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Association Between Sugar-sweetened Beverage Consumption and Overweight /Obesity by Physical Activity Status and Socio-demographic Factors in U.S. Adolescents: Analysis of the 2015 Youth Risk Behavior Survey

Bernice Edward

ABSTRACT

ASSOCIATION BETWEEN SUGAR-SWEETENED BEVERAGE CONSUMPTION AND OVERWEIGHT /OBESITY BY PHYSICAL ACTIVITY STATUS AND SOCIO-DEMOGRAPHIC FACTORS IN U.S. ADOLESCENTS:
ANALYSIS OF THE 2015 YOUTH RISK BEHAVIOR SURVEY

by

BERNICE EDWARD
STUDENT

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INTRODUCTION: Research has strongly linked increased consumption of sugar-sweetened beverages (SSBs) to obesity/overweight in youth.

AIM: This study aims to: (1) examine SSB consumption rates in high school students nationwide, (2) explore association between SSB consumption and adiposity (overweight/obesity), (3) examine gender, racial/ethnic, and physical activity (PA) status differences in SSB consumption.

METHODS: The Youth Risk Behavior Survey (YRBS)-2015 was employed in this study. Weighted percentages were used to examine differences in SSB consumption and adiposity prevalence by gender, race and PA status. Multivariate logistic regression was used to determine association between SSB consumption and adiposity. Adjusted and unadjusted odds ratios and 95% CIs were calculated.

RESULTS: Overall, 20% of students drank sodas daily ≥ 1 times a day and about 14% drank sports drinks daily. More male students consumed both sodas and sports drinks than female students. Soda consumption was largest in the group with zero days PA (25%) and consumption of sports drinks was highest in the daily PA category (24%) than the other categories. Multivariate logistic regression revealed higher odds of obesity among male students as compared to female students (OR=1.7, 95% CI=1.4, 2.1) and among Hispanic students as compared to white students (OR=1.5, 95% CI=1.2, 1.8), after adjusting for all other covariates. Students who engaged in daily PA had lower odds of obesity than those who had no PA (OR=0.6, 95% CI=0.5, 0.8). There was no significant difference in the odds of obesity between those who consumed SSBs and those who did not.

DISCUSSION: This study provides insight into SSB consumption trends in US adolescents by socio-demographic factors and PA status, as well as its association with adiposity. Male gender, certain racial minorities and lack of physical activity can potentially be responsible for greater SSB consumption. Sports drinks consumption is high even in physically active youth. Lack of association between SSB intake and adiposity may be due to the limited SSBs included.

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by

BERNICE EDWARD
STUDENT

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APPROVAL PAGE

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by

BERNICE EDWARD
STUDENT

Approved:

Dr. Ike S. Okosun
Committee Chair

Dr. Rodney Lyn
Committee Member

30th November, 2016
Date

Author's Statement Page

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Bernice Edward
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INTRODUCTION

Childhood and adolescent overweight and obesity are major public health concerns in the world. Globally, there has been a sharp increase in childhood obesity [1]. In the U.S., the prevalence of obesity in children and adolescents remains high and currently 17% of 2-19 year olds are obese and 5.8% are extremely obese [2]. Among adolescents aged 12-19 years, obesity increased from 10.5% in 1988-1994 to 20.6% in 2013-2014 and extreme obesity from 2.6% in 1988-1994 to 9.1% in 2013-2014 [2]. Being obese or overweight in youth is associated with obesity in adulthood [3]. Overweight and obesity in adolescence are also associated with increased risk of chronic diseases later in life as well as poor psychological outcomes and mental well-being [4-9]. Moreover, obesity was found associated with considerable increase in national healthcare expenditures in the period between 1998-2011 in the U.S. [10]. A recent estimate of the lifetime costs of obesity suggests about $19,000 of incremental lifetime per capita medical costs for a 10-year-old child who is obese through adulthood, as compared to $12,660 for a normal-weight 10-year-old [11].

Causes of obesity in children and adolescents are multifactorial, some of the main factors being poor dietary choices, sedentary behavior and lack of physical activity. In light of the growing obesity epidemic and the resulting non-communicable diseases in adulthood, it is increasingly necessary to examine the lifestyle choices that today's youth make. Excess energy intake, inadequate physical activity and increased consumption of sugary drinks have direct positive associations with obesity and weight gain in children [12, 13, 14]. Research has strongly linked increased consumption of sugar-sweetened beverages (SSBs) to adiposity (obesity/overweight) but studies exploring this association among children and adolescents by physical activity and socio-demographic differences are limited.

Study objectives The objectives of this study are to examine self- reported SSB consumption levels in American high school students as reported in the Youth Risk Behavior Survey (YRBS)-2015, and to explore possible associations with adiposity stratified by gender, race/ethnicity and physical activity status. Gaining a better understanding of the association between SSB consumption and adiposity in adolescents can help improve targeted interventions and policies to curb the rising obesity trends.

Research questions

- What are the consumption levels of SSBs in high school students in the U.S?
- Does SSB consumption vary by gender, race/ethnicity and physical activity status?
- Does adiposity prevalence vary by gender, race/ethnicity and physical activity status?
- Does adiposity prevalence vary by SSB consumption status?
- Are SSB consumption, gender, race/ethnicity and physical activity status significantly associated with prevalence of adiposity?

LITERATURE REVIEW

Obesity in high school students [15]

Approximately 14% of American high school children are obese, and 16.0 percent are overweight. Obesity is more prevalent among male high school students than their female counterparts (males 16.8 %, females 10.8 %). However, are overweight is more prevalent in females compared to males (males 15.5%, females 16.6%). Hispanic male students have the highest rate of obesity compared to males of other races (19.4% of Hispanic males, 18.2 % of black males and 15.6 % of white males). Among females, the prevalences of obesity are 15.2 %, 13.3% and 9.1% for Blacks, Hispanics, and Whites, respectively. Overall, Black students have the highest prevalence of obesity (16.8%), followed by Hispanic students (16.4%), American Indian/Alaska Native students (15.9%), and White students (12.4%).

Among the 37 states self-reporting obesity prevalence, the obesity rate in 11 states exceeds fifteen percent, and is greater than 10 percent in all states [15].

Sugar-sweetened beverages

Sugar-sweetened beverages (SSBs) are high sources of energy with poor nutritional value [16]. SSBs are beverages to which sucrose (sugar) or high fructose corn syrup has been added and these generally include soft drinks, fruit drinks, sports and energy drinks, tea and coffee drinks, and sweetened milk drinks [16]. In the U.S., SSBs are the largest contributor of energy intake [17] and adolescents are one of the largest consumer groups of SSBs, obtaining 10-15% of their total calories from SSBs [18]. Globally, consumption of SSBs in the period from 1997 to 2010 significantly increased from 9.5 to 11.4 gallons per person per year [19]. Among U.S. children and adolescents, SSB intake increased from 204 kcal/day in 1988-1994 to 224 kcal/day in 1999-2004 [18].

Current evidence suggests a strong direct link between increased consumption of SSBs and obesity/overweight [20]. A recent study analyzed global data from the Euromonitor Global Market Information Database, the International Diabetes Federation and the World Health Organization, to estimate the link between SSB consumption and obesity. The study reported that a 1% rise in SSB consumption was linked to adding 4.8 overweight cases per 100 people, and 2.3 obese cases per 100 people, especially in low and middle-income countries [19]. In California, a report using data from the California Health Interview Survey stated that occasional SSB consumption was associated with a 15% increased likelihood of being overweight or obese, and consumption of ≥1 SSBs per day was associated with a 27% increased likelihood of being overweight or obese [21]. A recent systematic review concluded that the majority of evidence indicates a direct link between SSB consumption and increased weight gain, overweight and obesity in children and adolescents [22]. Moreover, longitudinal studies have found that increased SSBs consumption in childhood and adolescence have long-term effects through adulthood, leading to overweight and obesity in adults [23, 24]. Certain randomized trials demonstrated a decrease in BMI and weight gain after lowering SSB consumption among adolescents [25, 26].

SSBs consumption also significantly contributes to increasing risk for cardiovascular disease and type 2 diabetes [27, 28, 29]. SSBs are associated with a greater incidence of diabetes [30], and decreased diet quality [31]. SSBs are associated with several other disorders, including increased triglycerides, increased uric acid, gout, non-alcoholic fatty liver disease and dental caries [32-37]. Additionally, recent estimates indicate about 184,000 U.S. adult deaths are attributable to SSBs globally, which includes death from cardiovascular disease, cancers and diabetes mellitus. Highest proportions of these deaths are in middle income countries (71%) followed by high-income countries (24%). Among the highly populated countries in the world, the U.S. has the second highest mortality rate attributable to SSBs [38].

With regard to policy measures to curb SSB consumption, several studies have evaluated the effect of SSB taxation and have found inverse associations between SSB tax and overweight/obesity. Ruff and Zhen examined the effect of SSB taxes on weight and obesity in New York City using dynamic weight loss modeling [39]. Simulated calorie reductions from a calorie-based SSB tax led to a 0.46 kg weight loss per person in year 1, 0.92 kg in year 10 and a weight loss of 5,531,059 kg over 10 years when weighted to the overall New York City adult population [39]. Another micro-simulation analysis in Washington D.C. aimed at comparing effects of three different federal policies on obesity prevalence in US school children - a penny-an-ounce excise tax on SSBs, after-school physical activity programs and banning fast food television ads targeted towards children. The results of the analyses showed that the SSB excise tax predicted the most significant effect in reducing the obesity rate in school children, when compared to the other two policies [40]. A meta-analysis of studies from four different countries including the U.S. consistently showed reductions in measures of BMI, overweight and obesity in response to escalations in SSBs price [41].

Physical activity

In addition to dietary factors, physical inactivity plays a key role in the development of obesity. Sedentarism defined by screen time among adolescents is positively associated with both weight gain and unhealthy eating behaviors including SSBs and fast foods [42, 43, 44]. Among U.S. high school students, those who had greater screen-based sedentary behaviors including television viewing and computer/video games activity were found to be less likely to eat healthy and more likely to consume SSBs [45]. The U.S. Department of Health and Human Services (DHHS) current physical activity recommendations for adolescents aged 6-17 years is at least 60 minutes daily [46]. The 60 minutes include both vigorous aerobic activities and muscle strengthening activities; each of which should be engaged in at least 3 times a week. Recommended aerobic activities include running, biking, sports (e.g., soccer, football, tennis) and dancing while muscle strengthening activities includes push-ups, pull-ups, sit-ups and weight lifting exercises. The 2013 National Youth Risk Behavior Survey indicates that only about 27% of high school students in the U.S. engage in physical activity for at least 60 minutes a day for a whole week, while about 52% of students had participated in muscle strengthening exercises on at least 3 of the past seven days [47].

METHODS

Survey Design and Sample

This is a cross sectional study and data are from the 2015 National Youth Risk Behavior Survey (YRBS) conducted by the Centers for Disease Control and Prevention. The YRBS is a national school-based survey of representative samples of 9th through 12th grade students in public and private schools. The YRBS monitors priority health risk behaviors and prevalence of obesity, because of their significant contributions to death, disability, and social problems in the nation's youth [48]. The survey is conducted biennially and student participation is anonymous and voluntary. The representative sample of students in grades 9-12 in public and private schools from the 50 states and District of Columbia is obtained by using a three-stage cluster sample design. Detailed information on the methodology of the YRBS has been reported [48].

The school response rate for this survey was 69%, the student response rate was 86% and the overall response rate was 60% [15].

Measures

- Sugar sweetened beverages

The main outcome variable of this study is sugar sweetened beverage (SSB) consumption, which is characterized by responses to the YRBS questions "*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.)*" and "*During the past 7 days, how many times did you drink a can, bottle, or glass of a sports drink such as Gatorade or PowerAde*? *(Do not count low-calorie sports drinks such as Propel or G2.)"*. For each question, student responses were dichotomized as "Yes" and "No" for consumption. For the purpose of this study, responses indicating consumption ≥ 1 times a day during the seven days before the survey were categorized as 'Yes' while all other responses were categorized as 'No', for both questions.

- Obesity / overweight

Overweight and obesity status is obtained from the mutually exclusive variables - Overweight (QNOWT) and Obese (QNOBESE) - that indicate those who are overweight or obese. Overweight is coded as 1= Overweight (≥85th percentile and <95th percentile for BMI by age and gender) and 0 = Not Overweight. Obese was coded as 1 = Obese (≥95th percentile for BMI by age and gender) and 0=Not Obese. QNOWT and QNOBESE was determined from age, sex and BMI data using the "SAS Program for the 2000 CDC Growth Charts" developed by the CDC's Division of Nutrition, Physical Activity, and Obesity.

- Physical activity

Physical activity status was determined by assessing reported physical activity indicated by responses to the question "*During the past 7 days, how many days were you physically active for a total of at least 60 minutes per day*?" Physical activity (PA) status was categorized into three groups: 1 = 0 days in the past week, 2 =1 to 6 days in the past week and 3 = 7 days in the past week.

- Socio-demographic characteristics

Socio-demographic variables included gender and race/ethnicity (American Indian/ Alaska Native, Asian, black/African American, Native Hawaiian/ Pacific Islander, white, Hispanic, Multiple-Hispanic, Multiple- non Hispanic) were determined by respondent self-report.

Analysis

Weighted percentages were used to examine differences in SSB consumption and obesity prevalence by 1) gender and race/ethnicity and 2) physical activity status. Simple logistic regression was performed to analyze univariate associations between adiposity and each of the covariates including SSB consumption, gender, race and physical activity status. Multivariable logistic regression was used to determine associations of each variable of interest with adiposity, after adjusting for all covariates of interest in the multivariable model. Odds ratios and 95% CIs were calculated. A p-value of < 0.05 and 95% Confidence intervals was used to determine statistical significance. SAS software (version 9.3, SAS Institute, Inc) was used for all statistical analyses.

RESULTS

Sociodemographic characteristics

The distribution of socio-demographic characteristics and the physical activity status among the eligible high school students for this study are shown in **Table 1**. This includes numbers and percentages of students by gender, race as well as physical activity category. Percentages of male and female students were approximately equal (51% male, 49% female). The highest proportion of students were white (54.5%), about 14% were black/ African American, and 10% were Hispanic students. To account for the uneven sampling, appropriate weight was used for oversampling of African American and Hispanic students. 59% of the students reported to have between 1 to 6 days of physical activity in the week before the survey, while only 27% met the physical activity recommendation of daily physical activity on all 7 days.

SSBs consumption

Table 2 indicates the consumption levels of SSBs - sodas and sports drinks - by socio demographic characteristics and physical activity status. Consumption of sodas and sports drinks refers to having consumed a can/bottle/glass of soda/pop (not counting diet soda or diet pop) or a can/bottle/glass of sports drinks (not counting low-calorie sports drinks) one or more times a day during the 7 days before the survey. Overall, 20% of students drank sodas one or more times a day and about 14% drank sports drinks one or more times a day. More male than female students consumed both sodas and sports drinks (Sodas: 24% for males, 16% for females; Sports drinks: 19% for males, 9% for females). Native

Hawaiian, multiple non- Hispanic, and black students were the largest consumers of sodas, followed by American Indians, multiple-Hispanics, Hispanics, and whites (27% for Native Hawaiians, 24% for multiple-non Hispanics, 23% for blacks, 22% for American Indians, 22% for multiple-Hispanics, 21% for Hispanics and 20% for whites). For sports drinks, Native Hawaiians and blacks had the largest percentage of consumers (20% for both Native Hawaiians and blacks). Among the physical activity (PA) categories, the largest percentage of students consuming sodas was in the group with zero days PA (25%), although a similar but slightly lower percentage of students (24%) in the daily PA category reported consuming sodas daily as well. Interestingly, consumption of sports drinks was highest in the daily PA category than the other categories (24% for daily PA, 10% for no PA, 10% for 1 to 6 days PA).

Prevalence of obesity and overweight

Table 3 indicates the prevalence of obesity and overweight by socio-demographic characteristics and physical activity status. In the overall sample, about 14% were obese and 16% were overweight. A larger percentage of male students were obese than female students (17% for males, 11% for females). Approximately similar proportions of females and males were overweight (17% for females, 16% for males). Among races, prevalence of obesity was highest among Native Hawaiians (19%), followed by a 17% prevalence in black, Hispanic and multiple-Hispanic students. The prevalence of overweight was highest in multiple-Hispanics (19%) and Hispanics (18%), followed by blacks (17%). Among PA categories, both obesity and overweight had the highest prevalence among students with zero days PA (Obesity: 16% for 0 days PA, 14% for 1 to 6 days PA, 12% for daily PA; Overweight: slightly over 17% for 0 days PA, 17% for 1 to 6 days PA, 14% for daily PA).

Table 4 shows the prevalence of overweight or obesity by SSB consumption. Consumption refers to having consumed a can/bottle/glass of soda/pop (not counting diet soda or diet pop) or a can/bottle/glass of sports drinks (not counting low-calorie sports drinks) one or more times a day during the 7 days before the survey. The prevalence of obesity was higher among those who consumed SSBs when compared to those who did not consume them (Sodas: 15.6% for those who consumed, 12% for those who did not consume; Sport drinks: 16% for those who consumed, 13% for those who did not consume). However, the prevalence of overweight was somewhat similar among those who consumed SSBs and those who did not.

Univariate and multivariate logistic regression analyses

The results of univariate logistic regression analyses of selected independent variables and the risk of obesity and overweight are shown in Table 5. Further multivariate logistic regression analyses are also shown in Table 5 indicating crude and adjusted odds ratios and confidence limits, after adjusting for all covariates in the model. Multivariate logistic regression revealed significantly higher odds of obesity among male students when compared to the odds of obesity among female students (OR = 1.7, 95% CI = 1.4, 2.1). Among races, Hispanic and multiple-non Hispanic students had significantly higher odds of obesity as compared to the odds of obesity among white students (Hispanic: OR=1.5, 95% CI=1.2, 1.8; Multiple – non Hispanic: OR=1.65, 95% CI=1.09, 2.48). On the other hand, the odds of obesity among Asian students was significantly lower than the odds of obesity among white students (OR=0.3, 95% CI=0.21, 0.54). Furthermore, the odds of obesity among students who performed daily physical activity was significantly lower than the odds of obesity among those who did not exercise daily (OR=0.6, 95% CI=0.46, 0.79). Regarding the association between SSB consumption and adiposity, the odds of obesity among those who consumed sodas or sports drinks $\geq$1 time per day was slightly higher than the odds of obesity among those who did not consume them ≥1 time per day, but this was not statistically significant. Furthermore, univariate and multivariate logistic regression analyses for those who consumed both sodas and sports drinks revealed no significant association with obesity (Adjusted OR=0.91, CI=0.72, 1.15) or overweight (Adjusted OR=1.02, CI=0.86, 1.23).

DISCUSSION

In light of the adolescent obesity trends and the need to examine dietary factors responsible for increased energy intake, this study reports SSB consumption levels among high school students in the U.S., using data from the YRBS 2015. Nationwide, 1/5th of the high school students consumed one or more can/bottle/glass of soda or pop everyday in the last seven days before the survey. This is consistent with recent literature that showed that soda remains the most frequently consumed SSB type among adolescents [49, 50]. Gender differences were observed in the consumption trends – significantly more number of male students consumed sodas and sports drinks than female students – which conforms to findings from other studies [50]. Native Hawaiian, multiple non- Hispanic, and black students had greater consumption of sodas than other races. Other recent studies found that racial minorities were more likely to consume SSBs [49, 50], and one study revealed an increase in SSB intake during the period from 1988 to 2004 among racial minority adolescents when compared to white adolescents [51]. Among PA categories, more students who did not perform any PA consumed sodas than those who performed PA. Interestingly, sports drink consumption was highest among students who performed PA daily, when compared to those who exercised less or did not exercise. Although previous studies have reported a triple increase in sports drinks consumption among adolescents in the period from 1999–2000 to 2007–2008 [49], what is interesting from the findings in this study, is that active adolescents who are meeting their PA recommendations continue to consume sugar-laden energy/sports drinks. This can indicate that adolescents may have a misguided perception of sports drinks that lacks specific knowledge about their sugar content, contribution to excessive energy intake and possibly weight gain. It may also mean that adolescents who exercise regularly feel that restricting sugar intake is unnecessary because of their physically active lifestyle. Additionally, peer influences among students within sport teams, fitness groups or social circles might play a role in the increased sport drink consumption among physically active youth.

In examining the association between SSB consumption and obesity, this study found that students who consumed sodas and sports drinks one or more times daily had a higher prevalence of obesity than those who did not consume them. This finding about the possible positive association between SSB consumption and obesity is congruous with earlier studies [20, 21]. However, the current study did not find a significant difference in the odds of obesity between those who consumed SSBs one or more times daily and those who did not. Certain studies have had similar findings in showing no association between SSBs and weight gain in children and adolescents [52, 53]. There could be several reasons for the lack of association between SSB consumption and adiposity in this study. A recent review of systematic literature reviews reported that all reviews that showed a direct association between SSB consumption and adiposity in children and adolescents involved longitudinal studies and only a few involved cross-sectional studies [22]. Although a majority of reviews showed a positive association between SSB consumption and weight gain, the authors concluded that discrepancies in results in current literature could be due to methodological differences in study design, measures or analyses [22]. In addition to study design, the fact that SSB consumption was measured only by soda and sport drinks consumption made the scope of finding any association very narrow, in the current study. It may have failed to measure the consumption of a wide range of other SSBs including sweetened teas/coffees, sweetened milk, milk alternatives, and fruit juices that are consumed at large by adolescents.

Regarding overall obesity prevalence, this study finds that more male students were obese than female students, which may be consistent with the earlier finding that more males consumed SSBs than females. Obesity prevalence was highest among Native Hawaiian students and the prevalence of overweight was highest in multiple-Hispanic, Hispanic and black students. Students with zero days PA had the highest prevalence of obesity and overweight than those who performed PA. The prevalence of overweight, however, did not vary between the SSB consumption groups. Students from Hispanic and multiple-non Hispanic racial groups had significantly higher odds of obesity when compared to white students, and male students had significantly higher odds of obesity than female students. Daily physical activity, as per recommendations, seemed to have a protective effect by lowering the odds of obesity significantly among students who exercised daily, as compared to those who did not exercise.

Strengths and Limitations

This study is among the first to examine trends of SSB consumption by PA status, socio-demographic factors and obesity/overweight prevalence in US adolescents using data from the 2015 YRBS. However, there are certain limitations to this study. First, all data obtained in the survey is self-reported and may have been inaccurately reported. Self-reported data on weight and height and thereby BMI could be erroneous. Second, within the scope of this study, SSBs included only sodas and sports drinks. Information on other SSB types like sweetened tea and coffee drinks, sweetened milk drinks, sweetened fruit/vegetable drinks were not available. Third, while exploring associations between SSBs and obesity/overweight, there are numerous other dietary, physical, genetic and environmental factors that could impact obesity status, which cannot be fully measured. Fourth, obtaining an accurate measure of caloric intake from SSBs was not within the scope of this survey. Lastly, this being a cross-sectional study it is difficult to gauge long-term patterns and implications of SSB consumption among adolescents.

Policy Implications and Future Recommendations

This study finds that a considerable proportion of adolescents nationwide consume SSBs, specifically sodas and sports drinks, one or more times daily. More males, and certain racial minorities are the largest consumers of SSBs, especially in the absence of daily physical activity. Certain policy measures are in place and have shown to be effective including reducing SSB advertising targeted towards children, reducing access to sodas in schools, using media influence to curb SSB consumption in children, increasing costs of SSBs and taxing SSBs to reduce purchase [54, 55, 56]. Following SSB bans in schools in certain states, studies found decreased consumption of SSBs by students [57, 58, 59]. Certain states like Berkeley and Philadelphia have passed heavy taxes on SSBs that are proving effective in reducing consumption. In New York City, implementing a SSB excise tax, educative media campaigns, reducing availability in various locations, curbing Supplemental Nutrition Assistance Program benefits, and controlling SSB portion sizes served at establishments, all led to a substantial decrease (27%) in SSB consumption among high school students [60]. In addition to a 20% tax, another recent study examined the effect of plain packaging and warning labels on SSB purchase and found a resulting reduction in preferences and reported SSB purchases [61]. Learning from these success stories, similar policy changes nationwide and more specifically in schools can be implemented to curb SSB consumption. It is especially important to impart knowledge about the deleterious effects of SSBs on health to adolescents to ensure they make informed choices. Social media can be a powerful tool among youth to be able to reach them effectively.

Further research can be focused on examining a wider range of SSBs and also the concurrent role of sugar-sweetened fast foods that are readily available and extensively marketed to adolescents. Additionally, more insight into the extent of influence by other factors such as adolescents' perceptions, preferences, motivations, locations, peer influence, parental guidance, parental SSB consumption, and access to SSBs at home is needed.

Conclusions

This study provides insight into SSB consumption trends in US adolescents by socio-demographic factors and PA status, as well as its association with obesity/overweight. Male gender, certain racial minorities and lack of physical activity can potentially be responsible for greater SSB consumption. Sports drink consumption is high even in physically active youth. Although this study does not find a significant association between SSB intake and adiposity, possibly due to the limited range of SSBs taken into account and the study design, we should consider the totality of evidence about the harmful effects of SSBs in youth. This study's findings can provide useful considerations while developing and implementing programs or policies that target reducing SSB consumption among adolescents. These findings about SSB consumption trends across gender, ethnicities and physical activity groups can help guide targeted strategies to reduce SSB consumption among high-risk populations. Ideally, a combination of measures including curbing availability, reducing targeted marketing, increasing SSBs cost, simultaneous reduction in costs of healthier alternatives, educative and informational measures through mass media, school-based policies and interventions targeted at adolescents and parents will together prove most effective in reducing SSB consumption.

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APPENDICES

Table 1: Socio-demographic characteristics and physical activity status of high school students[a]

Characteristic	%	N
Sex		
Male	51.30	7749
Female	48.70	7757
Race/Ethnicity		
American Indian/ Alaska Native	0.61	163
Asian	3.76	627
Black/African American	13.58	1667
Native Hawaiian/ Pacific Islander	0.65	100
White	54.48	6849
Hispanic	9.93	2365
Multiple- Hispanic	12.3	2756
Multiple – Non Hispanic	4.6	739
Physical Activity (≥60mins) in the past 7 days		
0 days	14.29	2341
1 to 6 days	58.64	9011
7 days	27.06	3893

[a]Weighted percentage may not add up to 100% because of rounding

Table 2: SSB consumption ≥1 time per day in the past week, by socio-demographic characteristics and physical activity status of high school students[a]

Characteristic	SSB consumption ≥1 time per day			
	Sodas		Sports Drinks	
	%	N	%	N
Total Sample	20.4	3413	13.8	1700
Sex				
Male	24.33	2002	18.69	1094
Female	16.44	1388	8.84	592
Race/Ethnicity				
American Indian/ Alaska Native	21.83	45	15.1	27
Asian	8.87	67	6.19	28
Black/African American	22.71	393	19.73	224
Native Hawaiian/ Pacific Islander	26.82	25	20.13	18

White	19.67	1513	12.42	657
Hispanic	21.13	489	14	274
Multiple- Hispanic	22.07	623	17.03	359
Multiple – Non Hispanic	24	165	14.49	83
Physical Activity (≥60mins) in the past 7 days				
0 days	25.08	582	10.36	180
1 to 6 days	17.71	1791	9.86	751
7 days	23.79	1014	23.77	755

[a]Weighted percentage may not add up to 100% because of rounding.

Table 3: Obesity/overweight prevalence by socio-demographic characteristics and physical activity status of high school students[a]

Characteristic	Obesity/overweight prevalence			
	Obese		Overweight	
	%	N	%	N
Total Sample	13.9	2171	16	2365
Sex				
Male	16.83	1319	15.55	1148
Female	10.81	852	16.55	1217
Race/Ethnicity				
American Indian/ Alaska Native	15.94	23	12.7	30
Asian	5.52	44	11.92	68
Black/African American	16.76	256	17.17	242
Native Hawaiian/ Pacific Islander	18.56	17	12.15	14
White	12.39	856	15.24	982
Hispanic	17.26	389	18.29	386
Multiple- Hispanic	15.77	444	18.54	484
Multiple – Non Hispanic	17.49	107	15.45	119
Physical Activity (≥60mins) in the past 7 days				
0 days	15.8	357	17.16	333
1 to 6 days	14.48	1303	16.59	1430
7 days	11.74	464	14.14	544

[a]Weighted percentage may not add up to 100% because of rounding

Table 4: Prevalence of obesity/overweight by SSB consumption in high school students

SSB consumption	Overweight/Obesity N (%)	
	Obese	Overweight
Sodas		
≥1 time per day in the last 7 days	15.61	15.44
0 times in the last 7 days	11.83	15.6
Sports Drinks		
≥1 time per day in the last 7 days	16.06	15.3
0 times in the last 7 days	12.9	15.86

Table 5: Univariate and multivariate associations between selected independent variables and obesity/overweight

	Obesity				Overweight			
	Adjusted		Unadjusted		Adjusted		Unadjusted	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
SSB consumption ≥1 time per day[a]								
Sodas	1.06	0.83, 1.37	1.19	0.96,1.48	0.93	0.80, 1.07	0.94	0.84, 1.06
Sports Drinks	1.11	0.83, 1.49	1.26	0.96, 1.63	0.99	0.82, 1.18	0.93	0.79, 1.09
Sex[b]								
Male vs. Female	1.71	1.4, 2.1**	1.67	1.40, 1.99**	1.02	0.88, 1.19	0.93	0.80, 1.08
Race/Ethnicity[c]								
American Indian/ Alaska Native	1.32	0.59, 2.97	1.34	0.61, 2.94	0.78	0.34, 1.77	0.81	0.39, 1.69
Asian	0.34	0.21, 0.54*	0.41	0.26, 0.67*	0.68	0.46, 0.99*	0.75	0.55, 1.02
Black/African American	1.33	0.97, 1.84	1.42	1.10, 1.85**	1.17	0.93, 1.49	1.15	0.96, 1.38
Native Hawaiian/ Pacific Islander	1.52	0.57, 4.05	1.61	0.63, 4.13	0.60	0.28, 1.3	0.77	0.40, 1.48
Hispanic	1.47	1.2, 1.8**	1.47	1.19, 1.83**	1.14	0.95, 1.37	1.24	1.06,1.46**
Multiple-Hispanic	1.27	0.96, 1.67	1.32	1.02, 1.72**	1.24	1.06, 1.46**	1.27	1.09,1.47**
Multiple – Non Hispanic	1.65	1.09, 2.48**	1.50	1.02, 2.19**	1.07	0.74, 1.55	1.02	0.73, 1.42
Physical Activity (≥60mins) in the past 7 days[d]								

1 to 6 days	0.88	0.70, 1.10	0.90	0.74, 1.10	0.92	0.76, 1.11	0.96	0.82, 1.12
7 days	0.60	0.46, 0.79*	0.71	0.57, 0.89*	0.75	0.55, 1.03	0.79	0.63, 1.01

[a]reference group=did not consume ≥1 time per day; [b]reference group=female; [c]reference group=white; [d]reference group=0 days; **indicates significant higher odds; *indicates significant lower odds