

The impact of breakfast intake on BMI in high school teenagers in California

by

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Abstract

Skipping breakfast is an unhealthy eating habit that commonly occurs in teenagers and has become a public health concern for the youth population in the state of California. The literature indicates a relationship between skipping breakfast and overweight/obesity, which may result from unhealthy dietary behavior and skipping other meals. This study aimed to assess the impact of skipping breakfast and breakfast eating frequency (low, moderate, and high breakfast intake) on body mass index. We hypothesized that skipping breakfast will result in higher BMI and higher consumption of sugar-sweetened beverages (SSB), while high breakfast intake will lower BMI.

An independent samples t-test was used to compare the mean BMI between breakfast-skippers and breakfast eaters. Further, the breakfast eaters were categorized into low, moderate, and high breakfast intake groups to assess the impact of breakfast frequency on BMI. A one-way ANOVA was used to determine the differences in BMI between breakfast-skippers and the above breakfast intake categories. Similar analyses were performed in males, females, and in different ethnic/race groups using the split file function in SPSS.

A significant difference was observed between the mean BMI of breakfast eaters and skippers ($p = 0.005$). The frequency of breakfast intake impacted BMI. High school teenagers who did not eat breakfast had a higher BMI ($p = <0.001$) compared to teenagers who had high breakfast consumption (5-7 days breakfast intake). Specifically, only the high breakfast intake group ($p = <0.001$) had a significantly lower BMI, but not

those who had low (1-2 days breakfast intake) ($p = 1.00$), or moderate (3-4 days breakfast intake) ($p=0.868$) compared to breakfast skippers. A similar trend was observed in females, males, non-Hispanic, and black African Americans when our dataset was split by gender and ethnicity. In summary, this study shows that skipping breakfast has a negative impact on high school teenagers' BMI. The study also revealed the importance of eating breakfast almost daily (5-7 days) to improve body weight; therefore, effective strategies to promote the daily consumption of breakfast are warranted to combat obesity in high school teens in California.

Key Words: breakfast, teenagers, sugar sweet beverages, body mass index

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Introduction

Overview

Breakfast defined and its importance for teens

Breakfast is the most commonly skipped meal of the day (BetterHealth, 2021). Breakfast is defined as the first meal of the day, within 2 hours of waking, typically eaten no later than 10:00 AM, and provides between 20 and 35 % of total daily energy needs (Bi et al., 2015). Many children do not eat breakfast in the morning for various reasons, from not being hungry to not having enough time to eat and the possibility of not having food to eat (Bi, et al., 2015). Breakfast plays a role on how a morning may start and how it can affect what types of food may be consumed throughout the day. Skipping breakfast is suggested to be associated with the consumption of food of low nutritional value accompanied by high energy density (Watson, 2019). It can also lead to an increased feeling of hunger and thus to the consumption of larger portions in subsequent meals during the day (Watson, 2019). Skipping breakfast is especially common in teenagers and becomes an unhealthy habit that may influence one's weight, BMI (Body Mass Index), and sugary drink consumption (Watson, 2019). Having a complete and balanced meal in the morning is an excellent way to maintain health and avoid future health risks.

Teenagers are still developing and growing, so it is essential to maintain a positive mindset and habit around eating breakfast. Establishing healthy dietary patterns during youth is an important public health strategy for improving health and preventing chronic diseases; however, few adolescents meet the U.S. government's recommendations for dietary or physical activity behaviors (Merlo et al., 2020). It can

be challenging to influence adolescents to eat regularly and demonstrate the benefit that can impact them in the long run (Merlo et al., 2020). Providing educative nutritional strategies should be a high priority in high schools, especially for those who skip breakfast and may struggle with living as overweight or obese.

Prevalence of skipping breakfast in teens

Unfortunately, skipping breakfast is common among adolescents. Depending on the definition of skipping breakfast and the studied age group, the prevalence ranges from 10% to 74.7% in children and adolescents (Peña-Jorquera et al., 2021). The large percentage range may suggest a concern in adolescents' eating patterns. According to NCHS data, almost 95.8% of children aged 2–5 years consumed breakfast, compared with 86.7% of children aged 6–11 years and 72.9% of adolescents aged 12–19 years (NCHS Data Brief, 2020). Many children do not have the opportunity to eat breakfast regularly because of working parents, long bus rides, or the inability of families to provide enough food. Diet quality can be influenced by several confounding factors, including cultural and food environment, socioeconomic status, child and family food preferences, and nutrition recommendations relevant to age, sex, country, and culture of the individual (Dalwood et al., 2020). It is essential to be aware of what may affect students' decision or ability to eat breakfast in the mornings.

Teenagers are more likely to be hungry when they reach school and will continue to be hungry until lunchtime, or they may eat less nutritious food to stave off hunger pangs. Various studies among adolescents and emerging adults found associations between skipping breakfast and overweight/obesity, more negative body

perception and unhealthy dietary behavior, including low fruit and vegetable intake, higher sodium intake, lower consumption milk/dairy, higher consumption of sweets, sugary or soft drinks, and skipping other meals (Pengpid, 2020). High school teenagers are less likely to eat breakfast, and during these years, weight fluctuates, which can also affect food consumption behaviors.

Breakfast habits and its effect on obesity

BMI is a calculation that estimates how much body fat a person has based on their weight and height (Gavin, 2020). BMI is used to categorize body weight as underweight, healthy weight, overweight, and obese. The BMI-for-age percentile growth charts are used to measure the size and growth patterns of children and teens in the United States. The BMI-for-age growth charts are based on the gender of the child or teen because the body size and growth patterns vary between the two. BMI-for-age percentiles for teens are Underweight- Less than 5th percentile, Healthy weight- 5th percentile to less than the 84th percentile, Overweight- 85th to less than the 95th percentile, and Obesity- equal or greater than the 95th percentile. A high BMI can indicate high body fatness. While BMI does not measure body fat directly but, BMI is correlated with more direct measures of body fat (CDC, 2021).

Breakfast consumption is shown to have an inverse association with body fat and is found to be protective against the development of obesity and overweight (Giménez-Legarre, N., et al. 2020). Specifically, regular breakfast consumption is also associated with a healthier BMI and a decreased likelihood of obesity (Boyers, 2018). Research shows that students who regularly eat breakfast have an easier time

maintaining a healthy body weight than students who regularly skip breakfast (Boyers, 2018).

Influence of Gender and Ethnicity on Breakfast Intake in California Adolescents

California has a population of over 39 million people, and the youth make up almost 28% which is a significant amount (US Census, 2021). The diversity in California youth is critical to acknowledge because different backgrounds have different experiences growing up. White, Hispanic/Latinos, and Black/ African Americans are the top three ethnicities in the state. It is important to keep the youth healthy as they are still developing physically. One way to keep youth healthy is ensuring they eat breakfast, get the proper nutrients, and reduce their sugar intake. It is essential to acknowledge that teenagers are not the same as all youth, and their eating habits vary between gender and race/ ethnicity. When examining 9th graders in California, 45.2% of females and 34.7% of males did not eat breakfast daily (Kids Data, 2022). Among 11th graders, 43.7% of females and 39.8% of males did not eat breakfast daily (Kids Data, 2022). The frequency of skipping breakfast increases among adolescents and is higher in girls, and “breakfast skippers” tend to consume more fast food, leading to increased weight gain from adolescence to adulthood (Peña-Jorquera et al., 2021).

Ethnicity and the household play a role in skipping breakfast as well. Children in households with food insecurity were more often African American (18.2% vs 13.6%) and Hispanic (34.1% vs 23.0%) and less often white (37.4% vs 51.5%) when compared with all other children (*Food insecure children % vs All other %*) (Peltz, 2019). Food insecurity may lead to little or no breakfast consumption in a household.

People of color tend to be at an economic disadvantage based on many factors, and it can affect the nutrients teenagers need during breakfast. More than 1 million children in California—and nearly 11 million nationwide—live in households experiencing food insecurity (Muth, N.D., 2019). Many of these low-income households attend schools that qualify for the National School Breakfast Program (SBP) which provides free nutritious meals in the mornings. The USDA's Food and Nutrition Service (FNS) administers the SBP and reimburses participating schools and residential childcare institutions for the meals served to students (USDA ERS, 2021). Any student in a participating school can get an SBP breakfast. Students from households with incomes at or below 130 percent of the Federal poverty line can receive a free breakfast; Between 130 and 185 percent of the Federal poverty line can receive a reduce-price breakfast; and above 185 of the Federal poverty line can receive a low cost full-price breakfast (USDA ERS, 2021). Therefore, it is essential to find out whether low-income ethnic minority high school teenagers will still under-consume breakfast even though they have access to participate in SBP.

Excessive consumption of Sugar Sweetened Beverages in teens

Sugar-Sweetened Beverages (SSBs) are drinks that have excess added sugars that are unhealthy to a high school student's diet (CDC, 2022). Frequent consumption of SSBs can lead to weight gain and a higher body mass index that may be out of a healthy weight (CDC, 2022). Examples of SSBs include but are not limited to regular soda (not sugar-free), fruit drinks, sports drinks, energy drinks, sweetened waters, and coffee and tea beverages with added sugars (CDC, 2022). Students may be more susceptible to these beverages if its easily accessible to them inside and outside of a

school environment (Mello, 2007). High consumption of sugar-sweetened beverages can cause excess weight gain and increase their BMI. There is broad consensus among public health experts that childhood overweight has become a serious public health problem, and the excessive consumption of sugar-sweetened beverages is increasingly acknowledged as a major contributor (Mello, 2007). The increased intake of these beverages may be affected by their lack of eating breakfast.

Youth who skip breakfast were found to make worse food choices (e.g., lower consumption of dairy foods, cereal products, fruits and vegetables, and higher consumption of energy-dense snack foods), which resulted in lower intakes of vitamins, minerals, fiber, and protein (Wadolowska et al., 2019). Beverages were found to contribute approximately 20% of the caloric intake to the diets of children and adolescents and can also contribute to excess consumption of added sugars and calories (Miller & Merlo et al., 2017). Approximately 25% of US adolescents consume more than 750 mL of sugar-sweetened beverages (SSBs) per day, which represents more than 350 calories (Keller & Della Torre, 2015). This consumption may be affected by food insecurities as well. For example, economically disadvantaged children tend to consume more sugar-sweetened beverages, which can contribute to obesity and increase the risk for chronic diseases later in life (Muth, N.D., 2019). Research has shown that many teenagers are skipping breakfast and as noted above, breakfast consumption helps youth to maintain a healthy body weight.

Youth who skip breakfast tend to be overweight or obese due to excess calorie intake as a result of skipping breakfast (Miller & Merlo et al., 2017). Skipping breakfast may also increase the consumption of SSBs, which increase calorie intake.

Additionally, teenagers are known to have a high consumption of SSBs. Based on the literature findings, it can be speculated that high schoolers who skip breakfast may consume higher amounts of SSBs, thus increasing their daily calorie intake and weight gain over time. However, to our knowledge, this association has not been clearly elucidated. Specifically, a research gap remains as to how breakfast intake correlates with sugar-sweetened beverage consumption and BMI among youth. Therefore, more research studies are needed to examine the association among breakfast intake, sugar-sweetened beverage consumption, and BMI.

Purpose of the Study

The purpose of the study is to assess the difference between breakfast intake (breakfast skipping and breakfast frequency) and BMI in high school teenagers in California using Standard High School 2017 Youth Risk Behavior Surveillance System (YRBSS). The current study will examine whether skipping breakfast and breakfast intake frequency (low, moderate, and high) can impact body mass index in negative or positive patterns.

Research Questions

The following research questions will be addressed:

1. Does skipping breakfast have an impact on body mass index (BMI) in high school teenagers residing in California?
2. Does the frequency of breakfast intake influence BMI compared to breakfast skipping?
3. Do high school teenagers who skip breakfast frequently consume sugar-sweetened beverages?

4. Are there similarities in the impact of breakfast frequency on BMI by gender and ethnicity in high school teenagers?

Hypotheses

The first question hypothesizes that high school teenagers who skip breakfast will have a higher BMI. The second question hypothesizes that high school teenagers who eat breakfast more frequently (5-7 days of breakfast consumption) will have a lower BMI. The third question hypothesizes that high school teenagers who skip breakfast will have a higher sugar-sweetened beverage consumption. The final question hypothesizes that the impact breakfast frequency will have on BMI will be similar in males, females, and different ethnic groups in high school teenagers.

Method

Design

A cross-sectional design was used to explore the impact of skipping breakfast and frequency of breakfast intake on BMI. The 2017 YRBSS Standard High School dataset was used to answer the above research questions. The YRBSS was developed in 1990 to monitor health behaviors that contribute markedly to the leading causes of death, disability, and social problems among youth in the United States (YRBSS, 2020). These behaviors, often established during childhood and early adolescence, include the behaviors such as unhealthy dietary behaviors, alcohol use, tobacco use, sexual behaviors, and behaviors that may cause unintentional injuries and violence (YRBSS, 2020). This survey is distributed throughout various states and large cities.

Procedures

The YRBSS data from the year 2017 was analyzed using these questions; During the past 7 days, on how many days did you eat breakfast?, During the past 7 days, how many times did you drink a can, bottle, or glass of soda or pop, such as Coke, Pepsi, or Sprite? (Do not count diet soda or diet pop.); How tall are you without your shoes on? / How much do you weigh without your shoes on? (These two will be used to calculate BMI); and What is your race? Responses by California participants responses were extracted from the 2017 National data to create a California data set. The formula “BMI = Weight (kg)/ Height (meter squared)” was used to compute this new variable in SPSS. The responses to the breakfast intake question “during the past 7 days, on how many days did you eat breakfast?” was regrouped into; breakfast skippers, (0 days) low breakfast consumers, (1-2 days),

moderate consumers (3-4 days), and high consumers (5-7 days). The responses for SSB were categorized into four sections (0 days) no SSB consumer, (less than 1 time per day in the past 7 days) low consumer, (2-3 times per day) moderated consumer, and (4 times or more a day) high consumer). The year 2017 was chosen because it was before the era of COVID-19 or the Coronavirus era. This study aimed to avoid any uncontrollable COVID-related confounding variables that could affect the study analysis.

Participants

The 2017 Youth Risk Behavior Survey dataset had a total of 14,483 participants, which is participants from nationwide. The current study used only responses from the state of California, which was a total of 1,728 participants. All responses were anonymous, and the data was obtained from California High School Teenagers during their time on school grounds. The survey is proctored and given to all students to answer anonymously and is answered via paper survey. This study's target population was female and male teenagers aged 14-18 years in high school. This also includes responses from ethnicities represented, such as Hispanic/Latino, White, African American, and Asian (SLYRBS, 2017). Random selection was used from these responses in California to analyze the data and conduct the appropriate statistical tests. The participants of California included the cities of Oakland, San Francisco, Los Angeles, and San Diego (CDC YRBSS Participation, 2020).

The YRBSS includes national, state, territorial, and freely associated state, tribal government, and local school-based surveys of representative sample 9th through 12th-grade students (YRBSS, 2020). These surveys are conducted every two

years, usually during the spring semester. The national survey, conducted by CDC, provides data representative of 9th through 12th-grade students in public and private schools in the United States (YRBSS, 2020). The state, territorial, and freely associated state, tribal government, and local surveys, conducted by departments of health and education, provide data representative of mostly public high school students in each jurisdiction (YRBSS, 2020).

Independent Variable and Dependent Variable

This research attempts to assess the association between breakfast intake and BMI. Therefore, the main independent variable is breakfast intake and is categorized as breakfast skippers (0 days), low consumers (1-2 days), moderate consumers (3-4 days), and high consumers (5-7 days). The dependent variables will include body mass index. BMI was used as a continuous variable. The responses for SSB will also be categorized into four sections (0 days) no SSB consumer, (less than 1 time per day in the past 7 days) low consumer, (2-3 times per day) moderated consumer, and (4 times or more a day) high consumer). Gender (female and male), Ethnicity (White, Black, or African American, Asian, American Indian or Alaskan Native, Native Hawaiian or Other Pacific Islander, and Hispanic), and SSB consumption are dependent variables. G*Power Software, version 3.1.9.2 determined the minimum sample size for the research questions. A medium effect size, an alpha level of 0.5, and a power of 95% were used to determine a minimal sample of 176 for the independent samples t-test and 280 for the ANOVA test.

Data Analysis

The data in this study were analyzed using the IBM Statistical Package for Social Sciences (SPSS) software, version 27. Descriptive statistics were performed to describe the participants' demographics, such as gender, race/ethnicity, age, height, weight, and BMI of the participants. To answer research question number one, a t-test of independence was performed to determine the differences between the mean BMI of breakfast-skippers and breakfast eaters. An Analysis of Variance (ANOVA) test was conducted to analyze question two to compare the BMI of breakfast skippers to the BMI of teenagers with low, moderate, and high breakfast intake. We repeated this analysis to determine the difference in BMI of males, females, and ethnicity using the split file function to split the dataset by gender and race/ethnicity variable to answer research question four. Finally, descriptive analysis was used to answer question three to determine the percent intake of no, low, moderate, and high SSB intake levels by our study participants.

Results

The current study used data from the 2017 Youth Risk Behavior Survey. The purpose of this study was to assess the impact of breakfast skipping and breakfast eating frequency (low, moderate, and high breakfast intake) on body mass index among participants in California. Secondly, this study examined the differences among males, females, Hispanic or non-Hispanic as well as ethnicity/race categorized as American Indian/ Alaskan Native, Asian, Black/ African American, Native Hawaiian/ Pacific Islander, and White. The percent SSB consumption of breakfast skippers were also documented. There were 1,728 participants within California out of 14,000 in nationwide responses.

Demographic Information

The sample consisted of approximately equal number of males and females, with a reported mean age of 16 years. The majority reported their race as White, followed and reported an average BMI of 23.38 ± 4.86 (kg / m²) (see table 1).

Table 1: Demographic description of 2017 YRBSS California sample

Variable	Sample Size (n)	Percent (%)	Mean $\pm$ SD
Age (years)	1716		16.05 $\pm$ 1.02
Height (m)	1728		1.68 $\pm$ 0.098
Weight (kg)	1728		66.06 $\pm$ 16.12
Gender			
Male	861	49.80%	
Female	850	49.10%	
Average BMI (kg/ m ²)			23.38 $\pm$ 4.86
Grade Level			
9th Grade	378	21.80%	
10th Grade	469	27.10%	
11th Grade	415	24%	
12th Grade	453	26.20%	
Ungraded or Other	15	0.90%	
Race/ Ethnicity			
American Indian or Alaskan Native	78	4.50%	
Asian	161	9.30%	
Black or African American	92	5.30%	
Native Hawaiian or other Pacific Islander	59	3.40%	
White	700	40.50%	
Other Race-Including Multi-Racial	638	37%	
Race/Ethnicity (Hispanic or not)			
Hispanic	1016	58.80%	
Not Hispanic	684	39.60%	
SD= Standard deviation			

Major Findings

Research Question 1: BMI difference between breakfast skippers and breakfast eaters

The first research questions aimed to examine if there was a difference in BMI between breakfast skippers and breakfast eaters. An independent samples t-test was performed to compare the mean BMI for breakfast skippers and breakfast eaters in

high school teenagers residing in California. Our t-test showed a significant difference ($t = 2.83$; $p\text{-value} = 0.005$) between breakfast skippers and breakfast eaters. The mean BMI of breakfast skippers ($M = 24.29$, $sd = 5.2$) was significantly higher than breakfast eaters ($M = 23.25$, $sd = 4.8$) (see figure 1). The hypothesis is that high school teenagers who skip breakfast will have a higher BMI. Therefore, we reject the null hypothesis.

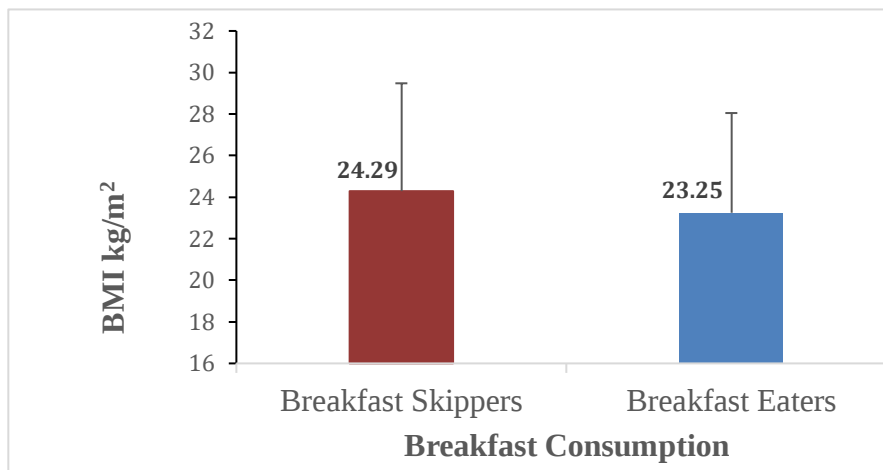


Figure 1: Comparison of BMI of breakfast skippers and breakfast eaters

Research question 2: The impact of breakfast frequency on BMI

The second research aimed to examine the mean BMI based on breakfast frequency. A one-way ANOVA was performed to compare the BMI of participants based on their frequency of breakfast intake. A significant difference was found among the frequency of breakfast intake ($F = 14.78$; $p < 0.001$). Tukey's HSD post hoc test determined the differences in BMI among breakfast skippers, low, moderate, and high breakfast intake. This analysis revealed that breakfast skippers had a higher BMI than those who reported a high Breakfast intake (Table 2). BMI for teenagers

who had low breakfast intake and moderate breakfast intake were not significantly different from the breakfast skippers BMI (Table 2).

Table 2: The comparison of the effect of breakfast skipping versus breakfast frequency on BMI

Breakfast intake categories	BMI (Mean± SD)	F	P-value
		14.78	<0.001*
Breakfast Skippers	24.29±5.19		
Breakfast Eaters			
Low Breakfast Intake	24.31±4.70		1.00
Moderate Breakfast Intake	24.69±5.66		0.86
High Breakfast Intake	22.73±4.57		<0.001

*=Overall ANOVA p-value and the rest are the pairwise comparison p-value, F= Computed F statistic, SD= Standard deviation

Research question 3: Breakfast skippers SSB consumption frequency

The third research question aimed to examine the frequency of SSB consumption among breakfast skippers. Descriptive analyses was performed to determine if teenage breakfast skippers frequently consume sugar-sweetened beverages. A total of 221 breakfast skippers were analyzed, in which 29% of the breakfast skippers reported not consuming any SSB, 62% reported low SSB, 7.2% reported moderate SSB intake, and 1.8% reported high SSB intake (See table 3).

Table 3: SSB Percent consumption levels of breakfast skippers

Breakfast Skippers SSB Intake	Frequency	Percent (%)
No SSB Consumption	64	29%
Low SSB Consumption	137	62%
Moderate SSB Consumption	16	7.20%
High SSB Consumption	4	1.80%

SSB= Sugar sweetened beverages

Research question 4: The impact of breakfast skipping and breakfast frequency on BMI by gender and ethnicity

The fourth research question examined the relationship between breakfast skipping and breakfast frequency on BMI by gender and ethnicity. A one-way ANOVA was used to compare the mean BMI between the four breakfast intake categories and further determine whether differences exist by gender and ethnicity. A significant difference in BMI among the four breakfast categories was observed for females ($F = 5.11$; $p = < 0.002$) and males ($F = 11.21$; $p = < 0.001$). Tukey's HSD was used to perform a pairwise comparison between breakfast skippers' BMI and the rest of the three breakfast frequency categories for males and females. This analysis revealed that the BMI of Breakfast Skippers was higher compared to high breakfast intake consumers. However, no significant difference in BMI was found for the low and moderate breakfast intake group compared to the breakfast skippers in females and males (See table 4a).

Table 4a: The comparison of breakfast skipping versus breakfast frequency on BMI by gender

Breakfast intake Categories by gender	Mean $\pm$ SD	BMI F	P-value
Males		11.21	<0.001*
Breakfast Skippers	24.16 $\pm$ 5.19		
Breakfast Eaters			
Low Breakfast Intake	24.52 $\pm$ 5.33		0.954
Moderate Breakfast Intake	25.50 $\pm$ 5.72		0.277
High Breakfast Intake	22.65 $\pm$ 4.49		0.024
Females		5.11	< 0.002*
Breakfast Skippers	24.42 $\pm$ 5.21		
Breakfast Eaters			
Low Breakfast Intake	24.14 $\pm$ 4.16		0.972
Moderate Breakfast Intake	23.91 $\pm$ 5.52		0.894
High Breakfast Intake	22.83 $\pm$ 4.65		0.013

*=Overall ANOVA p-value and the rest are the pairwise comparison p-value, F= Computed F statistic, SD= Standard deviation

Looking at the comparisons for ethnicity, no significant difference in BMI was found for the Hispanic group ($F = 3.588$; $p = 0.396$); however, the “not Hispanic” group ($F = 12.365$; $p = <0.001$) had a significantly lower BMI among breakfast categories. Tukey HSD post hoc pairwise comparisons showed that the high breakfast intake group had a lower BMI than the other intake categories (see table 4b). Race/ethnicity groups were then examined, in which no significant differences in BMI were found among American Indian/ Alaskan Native, Asian, Native Hawaiian/ Pacific Islander, and White. However, a significant difference in mean BMI among the breakfast consumption categories in Black/African Americans was noted. Specifically, the post hoc analysis showed a lower BMI ($p = 0.04$) for the high breakfast intake group (see table 4c in Appendix A). Our overall ANOVA for our five ethnicity groups had an ($F = 4.02$; $p = 0.008$).

Table 4b: The comparison of breakfast skipping versus breakfast frequency by ethnicity

Breakfast Intake Categories by ethnicity	BMI		
	Mean $\pm$ SD	F	P-value
Hispanic		3.588	0.396*
Breakfast Skippers	24.68 $\pm$ 5.22		
Breakfast Eaters			
Low Breakfast Intake	24.62 $\pm$ 4.67		1.00
Moderate Breakfast Intake	25.03 $\pm$ 5.83		0.96
High Breakfast Intake	23.63 $\pm$ 5.08		0.18
Not Hispanic		12.365	<0.001*
Breakfast Skippers	23.75 $\pm$ 5.15		
Breakfast Eaters			
Low Breakfast Intake	23.59 $\pm$ 4.72		0.972
Moderate Breakfast Intake	24.10 $\pm$ 5.35		0.894
High Breakfast Intake	21.63 $\pm$ 3.60		0.013

*=Overall ANOVA p-value and the rest are the pairwise comparison p-value, F= Computed F statistic, SD= Standard deviation

Table 4c: The comparison of breakfast skipping versus breakfast frequency by ethnicity

Breakfast intake categories by ethnicity	BMI		
	Mean $\pm$ SD	F	P-value
American Indian/Alaskan Native		4.02	0.008*
Breakfast Skippers	23.88 $\pm$ 5.11		
Breakfast Eaters			
Low Breakfast Intake	24.22 $\pm$ 5.42		0.99
Moderate Breakfast Intake	27.39 $\pm$ 7.35		0.61
High Breakfast Intake	24.31 $\pm$ 5.24		0.99
Asian			
Breakfast Skippers	22.91 $\pm$ 4.62		
Breakfast Eaters			
Low Breakfast Intake	22.83 $\pm$ 4.55		1.00
Moderate Breakfast Intake	25.32 $\pm$ 6.12		0.45
High Breakfast Intake	21.26 $\pm$ 3.59		0.43
Black/ African American			
Breakfast Skippers	26.92 $\pm$ 7.35		
Breakfast Eaters			
Low Breakfast Intake	24.68 $\pm$ 4.02		0.70
Moderate Breakfast Intake	24.49 $\pm$ 5.03		0.53
High Breakfast Intake	22.83 $\pm$ 3.80		0.04
Native Hawaiian/Pacific Islander			
Breakfast Skippers	27.99 $\pm$ 6.40		
Breakfast Eaters			
Low Breakfast Intake	24.88 $\pm$ 5.49		0.62
Moderate Breakfast Intake	24.68 $\pm$ 5.86		0.75
High Breakfast Intake	26.05 $\pm$ 5.96		0.83
White			
Breakfast Skippers	23.71 $\pm$ 4.27		
Breakfast Eaters			
Low Breakfast Intake	24.06 $\pm$ 4.57		0.96
Moderate Breakfast Intake	23.21 $\pm$ 4.96		0.93
High Breakfast Intake	22.43 $\pm$ 4.23		0.14

*=0overall ANOVA p-value and the rest are the pairwise comparison p-value, F= Computed F statistic, SD= Standard deviation

Discussion

Summary of Major Findings

This study assessed body mass index differences based on breakfast intake in high school teenagers. Although the average BMI (23.38 ± 4.86) for our study participants fell in the healthy weight range, our findings suggested that high school teenagers who skipped breakfast had a higher BMI than those who had a higher breakfast intake (i.e., students consuming breakfast > 5 days/week). These results demonstrate that breakfast consumption benefits high school teenagers because it leads to a healthier weight. Similar findings have been reported in previous studies (Giménez-Legarre, N. et al., 2020), in which breakfast consumption showed a protective effect against obesity and overweight. In a study by Wadolowska et al., 2019, frequent breakfast skippers were more likely to be overweight/obese and centrally obese, while those who skipped breakfast a few times a week were more likely to be overweight/obese as well.

The impact of breakfast frequency on BMI was intriguing in this study. Our results suggested that only high breakfast intake impacted BMI. In comparison, low and moderate breakfast consumption was not found to impact BMI. This result supports the need for programs, such as the school breakfast program, to help high schoolers increase the frequency of breakfast consumption. These results align with a study by Peña-Jorquera and colleagues that highlighted breakfast as an important meal that helps teenagers' health (Peña-Jorquera et al., 2021). Researchers concluded that complete and balanced nutrition is essential to maintain health to avoid health risks throughout the entire life cycle (Peña-Jorquera et al., 2021).

Youth that skips breakfast have been found to consume more sugar-sweetened beverages (SSB), potentially leading to increased weight gain from adolescence to adulthood (Peña-Jorquera et al., 2021). The findings from the current study demonstrated that 29% of the breakfast skippers reported that they did not consume SSB per week, and 69% reported consuming only 1-2 days/week SSB. This finding contradicts what is known in the literature (Keller & Della Torre, 2015), whose research suggests that skipping breakfast can increase SSB consumption. SSBs contribute between 10% and 15% to a youth's diet and are the primary source of added sugar (Keller & Della Torre, 2015). However, the results of the current study suggest that there is lower consumption of SSBs among breakfast skippers. To speculate, intake of SSBs is commonly underreported, especially in survey data collection research. Therefore, it is possible that the current study participants may have also under-reported their SSB intake.

Lastly, the current study investigated the impact of breakfast intake on BMI based on gender and ethnicity. It was found that BMI differed between breakfast skippers and those who reported a high breakfast intake had similar results in females and males. This finding aligns with previous research from the 2022 Kids Data resource. Male and female breakfast skippers had significantly higher BMI than those who frequently consume breakfast. Race and ethnic groups were also found to have significant impact on the dependent variable BMI. There was no difference found in mean BMI for White or Hispanic youth; however, differences in mean BMI among the four breakfast consumption categories were observed in the "not Hispanic" group. The results showed that youth who were "not Hispanic" that had high breakfast intake

had a lower BMI compared to breakfast skippers. Additionally, results demonstrated that Black/African American youth who reported a higher breakfast consumption had a significantly lower BMI. These findings are consistent with the research by (Peltz, 2019), which investigated ethnic backgrounds impact on breakfast consumption in the mornings.

Public Health Implications

The findings from this study have public health implications for health education and policy implementation. Currently, the nutrition education provided in schools is scant. But, providing adequate nutrition education to youth while they are still developing and forming different eating habits may impact their health in the long run. Giving the importance of breakfast eating, especially its impact on body weight, it is necessary to provide educational resources that may promote breakfast intake at home or at school. From a policy perspective, many schools currently close their breakfast line early. Therefore, a policy change in schools to mandate the keeping of breakfast serving lines or to open the breakfast serving station longer for those students who arrive late and have not gotten a chance to have a morning meal may help promote breakfast intake by school children.

Study Limitations

One major limitation of this study is that the data was collected using a survey. Therefore, participants' responses are subject to recall bias and response bias. Students may have limited knowledge or ability to recall accurately some of the information they were asked. It is also possible that they may not remember specific

details about themselves and may have underreported some things. For instance, students may not have remembered their height or weight correctly and wrote down what they may have believed they were. The inability to remember their height or weight may have impacted our computed BMI results. Additionally, students may have under-reported their SSB intake. All such reporting errors could undermine our results. The study focused on California high school students only; therefore, the findings cannot be extrapolated to other high school students outside California.

Using BMI as a proxy for obesity in the study may have some limitations. For instance, teenagers who may be athletic may be erroneously categorized as obese but their high BMI may be as a result of high muscle mass. Therefore, it is possible that the BMI estimated may be confounded by variables such as physical activity status, stress level, and overall energy intake that were not accounted for in the statistical analysis in this study. Overall, this study is based on secondary data, so the findings must be carefully interpreted with caution. A strength of this study is the fact that the study sample size is large. Therefore, we did have the power to support our statistical analysis for our t-test and ANOVA comparisons.

Conclusion

Skipping breakfast is common among high school teenagers, and based on the results of the current study, it can impact their BMI. This study supports the conclusion that skipping breakfast has negative impact on high school teenagers BMI in males, females, and non-Hispanics, specifically Black/African Americans. Our finding showed that consuming breakfast fewer than 5-7 days per week is not protective of body weight. On the other hand, contrary to what was hypothesized,

skipping breakfast did not result in increased intake of sugar sweetened beverages in teenagers.

Additionally, the findings of the current study showed that skipping breakfast had similar impact on BMI in both males and females. Therefore, it is important to educate and promote nutrition-based interventions equally to males and females. Our results suggested that ethnic groups, specifically in non-Hispanics, Black African Americans who had a higher breakfast intake had a significantly lower BMI. This study revealed the disparities that may exist with the impact of breakfast consumption on BMI by different ethnic group. It is necessary to intensify health promotion efforts among high school teenagers to encourage daily consumption of breakfast to promote healthy weight.

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