

# The Relationship between Frequency of High-Sugar, Salt and Fat Food Consumption and the BMI in Adolescents

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## Abstract

**Purpose:** To identify and analyze preliminary data on the consumption habits of sugar, salt, and fat and their relationship to the Body Mass Index (BMI) in adolescents.

**Methodology:** Observational study with a cross-sectional approach to high school adolescents in Surakarta. The number of incidental respondents aged 15-18 years was 31 students. Data on the characteristics of research respondents were obtained through questionnaires and the frequency of high-sugar, salt, and fat food consumption used the FFQ. Statistical data analysis of sugar and fat consumption on BMI using Fisher Exact and salt consumption on BMI using Chi-Square showed a p-value <0.05.

**Results:** The descriptive analysis results indicated that 61.3% of adolescents often consumed high-sugar foods and drinks, bivariate statistical analysis results showed a p-value of 0.026 (<0.05), meaning that there was a relationship between the frequency of high-sugar food and drink consumption and BMI in adolescents. 38.7% of adolescents often consumed high-fat food and drinks, meaning that there was a relationship between the frequency of high-fat food and drinks consumption and BMI with a p-value of 0.026 (<0.05). 54.8% of adolescents often consumed high-salt foods. However, based on the results of statistical tests, there was no relationship between the frequency of salt consumption and BMI as shown by a p-value of 0.889 (>0.05).

**Applications/Originality/Value:** The differences in research respondents, period and results that provide empirical evidence as the basic for the research to be carried out on the frequency of high sugar, salt, fat food consumption and the BMI of High School adolescents.

**Keywords:** BMI in adolescents, frequency, salt, sugar, fat

## Introduction Section

The Individual Food Consumption Survey (SKMI) 2014 revealed that 29.7% of Indonesia's population or equivalent to 77 million people consumed sugar, salt and fat exceeding WHO recommendations: sugar (> 50 grams/day), salt (> 5 grams/day), and fat (> 67 grams/day) (Atmarita et al., 2016) Due to lifestyle changes, more than 340 million children and adolescents aged 5-19 were overweight or obese in 2016. 19% of boys and 18% of girls were overweight (World Health Organization, 2018). The selection of high-sugar foods includes simple sugars commonly used as added sugars widely found in a wide variety of sweetened foods and drinks. Simple sugars consist of monosaccharides (glucose, galactose and fructose) and disaccharides (sucrose, lactose and maltose) (R. J. Johnson et al., 2010). Excessive sugar consumption can slow brain function and leptin resistance. Long-term consumption of fructose increases calorie intake due to the loss of satiety signals in the brain resulting in overweight (Mirmiran et al., 2015). The study conducted by Rabaity & Sulchan in 2012 revealed that foods containing simple sugars were mostly consumed by adolescents, including candy, cakes, ice cream, all types of chocolate, all sweet foods and drinks (Rabaity & Sulchan 2012)..

In addition to sugar, salt consumption in the adolescents of 3.1 grams/day is close to the limit of salt consumption in a person which should not exceed 5 grams/day (SKMI, 2014), salt serves to maintain the body's

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chemical balance, regulate fluid volume and make cell membranes strong and flexible. Salt consumption can bind water so that it is absorbed into the intravascular causing blood volume to increase. High salt intake causes adipocyte hypertrophy due to lipogenic processes in white fat tissue, if it continues, it may cause the narrowing of blood vessels by fat (Kautsar et al., 2014). Excess intake of foods that contribute large calories such as fat is also closely related to being overweight. Unused calories will be stored in the body, resulting in a body mass index exceeding normal (Novela, 2019). Consumption of high-fat foods and drinks over a long period of time can trigger the risk of increasing body weight (Marie Beslayet et al., 2020).

Overnutrition is an unbalanced nutritional status indicating a BMI higher than normal due to excessive intake resulting in an energy imbalance between food consumption and energy expenditure which can cause health problems. Lifestyle changes affecting adolescent eating habits include easier access to food, an increase in energy-dense food products and low physical activity known as the nutrition transition(Fayasari et al., 2018). The prevalence of global excess nutrition (overweight and obesity) has experienced an increasing trend in the last 30 years. One age group at risk of experiencing excess nutrition is adolescents. Overnutrition in adolescents needs attention because if it occurs in adolescence, it will tend to continue into adulthood and old age. Meanwhile, excess nutrition is a risk factor for degenerative diseases in adulthood (Mohammadbeigi, 2018). Therefore, it is important to find out and analyze the relationship between the frequency of high-sugar, salt and fat foods and drinks consumption on the body mass index in high school adolescents.

## **Method**

### ***Research Design, Place and Time***

The design used in the preliminary study was an analytical observational study with a cross-sectional approach. The cross-sectional study collects exposure and outcomes simultaneously to describe the subject's characteristics and the relationship between variables. The preliminary study was conducted on high school adolescents in Surakarta.

### ***Total Subjects and Subject Collection Method***

The number of incidental respondents was 31 high school students. Data collection method used in this study was purposive sampling based on inclusion requirements, namely in good health, male and female aged 15-18 years and willing to participate as respondents. The researcher explained to respondents in advance that the preliminary study was to fulfill scientific needs and asked for approval using informed consent.

### ***Types and Data Collection Method***

The data in this study are primary data, data on respondent characteristics were collected through respondent characteristic forms including gender, age, weight, and height, then BMI/A in adolescents was categorized based on Z-Score. Anthropometric data on body weight was obtained by weighing using a digital step-on scale while height measurement was carried out directly using a microtoise. Data on the frequency of high-sugar, salt and fat food and beverage consumption was measured using a Food Frequency Questionnaire. After that, the data obtained were categorized according to the operational definition of the variables.

### ***Data Processing and Analysis***

Height and weight data were processed to obtain nutritional status data based on Body Mass Index (BMI). The data were then categorized based on Z-Score into underweight -3SD to <-2SD, normal -2SD to 1SD, overweight > 1SD to 2 SD and obese >2SD (Ministry of Health of the Republic of Indonesia, 2020). Data on the frequency of sugar-rich food and beverage consumption was categorized based on the operational definition of the variables into often 3-6x/week, rarely 1-2x/week and never. Univariate analysis was conducted to describe the respondents' characteristic variables, including the distribution of gender, age, Z-Score index (BMI/A), and frequency of rich-sugar, salt and fat food and beverage consumption. Bivariate analysis was conducted to determine the relationship between the frequency of rich-sugar, salt and fat food and beverage consumption

and BMI/A. In the bivariate analysis, Fisher Exact test was used to determine the relationship between sugar and fat consumption and BMI, while the Chi-Square test was used to determine the relationship between salt consumption and BMI at a significance level of  $p<0.05$ .

## Results

The results indicated that based on the characteristics of most respondents aged 15 years by 45.2%, 80.6% of adolescents were female. Based on the body mass index, 16.1% of adolescents were overweight with Z-Score values  $> +1SD$  to  $+2SD$ , on average, 48.4% of adolescents rarely exercise, and 58.1% of adolescents have the habit of playing with gadgets in the frequent category.

**Table 1.** Distribution of Respondent Characteristics

Variable	Total	Percentage
Age		
15	14	45.2%
16	12	38.7%
17	2	6.5%
18	3	9.7%
Gender		
Male	6	19.4%
Female	25	80.6%
BMI		
Underweight	2	6.5%
Normal	24	77.4%
Overweight	5	16.1%
Exercise Habits		
Often	16	51.6%
Rarely	15	48.4%
Habit of Playing Gadgets		
Often	13	41.9%
Rarely	18	58.1%

Table 2 shows that 61.3% of adolescents consume high-sugar foods and drinks such as honey, syrup, sugar, jam, jelly, chocolate, biscuits/cookies, wafers, sweet bread, traditional snacks, soft drinks, bottled drinks, powder drinks and sweetened condensed milk. 54.8% of adolescents often consume several types of cheese and foods containing cheese, sauce, soy sauce and also chips in packaged form. Meanwhile, the consumption of foods containing fat showed 38.7%. Adolescents often consume types of food and drinks such as powdered milk drink, packaged liquid milk, soy milk, butter, margarine, junk food and snacks processed by frying.

**Table 2.** Distribution of Frequency of Sugar, Salt and Fat Consumption

Variable	Total	Percentage
Sugar Consumption		
Rarely	12	38.7%
Often	19	61.3%
Salt Consumption		
Rarely	14	45.2%
Often	17	54.8%

Fat Consumption					
Rarely	19			61.3%	
Often	12			38.7%	

Based on the statistical test in Table 3, it shows p-value of 0.026 (<0.05), meaning that there is a relationship between the frequency of high-sugar foods and drinks consumption on the BMI in high school adolescents.

**Table 3.** Correlation Between Frequency of Sugar Intake and BMI

Sugar consumption frequency	BMI		Total	<i>P value</i>
	Normal	Abnormal		
	N	%	n	%
Rarely	12	100	0	0
Often	12	63.2	7	36.8
Total	24	77.4	7	22.6
			31	100

Based on the statistical test in Table 4, it shows p-value of 0.889 (> 0.05), meaning that there is no relationship between the frequency of high-salt foods consumption on the BMI in high school adolescents.

**Table 4.** Correlation Between Frequency of Salt Intake and BMI

Salt frequency	consumption	BMI		Total	<i>P value</i>
		Normal	Abnormal		
		N	%	n	%
Rarely		11	78.6	3	21.4
Often		13	76.5	4	23.5
Total		24	77.4	7	22.6
				31	100

Based on the statistical test in Table 5, it shows p-value of 0.026 (<0.05), meaning that there is a relationship between the frequency of high-fat foods and drinks consumption on the BMI in high school adolescents.

**Table 5.** Correlation Between Frequency of Fat Intake and BMI

Fat Consumption Frequency	BMI		Total	<i>P value</i>
	Normal	Abnormal		
	N	%	n	%
Rarely	12	63.2	7	36.8
Often	12	100	0	0
Total	24	77.4	7	22.6
			31	100

The table of the correlation between the frequency of high-sugar fat foods and drinks intake and body mass index (BMI) uses the Fisher Exact test because it does not meet the Chi-Square requirements, some cells are less than 5 (> 20%), while the table of correlation between the frequency of high-salt foods intake uses the Chi-Square test.

## **Discussion**

Adolescents are individuals who are in a transition period from childhood to adulthood. Several changes occur in adolescents, one of which is eating behavior, both leading to healthy eating behaviors and tending to lead to unhealthy eating behaviors. Such eating behaviors are often characterized by the intake of foods and soft drinks rich in sugar, salt and fat.

Intake of food and beverage is an important factor that can affect nutritional status. This is because the quantity and quality of food and beverage consumed can affect the health level of individuals and communities. The overview of disease patterns that are the main cause of death in Indonesia has shown an epidemiological transition followed by demographic and technological transitions, namely changes in disease patterns from infectious diseases to non-communicable diseases which then become the key factors causing morbidity and mortality. Behavioral patterns of food consumption containing excess sugar, salt and fat can lead to non-communicable diseases at a young age (Kusnali et al., 2019). Globally, the increase in intake of foods containing sugar continues to increase, both in adolescents and adults (Malik et al., 2013). The selection of types of food among adolescents contains high calories, fat, salt, sugar, but is low in fiber and vitamins, especially when it tends to taste savory or salty. Foods containing sugar often consumed by respondents, including simple sugars, can cause weight gain associated with the body mass index in adolescents exceeding the normal category. Simple sugars found in many foods and drinks are commonly consumed by most adolescents. One of the simple sugars commonly added to food and drinks is fructose. Fructose can thwart the production of leptin so that the amount of leptin becomes low resulting in obesity (Johnson et al., 2017). Apart from that, the consumption of sugar-containing beverages is associated with obesity because it does not cause a feeling of fullness, and are easily absorbed by the body so that the consumption of other foods increases (Ruyter et al., 2012).

The increasing production of packaged foods and the growing fast food restaurants have led to a transformation in dietary patterns. Currently, food availability is increasing along with the rapid development of supermarkets selling processed foods. Processed foods purchased by the community generally contain preservatives such as salt and sugar. Currently, salt intake is dominantly derived from salt added to processed foods by food producers than home-cooked meals. If the food served by the family is high in sodium or is an unbalanced diet, then a person will tend to follow the family diet, especially the parent's dietary intake. The Ministry of Health Regulation No. 30 of 2013 recommends consuming no more than 5 g of salt. However, some snack products have a salt content of more than the salt daily limit (Rembet et al., 2021). The results of this study indicated that the frequency of high-salt food consumption was not a risk factor for overweight and high body mass index in adolescents. However, excessive salt intake can also increase thirst and hunger. An increase in salt consumption of 1 g/day can also increase the consumption of sugar-sweetened beverage by 17 g/day resulting in changes in body composition and an increased risk of being overweight (Grimes et al., 2013). Salt serves to maintain the body's chemical balance, regulate fluid volume and make cell membranes strong and flexible. Salt consumption can bind water so that it is absorbed into the intravascular causing blood volume to increase. High salt intake causes hypertrophic adipocytes due to lipogenic processes in white fat tissue. If it continues, it may cause the narrowing of blood vessels by fat. Therefore, excessive salt intake can jeopardize the body's functions and has serious effects on health. Too much salt causes water retention in the body which may cause blood volume to increase (Kautsar et al., 2014).

The consumption of high-fat foods or junk food also increased among adolescents. Several factors affect high-fat food consumption, including access to food and the abundance of food availability for fast-growing school children (Tariq et al., 2020). This study is in accordance with the theory stating that excessive fat intake can lead to being overweight. Tasty fatty foods can increase appetite and promote excessive food consumption. Fat is also the largest energy reserve in the body. Body fat is generally stored in the tissue under the skin (subcutaneous) by 50%, around the organs in the abdominal cavity by 45%, and by 5% in intramuscular tissue. Fat is a stored source of essential nutrients. Fat functions as the most concentrated source of energy providing 9 kcal per gram (Abadi et al., 2022). The frequency of high-fat food consumption by the respondents had micronutrient content with low fiber and a high energy density. Excess fat intake was related to the body mass index of adolescents included in the overweight category. In the adolescent group, it was found overweight or obese adolescents or those with non-ideal weight. Obesity is characterized by an increase in adipose tissue mass

caused by incoming energy exceeding expended energy, resulting in accumulation in the form of fat. Accumulation in the form of fat will result in hypertrophy and hyperplasia of adipose tissue. Leptin is a hormone synthesized by adipose cells. Leptin functions to regulate or provide satiety signals in a person's body thereby reducing the amount of food intake, increasing energy expended through specific signals in the hypothalamus, and maintaining homeostatic body weight and increasing the use of energy expenditure. If a person is overweight or obese, it will affect the work or metabolic system related to the hypothalamus (Oswal & Yeo, 2010).

This study also found that adolescents with overweight body mass index were those who rarely exercised on average, and often played gadgets for more than 2 hours per day. The increase in BMI was affected by several factors, including technological advances causing adolescents lazy to carry out activities or physical activities, such as exercises and daily activities. Sedentary behavior is characterized by low energy expenditure by the body. Activities carried out in a lying or sitting position have become independent risk factors for overweight and metabolic syndrome health disorders (Hashem et al., 2019). The recommended duration of screen time is not to spend more than 2 hours on leisure activities every day (Wachira et al., 2018). WHO reports that the prevalence of obesity in adolescents comes from lifestyle changes (unhealthy food intake and physical activity patterns) causing an energy imbalance, more calorie intake and lower calorie expenditure (Hadianfard et al., 2021). A sedentary lifestyle results in the accumulation of fat in the body causing an imbalance in metabolism, and has an effect on changes in leptin and insulin sensitivity, namely satiety and appetite control, so that it is positively related to adiposity (Hopkins & Blundell, 2016). Sedentary behavior of adolescents is also one of the significant risk factors that cause adolescents to experience degenerative diseases, diabetes mellitus, obesity and daily disorders (difficulty in sleeping, dizziness and accelerated aging). A sedentary lifestyle and light physical activity lead to the accumulation of fat in the body which is not released as energy. If this condition lasts longer, it can cause accumulation in the abdominal area which can interfere with the body's metabolism (Putra, 2017). Abdominal fat accumulation occurs in the abdomen in excessive amounts, including subcutaneous fat tissue and abdominal visceral fat. Fat accumulation occurs because the subcutaneous fat tissue becomes dysfunctional to energy imbalances in the body due to increased nutritional intake and less physical activity. Energy balance related to energy intake and expenditure is affected by the central nervous system, especially the hypothalamus. Leptin, ghrelin and several other hormones associated with appetite, especially those working in the hypothalamus, the area in the brain as the center for regulating food intake and energy expenditure. Therefore, a lack of leptin signaling due to leptin deficiency or leptin resistance may cause excessive appetite which can lead to central obesity (Aprilia, 2021). Therefore, many state that the lack of physical activity and excessive food and beverage consumption is one of the causes of changes in body mass index associated with obesity and non-ideal weight.

## **Conclusion**

Based on the results of the preliminary study, it can be concluded that there was a relationship between the frequency of high-sugar and fat food and drink consumption and BMI. The frequently consumed types of food and drink included honey, syrup, sugar, jam, jelly, chocolate, biscuits/cookies, wafers, sweet bread, traditional snacks, soft drinks, bottled drinks, powdered drinks and sweetened condensed milk. High-fat food include milk powder, packaged milk, soy milk, butter, margarine, junk food and fried snacks. Meanwhile, the frequency of high-salt food consumption had no relationship with BMI in adolescents. Seeing the risks associated with high-sugar and fat food and drink consumption, adolescents are expected to pay more attention to their dietary patterns. Obesity monitoring and prevention can be carried out by monitoring body weight during the School Health Unit (UKS) programs. The limitation of this preliminary study is the minimum number of respondents so it is necessary to conduct further research to obtain more accurate results.

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