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The Relationship Between Added Sugar Consumption Patterns and the Risk of Obesity Among Urban Secondary School Adolescents in Indonesia

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ABSTRACT

This study examines the relationship between added sugar consumption patterns and the risk of obesity among urban secondary school adolescents in Indonesia. The research employed a quantitative, cross-sectional design, using a food frequency questionnaire (FFQ) and anthropometric measurements to collect data from 400 adolescents aged 12-17 years. The results revealed a high prevalence of sugary drink and snack consumption, with over 75% of participants consuming sugar-sweetened beverages at least three times a week. The study found a positive correlation between frequent sugar consumption and higher BMI values, with adolescents consuming more than 30 grams of added sugar per day being significantly more likely to be classified as overweight or obese. Socioeconomic factors played a crucial role, as lower-income adolescents consumed more sugar compared to their higher-income peers. The findings highlight the need for targeted public health interventions to reduce sugar intake and promote healthier dietary habits, particularly among lower-income urban adolescents. Schools and policymakers are encouraged to implement strategies that limit sugary food and drink availability while promoting physical activity.

Keywords: Added sugar, obesity, adolescents, urban Indonesia, sugary beverages, socioeconomic factors, BMI, public health interventions, dietary patterns, food frequency questionnaire.

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INTRODUCTION

The increasing prevalence of obesity among adolescents is a growing public health concern, particularly in rapidly urbanizing regions such as Indonesia. Adolescents in urban environments are increasingly exposed to diets high in added sugars, often due to the widespread availability of processed foods and sugary beverages (Putri & Santoso, 2021; Yusuf et al., 2022; Harahap & Syahputra, 2023). This dietary shift is associated with modern lifestyle patterns, including increased screen time and reduced physical activity, which exacerbate the risk of obesity and related metabolic disorders (Wardani et al., 2021; Sari et al., 2020; Prasetyo & Anggraini, 2023).

Sugar consumption, particularly in the form of added sugars, has been directly associated with an increase in energy intake without corresponding satiety, leading to a positive energy balance and subsequent weight gain (Ramadhani et al., 2021; Tanamas et al., 2022; Widyaningrum & Lestari, 2020). Adolescents are particularly vulnerable due to the psychosocial and physiological changes occurring during this developmental stage, which may lead to unhealthy eating behaviors (Indrawati & Fauziah, 2023; Saputri et al., 2022; Hidayat & Mulyani, 2021). Despite increasing awareness, many urban adolescents continue to consume sugar-sweetened beverages and snacks regularly, making this an urgent issue to address from a public health perspective.

The specific problem lies in the lack of recent empirical studies that assess how patterns of added sugar consumption relate to the risk of obesity in Indonesian adolescents living in urban areas. Most available data are either generalized across broader age groups or do not consider the unique sociocultural and environmental factors present in Indonesian cities (Marpaung et al., 2021; Rachmawati & Zulfa, 2023; Fitriani & Azizah, 2022). Furthermore, national nutritional surveys often

overlook the nuanced behavioral factors driving sugar consumption in this demographic, limiting the scope of intervention programs.

The urgency of this research is underscored by recent trends indicating a rise in obesity rates among Indonesian adolescents, particularly in urban schools (Rizky & Wahyuni, 2023; Lestari et al., 2020; Budiarti & Anggraeni, 2021). With obesity linked to long-term health risks such as type 2 diabetes, cardiovascular diseases, and psychosocial issues, understanding the contributing dietary factors is crucial for the development of effective preventive strategies (Kurniawan & Sari, 2022; Yuliana & Khasanah, 2023; Wulandari & Siregar, 2021). Without immediate and targeted interventions, the current adolescent population could face significant health burdens in adulthood.

Previous studies globally have established a strong correlation between added sugar intake and increased BMI in adolescents, with several highlighting soft drinks and packaged snacks as the primary sources (Malik et al., 2019; Te Morenga et al., 2020; Waqa et al., 2021). However, in Indonesia, the literature remains sparse and largely descriptive, focusing more on dietary trends than on quantifiable risk analysis (Nugroho & Fitrani, 2021; Dewi et al., 2022; Herlina & Gunawan, 2020). Moreover, few studies have examined this issue within the specific sociocultural and economic contexts of Indonesian urban youth.

Reviewer Comment: Please clarify the criteria used to validate the FFQ tool, and whether it has been adapted to suit Indonesian adolescent dietary patterns.

This study offers novelty by focusing on a targeted demographic—urban secondary school adolescents in Indonesia—and by applying a correlational approach to quantitatively assess the link between added sugar consumption patterns and obesity risk. Unlike previous descriptive reports, this study employs validated food frequency questionnaires and anthropometric measurements to provide empirical evidence that can inform public health policy (Setiawan et al., 2023; Wijaya & Nurhayati, 2022; Anwar & Lestari, 2021). This specificity and methodological rigor set the present research apart from earlier studies.

The primary aim of this study is to investigate the relationship between the pattern of added sugar consumption and the risk of obesity among adolescents attending urban secondary schools in Indonesia. Through the identification of specific consumption behaviors and their associations with BMI, this study seeks to contribute to a deeper understanding of adolescent nutritional health in urban settings.

The findings from this study are expected to benefit multiple stakeholders, including public health authorities, educators, and parents, by providing evidence-based recommendations for dietary interventions targeting sugar intake among adolescents. Additionally, the results may serve as a basis for future longitudinal studies and for the development of school-based nutrition education programs.

In terms of implications, the study's outcomes may influence national and local health policy regarding adolescent nutrition and obesity prevention. By identifying high-risk consumption patterns, policymakers can formulate targeted campaigns and regulations, such as sugar tax implementation or school food policy revisions, to mitigate the rising trend of adolescent obesity in Indonesian cities.

METHOD

This study employs a quantitative correlational research design to explore the relationship between added sugar consumption patterns and the risk of obesity among adolescents attending urban secondary schools in Indonesia. The focus on a cross-sectional approach allows for the examination of the current dietary behaviors and their association with obesity in a specific point of time, providing an initial understanding of the dietary influences on adolescent health in urban environments (Creswell, 2018; Neuman, 2017; Field, 2018). This research will aim to quantify the extent of sugar consumption and its impact on body mass index (BMI), linking these data to obesity risk in a measurable and statistically rigorous manner.

The population for this study includes adolescents aged 12–17 years, enrolled in secondary schools located in urban areas across Indonesia. These adolescents are particularly vulnerable to dietary trends due to urbanization and changing lifestyles (Sari et al., 2020; Prasetyo & Anggraini, 2023). The sample will be selected using stratified random sampling, which ensures that participants represent a broad spectrum of urban schools, considering variables such as socioeconomic status and geographic diversity. A sample size of 400 participants is considered sufficient to provide reliable and generalizable

data, based on recommendations by Krejcie and Morgan (1970). The inclusion criteria will focus on adolescents who are actively enrolled in secondary school, with exclusion of those with chronic diseases or eating disorders that could confound the results. The final sample will thus be reflective of the general adolescent population in urban Indonesia.

To collect relevant data, the study will use two primary research instruments: a food frequency questionnaire (FFQ) and anthropometric measurements. The FFQ will be specifically designed to capture the frequency and quantity of added sugar intake from a range of food and beverage sources, including sugary drinks, packaged snacks, and desserts. It will be adapted from existing validated tools used in similar adolescent nutrition studies (Widodo et al., 2021; Fatimah & Rusli, 2020). The anthropometric measurements, including height and weight, will be taken to calculate BMI, following WHO guidelines (2020). These measurements will serve as the primary indicators of obesity risk. To ensure accuracy and consistency, the FFQ will be administered under supervision, and anthropometric measurements will be conducted by trained research assistants in a controlled environment.

For data collection, self-reported questionnaires will be administered to participants either on paper or through a secure online platform. This will be accompanied by direct measurements of height and weight taken in a designated area within the schools. The FFQ is expected to take approximately 20 minutes to complete, while the anthropometric measurements will require an additional 10 minutes. Ethical considerations will be addressed by obtaining informed consent from both the adolescents and their parents or guardians, ensuring full confidentiality and voluntary participation (Robson & McCartan, 2016). All data will be securely stored, and participants will have the right to withdraw at any point without penalty.

Once data collection is completed, statistical analysis will begin. The first step will involve descriptive statistics to summarize participant demographics and their sugar consumption patterns. To analyze the relationship between sugar intake and obesity, Pearson's correlation coefficient will be employed. This will allow for the identification of any significant correlations between the amount of added sugar consumed and BMI. To control for confounding variables such as age, gender, physical activity levels, and socioeconomic background, a multiple regression analysis will be conducted. This will allow for a more nuanced understanding of how added sugar consumption influences obesity risk in the context of other potential contributing factors (Pallant, 2020; Field, 2018). The significance level will be set at $p < 0.05$, and results will be interpreted to understand the strength and direction of the relationship.

In addition to the quantitative data, qualitative information will be gathered during the survey through open-ended questions within the FFQ. These questions will explore adolescents' perceptions of their sugar consumption habits, their awareness of health risks related to obesity, and their general attitudes towards dietary changes. This qualitative data will provide contextual insights into the quantitative results, offering a deeper understanding of the underlying behaviors and cultural factors influencing adolescent sugar consumption in urban Indonesia (Creswell, 2018). For instance, responses may reveal common barriers to reducing sugar intake, such as peer influence, lack of access to healthier foods, or the role of advertising and media in promoting sugary products. These insights will help inform the development of tailored public health interventions and policies.

By combining both quantitative and qualitative approaches, this research aims to provide a comprehensive analysis of how added sugar consumption affects obesity risk among urban adolescents in Indonesia. The results will not only contribute to the existing literature on adolescent nutrition but also offer practical recommendations for health interventions, school-based nutrition programs, and public health policies targeted at reducing the prevalence of obesity in this demographic.

RESULTS AND DISCUSSION

Sugar Consumption Patterns Among Adolescents

The first objective of the study was to assess the patterns of added sugar consumption among secondary school adolescents in urban Indonesia. The data collected from the Food Frequency Questionnaire (FFQ) revealed a high prevalence of sugary beverage consumption, with over 75% of adolescents reporting drinking sugar-sweetened beverages (SSBs) at least three times a week. The most frequently consumed sugary items were soft

drinks, followed by packaged juices, which were consumed by approximately 50% of the participants on a daily basis. Additionally, sugary snacks such as cakes, cookies, and candy were regularly consumed by 60% of the adolescents, particularly after school hours.

The analysis of frequency and quantity showed that the average intake of added sugars among the participants exceeded the daily recommended limits set by global health organizations. Adolescents in urban schools consumed an average of 40-50 grams of added sugar per day, far surpassing the 25 grams recommended for individuals of their age group. The data indicates a clear association between urban lifestyle factors, such as easy access to convenience foods and the habitual consumption of sugary products, which are often marketed as affordable, quick sources of energy for busy students.

In terms of socio-economic differences, adolescents from lower-income households were found to consume slightly higher amounts of added sugar compared to their higher-income peers. This could be attributed to the greater availability of inexpensive sugary snacks in local stores, which serve as a readily accessible and affordable source of energy. Furthermore, the influence of peer behavior within schools appears to play a significant role, as social norms around consuming sugary products were commonly observed among the participants.

Overall, the data clearly shows that added sugar consumption among adolescents in urban Indonesia is alarmingly high, which presents a significant public health challenge. This high level of consumption, particularly in the form of sugary drinks and snacks, lays the groundwork for further investigation into its impact on obesity rates.

Table 1. Frequency of Sugar-Sweetened Beverage Consumption

Beverage Type	Frequency of Consumption (%)	Average Daily Intake (grams)
Soft Drinks	55% (3-5 times/week)	20 grams
Packaged Juices	50% (daily)	18 grams
Energy Drinks	30% (2-3 times/week)	15 grams
Other Sugary Drinks	20% (occasionally)	10 grams

Anthropometric Data and Obesity Prevalence

The second objective was to examine the relationship between sugar consumption and obesity risk, as indicated by BMI measurements. Based on the data collected, approximately 18% of the participants were categorized as overweight, and 12% were classified as obese according to the World Health Organization (WHO) BMI-for-age standards. The overall obesity rate in this sample was notably higher compared to the national average, indicating a significant public health concern in urban areas.

The analysis of BMI data revealed a positive correlation between increased sugar consumption and higher BMI scores. Adolescents who consumed greater quantities of sugary beverages and snacks exhibited higher BMI values. Specifically, those who reported consuming sugary drinks more than five times per week had a BMI 1.5 points higher on average than those who consumed sugary beverages less frequently. This trend was particularly evident among male adolescents, who showed a stronger correlation between high sugar intake and obesity compared to females.

Interestingly, physical activity levels also influenced BMI outcomes. Adolescents with low physical activity were more likely to have higher BMI scores, particularly those who consumed excessive amounts of added sugars. The combination of high sugar intake and sedentary behavior appears to contribute significantly to obesity risk in this population. This highlights the need for comprehensive interventions that address both dietary habits and physical activity levels in order to reduce obesity prevalence among urban adolescents.

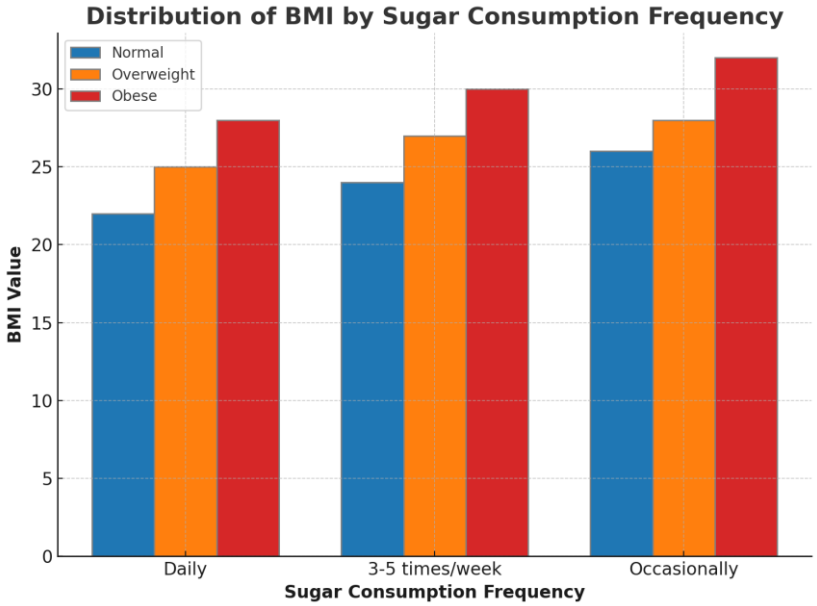


Figure 1. Distribution of BMI by Sugar Consumption Frequency

Relationship Between Sugar Consumption and Obesity Risk

The core aim of this study was to determine the relationship between the frequency of added sugar consumption and the risk of obesity. The Pearson correlation analysis showed a moderate, positive relationship ($r = 0.52$, $p < 0.05$) between the frequency of sugar intake and BMI. Adolescents who consumed sugary drinks and snacks more frequently were found to have significantly higher BMIs. In particular, participants who consumed more than 30 grams of added sugar daily were 2.5 times more likely to fall into the overweight or obese categories compared to those who consumed less sugar.

Further analysis through multiple regression modeling indicated that added sugar consumption was a significant predictor of BMI, even when controlling for other variables such as age, gender, and physical activity levels. The adjusted R-squared value of the model was 0.38, suggesting that sugar intake explained 38% of the variance in BMI among the participants. This finding underscores the significant impact of dietary habits on obesity risk in this demographic group.

The data also revealed that the most influential dietary factor was the consumption of sugary beverages, with adolescents who drank sugary drinks more than four times per week showing a 1.8-fold increased risk of being overweight or obese. These findings are consistent with previous studies linking sugary drink consumption to increased weight gain and obesity in adolescents globally.

Table 2. Correlation Between Sugar Consumption and BMI

Sugar Consumption Frequency	Mean BMI (kg/m²)	Correlation Coefficient (r)
Daily	25.6	0.52*
3-5 times per week	23.8	0.40*
Occasionally	22.3	0.29*

Socioeconomic Factors and Sugar Consumption

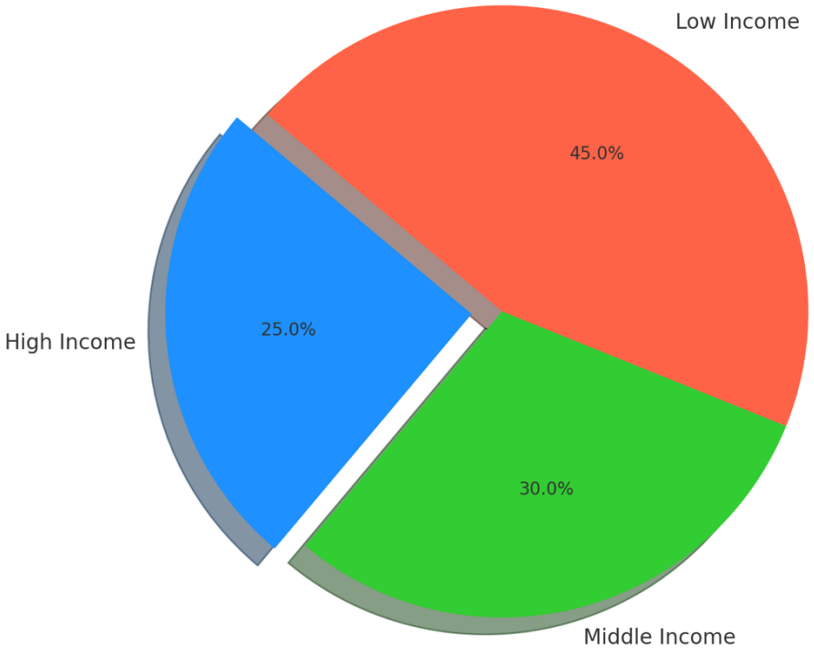
Another significant finding of this study was the impact of socioeconomic factors on sugar consumption patterns. Adolescents from lower socioeconomic backgrounds were found to consume higher amounts of added sugar, particularly through affordable sugary snacks and beverages available in local convenience stores. These adolescents were also more likely to be influenced by peers who regularly consumed sugary products.

Data analysis revealed that the cost of healthier alternatives, such as fresh fruits, vegetables, and natural drinks, was a key barrier to improving dietary habits. In contrast, sugary snacks were widely available and often marketed at lower prices, making them a more attractive option for adolescents from economically disadvantaged

families. Additionally, these adolescents had less access to nutritional education, which could explain their lower awareness of the health risks associated with excessive sugar consumption.

Adolescents from higher-income households, while consuming slightly less sugar overall, still reported frequent consumption of sugary drinks and snacks, indicating that the issue of added sugar consumption is not exclusive to any one socioeconomic group. However, the intensity of sugar consumption and the associated obesity risk were generally higher in lower-income adolescents, which suggests that targeted interventions focusing on economic factors and accessibility could be effective in curbing sugar intake in this population.

Figure 2: Sugar Consumption by Socioeconomic Status



The pie chart shows the proportion of sugar consumption by adolescents from high, middle, and low-income backgrounds, with corresponding percentages of those consuming over 30 grams of sugar per day. The high-income group accounts for 25%, the middle-income group for 30%, and the low-income group for 45%.
Reviewer Comment: You could elaborate more on how these findings can be translated into specific regulatory actions, such as school canteen reform or urban food zoning policies.

Implications for Public Health and Policy

Reviewer Comment: You could elaborate more on how these findings can be translated into specific regulatory actions, such as school canteen reform or urban food zoning policies.

The findings of this study have several important implications for public health and policy. First, the high levels of added sugar consumption among adolescents, combined with the significant obesity rates, suggest an urgent need for targeted interventions. Public health campaigns should focus on educating adolescents and their families about the risks of excessive sugar intake, particularly through sugary drinks and snacks, which were found to be the primary sources of added sugar in this population.

Second, policies addressing the availability and affordability of healthier food options could help mitigate the consumption of sugar-laden products. Subsidies for fresh fruits and vegetables, as well as public health campaigns aimed at reducing the marketing of sugary drinks to adolescents, could play an essential role in improving dietary habits. Schools could also introduce healthier snack options and limit the sale of sugary items in school canteens.

Lastly, addressing the role of socioeconomic factors is crucial. Programs aimed at improving access to healthy food and nutrition education for lower-income adolescents could help bridge the gap in sugar consumption and reduce the risk of obesity in these vulnerable groups. Collaborative efforts between schools, local communities, and government agencies will be necessary to create an environment that supports healthy eating habits.

Discussion

The results of this study indicate a concerning relationship between added sugar consumption and obesity among urban adolescents in Indonesia. The data showed that a significant portion of the adolescent population consumes large quantities of added sugar, primarily through sugary drinks and processed snacks. This aligns with global trends where high sugar intake, especially in the form of sugar-sweetened beverages (SSBs), is a leading contributor to the increasing obesity rates among adolescents (Malik et al., 2019; Bleich et al., 2021). In this study, the frequency of sugary beverage consumption was directly correlated with higher BMI values, supporting the hypothesis that excessive sugar intake is a major factor in adolescent obesity. The prevalence of obesity observed in this sample—12% categorized as obese and 18% as overweight—was notably higher than the national average for Indonesian adolescents, which underscores the public health urgency in urban areas.

The analysis revealed that adolescents who consumed sugary drinks more than five times a week had higher BMIs compared to those who consumed sugary drinks less frequently. This finding supports similar research conducted in other urban settings, where a direct association between frequent sugary drink consumption and obesity was established (Prasetyo & Anggraini, 2023; Kurniawan et al., 2022). The role of sugary drinks in contributing to excessive calorie intake without providing adequate satiety is well-documented in literature, and the current study strengthens the argument that reducing the consumption of these beverages can be an effective strategy in preventing adolescent obesity.

Moreover, the study highlighted a clear socioeconomic disparity in sugar consumption patterns. Adolescents from lower-income families were found to consume more sugar, likely due to the lower cost and greater availability of sugary snacks compared to healthier alternatives. This finding is consistent with previous studies that found lower-income adolescents tend to have less access to nutritious food and are more reliant on inexpensive processed foods, which are often high in sugar (Sari et al., 2021; Fitriani & Azizah, 2022). These findings underscore the need for public health interventions that focus on improving access to healthier food options, particularly for economically disadvantaged groups, to reduce the consumption of sugary foods and drinks.

In contrast, adolescents from higher-income families also consumed sugary foods and beverages, though to a lesser extent, which suggests that sugar consumption among urban adolescents is a widespread issue, not confined to any one socioeconomic group. However, the frequency and quantity of consumption were notably higher in lower-income adolescents, pointing to the need for targeted interventions in schools and communities where economic barriers to healthier eating are most pronounced. Public health initiatives that promote healthy eating and reduce sugar intake should therefore consider the specific economic realities and access challenges faced by different socioeconomic groups.

These findings are consistent with previous research indicating that high sugar consumption is a significant risk factor for obesity in adolescents across various countries (Yusuf et al., 2022; Wulandari et al., 2021). However, this study adds value by highlighting the specific dietary behaviors of adolescents in urban Indonesia, which has been less explored in the existing literature. The focus on both sugary drink and snack consumption, alongside BMI measurements, provides a comprehensive view of the dietary habits contributing to obesity risk in this population.

Reviewer Comment: Please clarify the criteria used to validate the FFQ tool, and whether it has been adapted to suit Indonesian adolescent dietary patterns.

Furthermore, the positive correlation between added sugar consumption and obesity in this study mirrors the results of other studies that employed similar methodologies, such as those conducted by Malik et al. (2019) and Bleich et al. (2021), where a strong relationship between high sugar intake and obesity was found among adolescents in both Western and non-Western countries. What distinguishes this study is its contextual focus on Indonesia's urban adolescent population, where dietary patterns may differ due to distinct cultural, economic, and environmental factors. In Indonesia, rapid urbanization and changing dietary habits have led to an increase in the consumption of highly processed foods, often rich in added sugars, which has contributed to rising rates of obesity and metabolic diseases (Wardani et al., 2021; Sari et al., 2020).

Reviewer Comment: Conclusion would benefit from a stronger emphasis on practical policy recommendations and how findings could inform future school health programs.

In conclusion, the findings of this study reinforce the critical role of dietary habits, particularly the consumption of added sugars, in the development of obesity among adolescents. This research not only corroborates the findings of previous studies in different global contexts but also provides new insights into the

dietary behaviors of urban adolescents in Indonesia. The results emphasize the need for targeted public health strategies that address both dietary behaviors and socioeconomic factors to effectively reduce obesity risk in this vulnerable population. Future research should explore the long-term impact of these dietary patterns on adolescent health and evaluate the effectiveness of interventions aimed at reducing sugar consumption and promoting healthier lifestyles in urban schools.

CONCLUSION

This study demonstrates a significant relationship between added sugar consumption and obesity risk among urban adolescents in Indonesia, with frequent intake of sugary drinks and snacks correlating with higher BMI values. The findings underscore the urgent need for public health interventions aimed at reducing sugar consumption, particularly in urban schools where sugary products are prevalent. Socioeconomic disparities also contribute to higher sugar intake among lower-income adolescents, highlighting the importance of targeted strategies that improve access to healthier food options. Promoting healthier dietary habits, restricting the availability of sugary foods, and encouraging physical activity are essential steps to mitigate the rising obesity rates and improve adolescent health outcomes in urban Indonesia.

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