

Relation Between Soft Drink Consumption and Obesity in Adolescents

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ARTICLE INFO	ABSTRACT
<p>Keywords: obesity, soft drink, adolescents, physical activity, caloric intake.</p>	<p><i>This study examines the relationship between soft drink consumption and obesity among adolescents. Obesity, a critical public health issue, has shown a rising prevalence globally, including in Indonesia, due to changes in dietary patterns and lifestyle. The research adopts a cross-sectional design conducted at Santo Thomas 1 Private High School in Medan, involving 198 students categorized into obese and non-obese groups based on Body Mass Index (BMI). The findings reveal that frequent soft drink consumption (more than three times a week) significantly increases the risk of obesity ($p = 0.0001$). Additionally, low physical activity and excessive caloric intake were identified as major contributing factors. Multivariate analysis highlighted low physical activity as the dominant risk factor for obesity, with an odds ratio of 36.351. The study underscores the need for targeted interventions to reduce soft drink consumption and promote healthier lifestyle choices among adolescents to mitigate the adverse effects of obesity on health outcomes.</i></p>

INTRODUCTION

Obesity is a condition in which excess body fat has accumulated that may have a negative effect on health. (Sjarif et al., 2011) Functionally, obesity is described as excessive increase in stored somatic fat mass in the form of triglyceride. (Hadi, 2024) Obesity in children is a complex malnutrition problem. (Sjarif et al., 2011) At this moment, Indonesia is facing a double issues regarding nutrition, where, malnutrition has not yet been resolved, obesity is running rampant. Obesity is considered as the first sign that have a significant impact on the development of children especially psychosocial aspect. (Hadi, 2024) Children with obesity has a higher risk on becoming obese in adulthood, which also make them more susceptible to metabolic disease and mortality with increase in treatment expenses. (Sjarif et al., 2011). (Hoppin, 2008) Obesity gives negative impact on children and adolescent's quality of life, such as obstructive sleep apnea, orthopedic disease, hypertension, cardiovascular disease, diabetes mellitus, and metabolic syndrome when they become adult. (Sjarif et al., 2011). (Duncan et al., 2011). (Malik et al., 2006)

Energy usage in the body is regulated to be in a balance state. (Bray et al., 2004) However, there are often energy balance disturbance that most often caused by nutrition. (Sjarif et al., 2011) Unhealthy eating habit such as overeating and overconsumption of high-sugar food and drinks may cause obesity. (Sjarif et al., 2011). (Bray et al., 2004). (Batubara et al., 2017)

These days we can see lifestyle changes such as westernization, sedentary living and easy access to high calorie food especially in big cities. (Hidayati et al., 2006) Drinks can have a significant contribution to energy structure in diet. (Melanson et al., 2008) Increase of drink consumption with artificial sweetener such as soft drink may cause a higher calorie intake that cause obesity in children. (Tam et al., 2006) (Marr, 2004) National survey in USA indicates that in the last 20 years the number of obesity is increasing with the increase of carbohydrate consumption in the form of increased sugar intake. Thus, Dietary Guidelines for American suggests public to choose food and beverage that may decrease sugar intake. (Malik et al., 2006)

A study in Australia shows the proportion of children who consume soft drink more than 3 times a week is 43%. The experiment studies the relation between soft drink consumption with obesity in school age children and it shows that children who drink soft drink more than 3 times a week have higher obesity rate by 2.2 fold compare to those who consume soft drink less than 3 times a week, with the assumption one soft drink equal to 250cc. (Sanigorski et al., 2007)

There are a lot of studies about the effects of high fat food in obesity. Soft drink consumption is another component that has not been studied well in Indonesia, whereas in America and European countries that kind of studies has been done a lot. Acknowledging that these days children start drinking soft drink since early age, we decide to conduct a study to understand the relation between soft drink consumption with obesity in adolescent.

Numerous studies have established a strong correlation between soft drink consumption and obesity. A cross-sectional study in California highlighted that students consuming soft drinks more than three times a week had a 1.6 times higher risk of obesity. Similarly, research in Saudi Arabia identified a significant association between soft drink intake and increased BMI among school children. In Greece, findings demonstrated that children consuming over 250 ml of sugary beverages daily exhibited a 2.35-fold greater risk of obesity compared to their peers, along with deficiencies in essential nutrients such as calcium and vitamins A and E. These studies collectively underscore the critical impact of dietary patterns, particularly the consumption of sugary beverages, on adolescent

Despite the abundance of international studies, there remains a dearth of research exploring the specific relationship between soft drink consumption and obesity among adolescents in Indonesia. While studies from Western and Middle Eastern countries have provided substantial evidence, the socio-cultural and dietary variations unique to Indonesian adolescents have not been adequately addressed. This study seeks to bridge this gap by analyzing the frequency of soft drink consumption and its contribution to obesity within a localized context.

The novelty of this study lies in its focus on Indonesian adolescents, exploring the relationship between soft drink consumption and obesity while considering cultural dietary habits and environmental factors. Unlike previous research, this study integrates physical activity levels and caloric intake as interacting variables, providing a more comprehensive understanding of obesity's behavioral and environmental determinants in a developing nation.

The primary objective of this study is to investigate the relationship between soft drink consumption and obesity among Indonesian adolescents by analyzing the frequency and volume of soft drink intake, identifying the role of physical activity and caloric intake as moderating factors in the relationship between diet and obesity, and developing targeted recommendations to reduce obesity prevalence in this population. This research provides valuable insights for healthcare policymakers, educators, and parents, offering actionable knowledge to design effective interventions aimed at curbing adolescent obesity rates. Furthermore, the findings contribute to academic literature by highlighting socio-cultural factors influencing dietary behaviors, paving the way for further research in similar contexts.

METHOD

Design and subject of the study

This was a cross sectional study, done in Santo Thomas 1 private high school in Medan. This study was conducted in January 2015. Target population was students. Reached population was target population who studied in Santo Thomas 1 private high school Medan in January 2015. Sample was the reached population, who fulfill inclusion criteria selected using consecutive sampling. Samples who met the inclusion criteria would then be divided into obese group and non-obese group using Body Mass Index (BMI). Children who consume drugs such as prednisone and children who were on diet were excluded from this study. This study was approved by Ethic Committee of North Sumatra University Medical Faculty and gets the agreement from the student's parents.

Statistical analysis

The collected data was processed, analyzed and presented by using computer program with p value < 0.05 and *confidence interval* (CI) 95%. To analyze the relation between soft drink consumption with obesity in adolescent we used *odds ratio*(OR) and to determine whether there is a significant relation between soft drink consumption with obesity, we use *Chi-square*.

RESULTS AND DISCUSSION

RESULTS

This study was conducted in Santo Thomas 1 private high school in Letjend S. Parman Rd. No. 109 Medan from 19 – 26 January 2015. There were 2 canteens in the school that sell soft drinks especially soft drinks with artificial sweetener. The amount of students in that school was 1322 and the study was conducted on 198 students chosen based on the inclusion criteria with 101 (51%) male students. The sample was divided into two groups based on their BMI, obese group and non-obese group. After the examination of 198 students were done, we found the mean body weight of the students was 76.55 kg and mean body height was 163.78 cm.

Characteristics	Obesity		P
	Yes (n=101)	No (n=97)	
Gender (n%)			
Boys	62 (61.4)	39 (38.6)	0.003*
Girls	39 (40.2)	58 (59.8)	
Age, years (SB)	15.9 (0.81)	16.10 (0.8)	0.159**
Parents occupation, n (%)			
Teacher	1 (50)	1 (50)	0.941*
Private employee	31 (54.4)	26 (45.6)	
Government employee	13 (48.1)	14 (51.9)	
Entrepreneur	56 (50)	56 (50)	
Parents income, million Rp n (%)			
≥ 8	29 (65.9)	15 (34.1)	0.180*
6 - < 8	44 (46.8)	50 (53.2)	
4 - < 6	22 (44.9)	27 (55.1)	
2 - < 4	5 (50)	5 (50)	
< 2	1 (100)	0	
Soft drink consumption, n(%)			
> 3 times/week	63 (67.7)	30 (32.3)	0.0001*
≤ 3 times/week	27 (35.5)	49 (64.5)	
Never	11 (37.9)	18 (62.1)	
Physical activity, n(%)			
Low	52 (61.9)	32 (38.1)	0.0001*
Moderate	39 (60)	26 (40)	
High	10 (20.4)	39 (79.6)	
Calorie intake (RDA), n(%)			
Exceed	88 (68.8)	40 (31.2)	0.0001*
Not exceed	13 (18.6)	57 (81.4)	

* Chi square ** Mann whitney

Figure. 1 Subject Characteristics

Analysis of the result shows a significant relationship between gender and obesity (p=0.003). From 101 male students, there were 62 students (61.4%) with obesity whereas there were only 39 (40.2%) female students with obesity.

There was no significant difference in the mean age between obese students and non-obese students (p=0.159). Based on the analysis of the student's parent occupation and income, there was also no significant relation with student obesity (p >0.05).

Based on soft drink consumption frequency, 67.7% students in obese group consumed soft drink more than 3 times a week. Analysis result shows that there was a significant relation between soft drink consumption frequencies with the occurrence of obesity (p=0.0001).

Based on physical activity, in obesity group there were 61.9% students who have low physical activity. In sample with high physical activity, only a small portion belongs to obese group, 20.4%. Analysis result shows that there was a significant relation between physical activities with obesity (p=0.0001). (Table 1)

Table 1. Relation between soft drink consumption and obesity

Soft drink consumption	Obesity		P	OR	95% CI
	Yes (n=101)	No (n=97)			
> 3 times/week	63 (67.7)	30 (32.3)	0.004	1.786	1.098-2.904
Never	11 (37.9)	18 (62.1)			
≤ 3 times/week	27 (35.5)	49 (64.5)	0.819	0.937	0.537-1.632
Never	11 (37.9)	18 (62.1)			

Based on the frequency of soft drink consumption, analysis shows that the risks of obesity in students who consumed soft drink > 3 times a week was 1.786 times higher with 95% CI 1.098-0.904 compare to those who consumed no soft drink. On the other hand, the group of students who consumed soft drink ≤ 3 times a week had no significant difference between those who do not consumed soft drink (p=0.0819). (Table 2)

Table 2. Relation between physical activity and obesity

Physical activity	Obesity		p	OR	95% CI
	Yes (n=101)	No (n=97)			
Low	52 (61.9)	32 (38.1)	0.0001	3.033	1.702-5.406
High	10 (20.4)	39 (79.6)			
Moderate	39 (60)	26 (40)	0.0001	2.940	1.634-5.290
High	10 (20.4)	39 (79.6)			

Based on physical activities, analysis shows the risk of obesity in children with low physical activity was 3.003 times higher with 95% CI 1.702-5.406 compared to the children with high physical activities. On the other hand, the students with moderate physical activities had 2.940 times higher risk (95% CI 1.634-5.290) to have obesity compared to students with high physical activities. (Table 3)

Table 3. Relation between calorie intake and obesity

Calorie intake	Obesity		p	OR	95% CI
	Yes (n=101)	No (n=97)			
Exceed	88 (68.8)	40 (31.2)	0.0001	3.702	2.236-6.129*
No	13 (18.6)	57 (81.4)			

* chi square

Analysis shows that there was a significant relation between calorie intakes with obesity (p=0.0001). The risk of obesity in students with excessive calorie intake was 3.702 times higher with 95% CI 2.236-6.129 compare to students with normal calorie intake. (Table 4)

Table 4. Multivariate analysis of the factors that influence obesity

Variable	Coefisien	P	OR	95% IK OR	
				Lower	Upper
Gender (boy)	-1,465	0.001	0.231	0.100	0.533
Soft drink					
➤ >3 times / week	2.144	0.001	8.534	2.448	29.754
➤ ≤3x times/ week	0.011	0.985	1.011	0.327	3.125
Physical activity					
➤ Low	3.593	0.0001	36.351	9.951	132.795
➤ Moderate	3.562	0.0001	35.246	9.438	131.623
Calorie intake (exceed RDA)	2.502	0.0001	12.208	4.978	29.940

Variables that may cause obesity in this study were gender, soft drink consumption, physical activities and calorie intake (p<0.05) based on multivariate analysis using double logistic regression test.

Based on gender variable, we found that the risk of male students to have obesity was 0.231 times higher compared to their female counterpart. The risk of obesity in the student who consumed soft drink more than 3 times a week was 8.534 times higher compared to those who never drink soft drink. There was no significant difference between students who drinks soft drink ≤ 3 times a week with those who never drink soft drink.

The risk of obesity in the student with low physical activities was 36.351 times higher compared to those with high physical activities. In addition, the students with moderate physical activity had 35.264 times higher risk of being obese compared to their friends with high physical activities.

Based on the amount of calorie intake, we found that the children with excessive calorie intake may had 12.208 times risk of obesity compared to those with normal calorie intake.

The result of multivariate analysis also shows that the dominant variable that influences the rate of obesity in this study was low physical activities with the highest OR 36.351. (Table 5)

Discussion

Obesity in children is a health problem that requires attention because it may increase the morbidity and mortality in children. The prevalence of obesity is increasing in many countries whether in develop or developing countries where the increase of prevalence is assumed as the part of lifestyle change such as overconsumption of soft drink.(Bray, 2010)

Obesity is linked with other comorbidity such as hypertension, cardiovascular disease, diabetes, orthopedic disease, and other metabolic syndrome.(SILVERSTEIN et al., 2004) Because there are a lot of negative effect of obesity then it must be prevented.(St-Onge et al., 2003)

Eventhough obesity is caused by imbalanced in energy homeostasis, the exact mechanism behind this process is not yet known. In general, obesity is caused by complex interaction of genetic, metabolic, cultural, socioeconomic and behavioral factors that include nutrition and lifestyle.(Malik et al., 2006)(SILVERSTEIN et al., 2004) For the last decades there is a massive lifestyle changes occurring that may cause decrease in physical activities and increase in calorie intake.(SILVERSTEIN et al., 2004) Behavioral factor play a big role in obesity, western lifestyle that copies the lifestyle of people from the western hemisphere plays a big role in obesity. Younger people tend to consume fast food and soft drink. In addition, sedentary lifestyle with low physical activities play a huge role in children obesity.(Malik et al., 2006)

The connection between soft drink consumption with obesity is based on the fact that fructose consumption cannot provide satisfaction (feeling full) that may make children to eat more food from other sources. Moreover, it is said that children cannot compensate calorie in the form of fluid compare to solid carbohydrate thus daily calorie intake may increase and causing obesity.(Malik et al., 2006)(Bray et al., 2004)

In this study, mean body weight is 76.55 kg, where this number is higher compared to the guideline from Recommended Dietary Allowance (RDA) which is 50 kg for female and 56 kg for male.

From this study we found significant relation between soft drink consumption with obesity with $p=0.0001$. This result is consistent with a cross-sectional study in California that study the relation between soft drink consumption with obesity in 319 students. Study in California found a significant relation between soft drink consumption with students obesity with $p=0.03$.(Giammattei et al., 2003)

From the analysis of this study we found that the risk of obesity in children who consume soft drinks > 3 times a week is 1.786 times higher than those who do not consume soft drink at all and we found no significant difference between the children who consume soft drink ≤ 3 times a week with those who did not drink soft drink, OR 0.937. This finding is consistent with a study in California that found that the risk of obesity in children who drinks soft drink ≥ 3 times a day and watch television ≥ 2 hours a day is 1.61 fold in logistic regression test.(Giammattei et al., 2003) A prospective study in Boston in 548 children in the span of 19 months found that with every increase of soft drink consumption, it will also increase BMI and obesity frequencies. The risk of obesity will increase 1.6 times with one daily consumption of soft drink.(Ds, 2001)

American cohort study in adult also found a significant relation between soft drink consumption and weight gain leading to obesity.(Bes-Rastrollo et al., 2006) This indicates that the effect on soft drink intake is not only found in children but also in adults.

A prospective cohort study in America in more than 10.000 children found that consumption of soft drink gives more contribution in weight gain because of the increase in daily calorie intake.(Berkey et al., 2004) A study in Saudi Arabia also found a significant relation between soft drink consumption with the increase in BMI, upper arm measurement, and obesity. In addition, there was also a strong connection between soft drink consumption and fast food that tend to increase total daily calorie intake with p value <0.001 .(Collison et al., 2010)

Cross sectional study in 856 children in Greece found high soft drink consumption have a relation with bad eating habit with inadequate nutrition intake and increasing in obesity risk. Obesity risk in children who consume beverage > 250 ml per day is 2.35 more than those who do not consume soft drink and also found that children with high soft drink consumption tend to have lower calcium, vitamin A, vitamin E, milk and vegetable intake with $p < 0.05$. This may cause a negative impact in bone growth and can increase the likelihood of osteoporosis in adult. Low fruit and vegetable consumption in children who consume soft drinks may cause a lot of long-term health problem such as diabetes and cardiovascular disease.(Linardakis et al., 2008)

In a cross sectional study in Australia, they found children who consume soft drink >750 ml in a week have 2.2 times obesity rate compare to those who do not drink soft drink.(Sanigorski et al., 2007) This finding is consistent with our study where the risk of obesity in children who consume soft drink >3 times a week, with the assumption one serving of soft drink equal to 250ml, is 1.78 times higher.

A study in England found that there is a significant relation between body weight with calorie intake and physical activity that tends to be sedentary. Sedentary lifestyle can cause 1.11 times risk in obesity compared to high physical activity.(Gibson & Neate, 2007) This is also consistent with this study, where the children with low physical activity have 3.03 times changes of obesity compare to those with high physical activities and logistic regression analysis shows that physical activity plays an important role in obesity.

From the England study, there is also a positive relation between calorie intake with obesity with OR 1.58. (Gibson & Neate, 2007) This finding also support our study where the risk of obesity in children with excessive calorie intake based on RDA guideline is 3.7 times higher compare to those with moderate calorie intake.

The weakness of this study is that the method we used is cross sectional that examine the relation in a time that it cannot see a long-term causative relationship. Moreover, the cause of obesity tend to be multifactorial and this study focus on behavioral factors i.e. food intake and physical activity, that have high bias value. Other factors that play important roles as the cause of obesity such as genetic factor cannot be exactly measured considering genetic examination cannot be performed and the study was conducted in short period of time. A bigger and longer study is needed to deeper analyzed various factors that may cause obesity.

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CONCLUSION

Softdrink consumption has a significant relation with the occurrence of obesity in adolescents. Consumption of soft drinks more than 3 times a week can cause a higher risk of obesity. Other risk factors that also play a role in obesity are gender, physical activities, and the amount of calorie intake.

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