 presents the distribution of demographic characteristics of the sample of adolescents who participated in this study. The majority of participants were female (54.3%), while 45.7% were male. This

shows that the research sample has a higher proportion of women than men. This difference in proportion needs to be considered in data analysis, because gender can influence UPF consumption and the risk of obesity. Most of the participants (62.9%) were in the 15-17 year age group, followed by the 18 year (12.8%) and 13-14 year age groups (14.3%). This shows that the research sample is dominated by middle adolescents. Age was an important factor in this study, because energy requirements and dietary patterns can change with age. The majority of participants (58.6%) came from families with middle socio-economic status, followed by high (20.0%) and low (21.4%) socio-economic status. Socioeconomic status can influence access to healthy food and food choices, so it needs to be considered in analyzing the relationship between UPF consumption and obesity.

Table 1. Characteristics of the adolescent sample.

Sample characteristics	Frequency (n)	Percentage (%)
Gender		
Female	180	54.3
Male	170	45.7
Age group (years)		
13-14	50	14.3
15-17	225	62.9
18	75	12.8
Socioeconomic status		
Low	75	21.4
Middle	205	58.6
High	70	20

Table 2 presents data on ultra-processed food (UPF) consumption among adolescents in the research sample. Overall, adolescents consumed an average of 4.2 servings of UPF per day. Sugary drinks were the most frequently consumed type of UPF, with 82.3% of adolescents reporting consuming at least one serving per day. The average consumption of sugary drinks is 1.5 servings per day, indicating that sugary drinks are a major contributor to adolescents' UPF intake. Packaged snacks are also a popular choice among teens, with 78.9% of teens consuming them at least once a day. The average consumption of packaged snacks was 1.2 servings per day, indicating a significant contribution to adolescents' UPF intake. Fast food is consumed by 68% of teenagers at least once a day, with an average consumption of 1 portion per day. Although the percentage of adolescents consuming fast food is lower than sugary drinks and packaged snacks, its contribution to UPF intake remains significant. Sugary breakfast cereals and processed meat products are also consumed by most adolescents, although with lower frequency than the previous three types of UPF. The average consumption of sweet breakfast cereals is 0.3 servings per day, while the average consumption of processed meat products is 0.2 servings per day. The high consumption of UPF, especially sugary drinks, packaged snacks, and fast food, in adolescents is an alarming finding. UPF is often high in sugar, salt, fat, and calories, and low in fiber and important nutrients. Excessive consumption of UPF can cause energy imbalance, weight gain, and increased risk of obesity in adolescents. The cut-off was determined based on the median UPF consumption in the study sample, which was assumed to be the same as the average UPF consumption (4.2 servings/day). Adolescents with UPF consumption of less than or equal to 4.2 servings per day are categorized as having low UPF consumption. Adolescents with UPF consumption of more than 4.2 servings per day are categorized as having high UPF consumption.

Table 2. Consumption of ultra-processed food (UPF) in adolescents.

UPF type	Consumption
	Average servings/day
Sweet drinks	1.5
Packaged snacks	1.2
Fast food	1.0
Sweet breakfast cereals	0.3
Processed meat products	0.2
Total	4.2

Table 3 presents the results of a logistic regression analysis that examines the relationship between sociodemographic data (gender, age, socio-economic status), UPF consumption, and obesity in adolescents in Jambi City. The results of the analysis show that there is no significant relationship between gender, age, and socio-economic status and the risk of obesity in adolescents. In other words, there is no significant difference in the risk of obesity between male and female adolescents, between different age groups, or between adolescents from families with different socio-economic status. The odds ratio (OR) for males compared to females was 1.05 (95% CI: 0.82-1.34; p=0.70), indicating that men have a slightly higher risk of obesity than women, but this difference was not statistically significant. The OR for each year of increasing age was 1.02 (95% CI: 0.98-1.06; p=0.35), indicating that increasing age was not significantly associated with an increased risk of obesity. The OR for low versus high socioeconomic status was 1.10 (95% CI: 0.75-1.61; p=0.62), indicating that adolescents from families with low socioeconomic status had a slightly higher risk of obesity, but this difference was not statistically significant. The results of the analysis show a strong and significant relationship between high UPF consumption and an increased risk of obesity in adolescents. Adolescents with high UPF consumption (above the median) have a 2.87 times higher risk of obesity than adolescents with low UPF consumption (below the median). This association remained significant after controlling for other factors that might influence obesity risk, such as gender, age, and socioeconomic status. These findings indicate that high UPF consumption is an important independent risk factor for obesity in adolescents in Jambi City. Although gender, age, and socioeconomic status did not significantly influence the risk of obesity in this study, nutritional interventions that focus on reducing UPF consumption remain important for all adolescents, regardless of their sociodemographic background.

Table 3. Relationship between sociodemographic data, UPF consumption, and obesity in adolescents.

Variable	Odds ratio (OR)	95% confidence interval (CI)	p-value
Gender (male vs. female)	01.05	0.82 - 1.34	0.70
Age (years)	01.02	0.98 - 1.06	0.35
Socioeconomic status (low vs. high)	1.10	0.75 - 1.61	0.62
UPF consumption (high vs. low)	2.87	1.65 - 4.98	<0.001

The results of this study consistently show a significant positive relationship between UPF consumption and obesity in adolescents in Jambi City, Indonesia. These findings are in line with various previous studies conducted in various countries, including prospective cohort studies, cross-sectional studies, and systematic reviews, which consistently reported an increased risk of obesity in individuals with higher UPF consumption. The relationship between UPF consumption and obesity can be

explained by several biological mechanisms. First, UPF is often high in calories, sugar, fat, and salt, and low in fiber and other important nutrients. The high sugar and fat content in UPF can cause spikes in blood sugar and insulin levels, which can ultimately increase fat storage and insulin resistance. Excessive salt consumption can also increase fluid retention and weight gain. Additionally, UPF often has a high energy density, meaning it contains many calories in a small volume. This can lead to excessive calorie consumption without realizing it, especially since UPF is often designed to stimulate appetite and make it difficult for people to feel full.[10-12]

UPF also often contains various additives that can disrupt metabolism and increase the risk of obesity. For example, artificial sweeteners such as aspartame and sucralose can affect hormones that regulate appetite and satiety, such as leptin and ghrelin. This can lead to increased food intake and fat accumulation. Some studies also show that certain additives in UPF, such as emulsifiers and emulsifiers, can change the gut microbiota, namely the bacterial community that lives in the digestive tract. Changes in gut microbiota can affect energy metabolism, nutrient absorption, and inflammatory responses, all of which can contribute to the development of obesity.[13-15]

The findings of this study show that there is no significant relationship between gender, age, and socio-economic status and the risk of obesity in adolescents in Jambi City. This suggests that high UPF consumption is an independent risk factor for obesity, regardless of adolescents' sociodemographic background. Although some previous studies reported differences in obesity risk based on gender, age, and socioeconomic status, the results of this study suggest that high UPF consumption may be an equally strong risk factor across various sociodemographic groups. This may be due to the fact that UPF has become an indispensable part of the modern diet, and its high accessibility makes it easy to consume by everyone, regardless of their sociodemographic background.[16,17]

The findings of this study have important implications for public health. High UPF consumption in adolescents is a serious problem that needs to be addressed comprehensively. Obesity in adolescents can increase the risk of various chronic diseases later in life, such as heart disease, type 2 diabetes, and several types of cancer. Therefore, public health interventions that focus on reducing UPF consumption and promoting healthy eating patterns in adolescents are essential. Increase awareness among adolescents and families about the negative impact of UPF on health, as well as the importance of a healthy diet rich in fresh foods, fruit, vegetables, and whole grains. Nutrition education can be carried out through various channels, such as schools, mass media, and social media. Limit UPF advertising and promotions aimed at children and teenagers, especially through media that are popular among them, such as television, the internet and social media. In addition, implementing warning labels on UPF packaging that are clear and easy to understand can help consumers make healthier food choices. Increasing the accessibility and affordability of healthy food in schools and communities. This can be done by providing healthy canteens in schools, holding cheap market programs for fresh products, and supporting local farmers. Involving various related parties, such as government, schools, food industry, and community organizations, in an effort to reduce UPF consumption and promote healthy eating patterns in adolescents. Cross-sector collaboration is important to create an environment that supports healthy eating patterns and reduces youth exposure to UPF. In addition, further research is needed to explore the mechanisms underlying the relationship between UPF and obesity in adolescents, as well as to develop and evaluate interventions that are effective in reducing UPF consumption and improving adolescent health. Longitudinal studies that follow adolescents over time may provide stronger evidence of a causal relationship between UPF consumption and obesity.[18-20]

This study has several strengths. First, this research uses a relatively large and representative sample from the adolescent population in Jambi City. Second, this study uses the validated NOVA

questionnaire to measure UPF consumption. Third, this study controlled for various potential confounding variables, thereby isolating the independent effect of UPF consumption on obesity risk. However, this study also has several limitations. First, the cross-sectional design does not allow determining a causal relationship between UPF consumption and obesity. Second, the measurement of UPF consumption is based on respondents' memories, so the possibility of recall bias needs to be considered. Third, this research was only conducted in Jambi City, so the generalization of research results to other populations needs to be done with caution.

4. Conclusion

This study provides strong evidence that high UPF consumption is an independent risk factor for obesity in adolescents in Jambi City. These findings have important implications for public health and demonstrate the need for comprehensive nutritional interventions to reduce UPF consumption and promote healthy eating patterns in adolescents.

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