



The Relationship Between Consumption of Sweet Foods and Beverages and Physical Fitness Levels Among Adolescents

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Abstract

Adolescence is a critical transitional phase marked by significant physical development and changing dietary habits, including an increased preference for sugar-sweetened products. Excessive sugar consumption is theoretically linked to metabolic disturbances and muscle fatigue, which may negatively impact physical fitness. This study aims to investigate the relationship between sugar-sweetened intake and physical fitness levels among adolescents at Batik 1 Surakarta Senior High School. An observational study with a cross-sectional approach was conducted involving 91 adolescent students at Batik 1 Surakarta Senior High School, selected through simple random sampling. Sugar-sweetened intake, encompassing both foods and beverages, was assessed using a FFQ covering the past month. Physical fitness levels were measured using the Harvard Step Test to calculate the Physical Fitness Index (PFI). Data were analyzed using the Chi-Square test to identify significant correlations between variables, with a significance threshold of $p < 0.05$. The Chi-Square test results showed a p -value = 0,080 with an Odds Ratio (OR) of 2,375 (CI = 0,889-6,344), indicating no statistically significant relationship between the consumption of sweet foods and beverages and physical fitness levels among adolescents at Batik 1 Surakarta Senior High School. However, frequency distribution data revealed an interesting trend; the group of adolescents with infrequent sugar-sweetened intake had a higher proportion of those in the "fit" category (33,3%) compared to the high-intake group (17,4%). This suggests a tendency for decreased physical fitness among individuals who more frequently consume sugar-sweetened products. This study concludes that there is no significant direct relationship between the consumption of sweet foods and beverages and physical fitness levels among adolescents. This suggests the need for further investigation into other contributing factors in future research to better understand the multifactorial complexity of physical fitness.

How to Cite

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INTRODUCTION

Adolescence is a transitional period from childhood to adulthood characterized by significant physical, psychological, and social changes. This period is one of the most critical phases in human development because health and well-being at this age influence health trajectories with lifelong consequences. Nutritional vulnerability increases during adolescence due to heightened nutritional requirements; however, the dietary quality consumed by this age group often declines significantly (Februhartanty et al., 2019; Heslin & McNulty, 2023; Singh et al., 2019).

According to the Indonesian Health Survey (SKI) 2023, the prevalence of nutritional status among adolescents (16-18 years old) in Central Java Province showed that 9.8% were underweight, while 11.6% were categorized as overweight and obese (Kemenkes, 2023). The results of a preliminary study, which measured the nutritional status of 25 students at Batik 1 Surakarta Senior High School, showed that 28% of the respondents experienced overnutrition and 16% experienced undernutrition.

Physical fitness is defined as the body's capacity to perform daily tasks effectively and efficiently over a relatively long period without experiencing excessive fatigue (Depkes, 2005). Physical fitness is influenced by several factors, one of which is dietary habits (Prayoga & Susanto, 2020). An imbalanced diet, whether due to nutritional deficiencies or excessive intake of energy and nutrients, has the potential to disrupt metabolic functions, which ultimately leads to a weakened immune system, impaired physical performance, and an increased risk of fatigue (Kiani et al., 2022; Litaay et al., 2021).

Adolescents tend to follow the trend of consuming fast foods, such as sugar-sweetened foods and beverages. The trend of modern, high-sugar food and drinks encourages the increased consumption of sweetened products, further supported by the ease of online purchasing access (Asriati, 2023). Routine consumption of sugar-sweetened foods and beverages can lead to obesity (Pratama, 2023). Obesity is characterized by a high Body Mass Index (BMI). A higher BMI value is associated with elevated blood glucose levels, which increases the risk of insulin resistance. Consequently, glucose is not properly absorbed, leading to energy deficiency in the body, which can trigger fatigue or physical exhaustion (Harahap et al., 2020).

According to study by Zhang et al (2023),

there is a negative correlation between the consumption of sugar-sweetened beverages and muscle strength. Adolescents who excessively consume these beverages exhibit lower levels of muscle strength, indicating that sugar-sweetened beverage intake is associated with a decline in adolescent muscle power. This reduction in muscle mass and function can lead to faster muscle fatigue and indirectly result in decreased physical fitness levels. One underlying cause is that high intake of sweetened beverages can trigger obesity, which subsequently impacts the decline of leg muscle strength, particularly in the standing long jump test.

Other studies have also proven that high consumption of sugar-sweetened beverages increases sugar levels in the body, which subsequently triggers cellular autophagy and telomere shortening in humans. This process accelerates cellular aging and death, thereby reducing muscle mass (Leung et al., 2014). Furthermore, the consumption of sugar-sweetened beverages can increase the risk of undernutrition by displacing the intake of nutrient-dense foods, thereby reducing the intake of energy, protein, and micronutrients (Guo et al., 2024).

The results of a preliminary study conducted on 20 students at Batik 1 Surakarta Senior High School indicated diverse physical fitness levels among the respondents: 10% were in the 'fair' category, 40% were in the 'good' category (predominantly males), and the remaining 50% were in the 'poor' category. These findings show that the highest prevalence was found in the poor physical fitness category. Interviews with the students revealed frequent sugar-sweetened intake, driven by factors such as peer influence and the widespread availability of sweetened products within and outside the school environment. Furthermore, the novelty of this study lies in the scarcity of research analyzing the simultaneous consumption of sweet foods and beverages in relation to physical fitness levels among adolescents. Based on these field phenomena, the researcher is interested in further investigating this issue through a study titled 'The Relationship between consumption of sweet foods and beverages and Physical Fitness Levels among Adolescents at Batik 1 Surakarta Senior High School. The purpose of this research is to determine the relationship between the consumption of sweet foods and beverages and physical fitness levels among adolescents at Batik 1 Surakarta Senior High School.

METHOD

The study employed an observational method with a cross-sectional approach. A cross-sectional study investigates the relationship between independent and dependent variables by conducting measurements simultaneously. This study aims to identify the relationship between the consumption of sweet foods and beverages and physical fitness levels among adolescents at Batik 1 Surakarta Senior High School.

The study was conducted at Batik 1 Surakarta Senior High School, involving 91 adolescent respondents aged 15-18 years selected through a simple random sampling technique. Inclusion criteria consisted of students who were willing to participate and were not athletes. Meanwhile, the exclusion criteria included students who transferred schools, provided incomplete questionnaires, withdrew during the study, or had specific medical conditions such as lower extremity joint problems, obesity ($>+2$ SD), diabetes mellitus, and pulmonary diseases.

Primary data were collected using three main instruments: a Food Frequency Questionnaire (FFQ) to assess sugar-sweetened foods and beverages over the past month, with results categorized as 'infrequent' $<$ median and 'frequent' $\geq$ median; a 33-cm high bench for the Harvard Step Up Test, with a maximum duration of 5 minutes or until exhaustion; and a metronome set at 120 bpm. These tools were utilized to evaluate physical fitness levels through the Physical Fitness Index (PFI) calculation. After finishing the 5-minute Harvard Step Test or reaching exhaustion, subjects rested in a comfortable chair. Recovery heart rates were then recorded at three intervals: 1–1.5 minutes, 2–2.5 minutes, and 3–3.5 minutes during the seated recovery phase (Kim et al., 2022). In addition, anthropometric data were collected to evaluate the nutritional status of the participants. The Physical Fitness Index (PFI) was then determined based on the standard formula established by Brouha (1943) as cited in Yadav et al (2020).

$$\text{PFI} = (\text{Stepping duration in seconds} \times 100) / (2 \times (\text{Pulse Rate } 1+2+3))$$

Physical fitness level was categorized based on the Physical Fitness Index (PFI) score. Participants were classified as fit if the total score was ≥ 65 , and as less fit if the total score was < 65 .

The relationship between the independent and dependent variables was identified through bivariate analysis. In this study, the independent

variable was consumption of sugar-sweetened foods and beverages, while the dependent variable was physical fitness. Data were initially tabulated and organized using Microsoft Excel before being analyzed. As both variables used an ordinal scale, the statistical analysis technique employed was the Chi-Square test, performed using SPSS software with a significance level of $p\text{-value} < 0.05$. The frequency distribution of study variables and participant characteristics was further detailed through univariate analysis, presented in percentage form.

RESULTS AND DISCUSSION

The respondents involved in this study were students of Batik 1 Surakarta Senior High School, totaling 91 individuals who met the inclusion and exclusion criteria.

Table 1. Research Respondents Characteristics

Respondents Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	34	37,4
Female	57	62,6
Total	91	100,0
Age		
16 years old	31	34,1
17 years old	57	62,6
18 years old	3	3,3
Total	91	100,0
Nutritional Status		
Undernutrition	5	5,5
Good	75	82,4
Overnutrition	11	12,1
Total	91	100,0

Based on **Table 1**, the frequency distribution of respondent characteristics indicates that out of 91 respondents, the majority are female (62,6%), while the remaining 37,4% are male. Females tend to have a higher intake of sugar-sweetened intake compared to males and often exhibit poor dietary patterns, such as replacing main meals with snacks, skipping meals more frequently, consuming more food during the day, and being at a higher risk of uncontrolled eating (Lombardo et al., 2020). In general, the physical fitness levels of male students were found to be higher than those of female students (Maulana et al., 2024). This is consistent with the findings of Busing & West (2016), who stated that there are significant gender differences in nearly all physical fitness parameters, with the exception of par-

tial curl-ups.

Based on age, it can be interpreted that the majority of respondents are 17-year-old adolescents (62,6%). Adolescents exhibit significant vulnerability in determining dietary patterns as they are in a transitional phase toward adulthood. Greater autonomy in food selection without supervision, combined with aggressive marketing strategies and product affordability, may increase the risk of high sugar intake, particularly due to peer influence. This phenomenon is exacerbated by the low attention adolescents pay to nutritional labels and halal certification on packaging, leading to the frequent neglect of health and food safety aspects for the sake of product accessibility (Arumsari et al., 2022).

Based on nutritional status, the results show that the majority of respondents fall into the good nutritional status category (82,4%). Meanwhile, a small proportion are categorized as overnutrition (12,1%) and undernutrition (5,5%). A good nutritional status is reflected in a balanced, nutrient rich diet, which plays a vital role in supporting physical fitness by providing sufficient energy for activities, enhancing immune function, and optimizing post-exercise recovery. However, a good nutritional status will not improve fitness levels if it is not balanced with regular physical activity (Setiawan et al., 2022). According to (Hukubun & Souisa, 2019), a better nutritional status leads to a higher level of physical fitness. Good and regular nutrition exerts a positive influence on physical fitness conditions. In other words, nutritional status significantly influences an individual's level of physical fitness.

Sweet foods and beverages are products characterized by high levels of added sugars, such as glucose and fructose. Excessive fructose consumption can contribute to the development of leptin resistance, a condition where the body does not respond optimally to the hormone leptin. Consequently, satiety signaling becomes disrupted, leading to an increased appetite. This condition can trigger an energy imbalance that, in the long term, poses a risk of causing overnutrition (Fatmawati, 2019; Ferinawati & Mayanti, 2018; Habsidiani & Ruhana, 2023). The frequency distribution of sweet foods and beverages consumption is presented in the following **Table 2**.

Table 2. Frequency Distribution of Sweet Foods and Beverages Consumption

Category	Frequency (n)	Percentage (%)
Infrequent (<696)	45	49,5
Frequent (≥695)	46	50,5

Total	91	100,0
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The frequency of sweet food and beverage consumption presented in **Table 2**, was categorized as infrequent if the total final score was < 695 and as frequent if the total final score was ≥ 695. Based on the analysis of consumption frequency data over the past month, 50,5% of respondents were classified in the frequent category, while 49,5% were in the infrequent category. This distribution indicates a very small difference in proportion between the two groups, amounting to only 1%.

The results indicate that the proportions of respondents with frequent and infrequent consumption of sweet foods and beverages were relatively balanced, with only a very small difference. This condition suggests that sweet consumption behavior among the respondents was fairly evenly distributed and not concentrated in a particular category. The relatively high proportion of sweet consumption may be influenced by various factors, including knowledge, school and home environments, peer influence, as well as exposure to media or advertising, as adolescents are highly influenced by their social circles, both directly and through media (Zaliyanti & Mardhiati, 2025).

Maintaining health is essential because good health conditions are reflected in optimal physical fitness levels. Physical fitness plays an important role in influencing an individual's ability to perform daily activities (Sinuraya & Barus, 2020).

Table 3. Frequency Distribution of Physical Fitness Levels

Category	Frequency (n)	Percentage (%)
Fit (≥65)	23	25,3
Less Fit (<65)	68	74,7
Total	91	100,0

Based on the data in **Table 3**, regarding the distribution of physical fitness categories, most respondents were classified as having less physical fitness (74,7%), while the remaining 25,3% were categorized as fit. The proportion of respondents with less fitness is relatively high and may be influenced by various factors. This is consistent with research by Ramadhani & Budi-ono (2025), which states that adolescent physical fitness is influenced by several factors, such as sex, body mass index, body fat percentage, physical activity, screen time, sedentary behavior, and smoking habits.

Based on **Table 4**, the Chi-Square analysis results show a p-value = 0,080 with an OR

of 2,375 (CI = 0,889-6,344), meaning that H0 is accepted. Thus, it can be concluded that there is no significant relationship between consumption of sweet foods and beverages and the physical fitness levels among adolescents at Batik 1 Surakarta Senior High School. In the group with infrequent consumption of sweet foods and beverages, a higher proportion of respondents was classified as fit (33,3%) compared to the group with frequent consumption (17,4%). Conversely, most respondents in the frequent consumption group were categorized as having less physical fitness (82,6%). This suggests a tendency toward lower physical fitness levels among individuals who more frequently consume sweet foods and beverages.

Table 4. Relationship Between Consumption of Sweet Foods and Beverages and Physical Fitness Levels Among Adolescents at Batik 1 Surakarta Senior High School

Consumption of sweet foods and beverages	Physical Fitness Levels						p-value	OR	CI
	Fit		Less Fit		Total				
	n	%	n	%	n	%			
Infrequent (<695)	15	33,3	30	66,7	45	100	0,080	2,375	0,889-6,344

The findings of this study are supported by Estrada-Reyes et al., (2018), which examined the relationship between dietary patterns and physical fitness levels among adolescents in Mexico. The study reported that dietary patterns, including high-sugar intake, were not significantly associated with physical fitness levels in adolescents, with a p-value of 0,83. Furthermore, this is reinforced by Danenra et al. (2025), who examined the correlation between blood glucose levels and physical capacity in adolescents using the Harvard Step Test. Their results showed that while students' blood glucose levels ranged from normoglycemia to prediabetes, the Spearman correlation test indicated a weak and non-significant relationship between blood glucose and physical capacity ($r = 0,045$; $p = 0,759$). That study concluded that blood glucose levels have no significant relationship with physical capacity, suggesting that other factors such as muscle mass, daily physical activity, and body composition may play a more substantial role. These comparisons strengthen the current study's finding that there is no significant relationship between sweet food and beverages (which contributes to blood glucose levels) and physical fitness levels among adolescents at Batik 1 Surakarta Senior High School.

The results of this study differ from the research conducted by Fan et al. (2024), which

found a significant relationship between sugar-sweetened beverage consumption and physical fitness indices among adolescents in China. That study, involving 8,136 adolescents, demonstrated that the group consuming sweetened beverages ≥ 5 times per week had the highest risk of lower fitness indices (OR = 1,47; 95% CI: 1,29-1,68; $p < 0,001$). These findings emphasize that physical fitness is multifactorial, as it is influenced not only by the consumption of sweet foods or beverages but also by other factors. The discrepancy in results is likely due to the significant difference in sample scale and the lack of analysis of confounding variables that may also affect physical fitness.

Based on research by Ramadhani & Budiono (2025), several other factors can influence physical fitness, including: 1) Sex, which relates to differences in body structure, as males generally have greater muscle mass while females tend to have higher body fat (adiposity); 2) High Body Mass Index (BMI) and body fat percentage, which are linked to an increased workload on the heart and lungs, thereby reducing cardiovascular efficiency and accelerating fatigue during activity; 3) Physical activity, which improves heart function by strengthening the heart muscle and increasing its capacity to pump blood more efficiently; 4) Sedentary behavior and increased screen time, which can reduce physical activity and lead to obesity. Individuals with obesity tend to have a higher desire to consume sweetened beverages, further worsening obesity and decreasing physical fitness; and 5) Smoking habits, which can slow physical recovery because the carbon monoxide in cigarettes reduces the oxygen supply to the muscles and body tissues (Firdaus et al., 2021; Gavin & Bessesen, 2020; Rousham et al., 2022).

In addition, according to research by Hardiansyah et al. (2023), hemoglobin levels are also a factor that influences physical fitness. An individual with normal hemoglobin levels can effectively transport oxygen to body tissues to produce energy, thereby increasing physical fitness and optimizing physical activity. The level of an individual's VO_{2max} endurance is highly dependent on the body's ability to intake oxygen, as hemoglobin serves as an oxygen transport mechanism. Higher hemoglobin levels lead to a better respiratory system, as the availability of oxygen delivered and stored in muscles through the bloodstream increases. Conversely, low hemoglobin levels can impair oxygen circulation in the blood. This prevents various parts of the body from receiving optimal oxygen, resulting

in reduced energy production, rapid fatigue, and decreased physical fitness (Wahyudin, 2016).

This study has several limitations. First, the scope of respondents is still limited as the research subjects do not cover all adolescents at Batik 1 Surakarta Senior High School. This resulted in a relatively small sample size, which may affect the generalizability of the findings. Second, the measurement of sweet foods and beverages consumption was based only on data from the past month, which may not fully reflect long-term dietary patterns or the respondents actual consumption behavior. These limitations should be considered for future research to involve a larger sample and use a longer measurement period to obtain a more comprehensive overview.

CONCLUSION

This study concludes that there was no significant relationship between the consumption of sweet foods and beverages and physical fitness levels among adolescents at Batik 1 Surakarta Senior High School, as indicated by a p-value of 0,080. Nevertheless, the data distribution showed that the majority of respondents with a high frequency of sweet food and beverage consumption tended to fall into the less fit category. These findings indicate a tendency toward decreased physical fitness levels among adolescents who more frequently consume sweet foods and beverages. Therefore, future studies are recommended to involve a broader sample scope and consider other factors that may influence physical fitness in order to obtain more comprehensive results.

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