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A Comparison Study among the High School Students in the US: Obesity and Overweight Rates among Racial Minorities—Stress, Dietary Behavior, Sports and Physical Activity Participation

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A Comparison Study among the High School Students in the US: Obesity and Overweight Rates among Racial Minorities—Stress, Dietary Behavior, Sports and Physical Activity Participation

Abstract:

Background: The Youth Risk Behavior Surveillance System (YRBSS) collects data on American youth primarily for assessing various health risk factors. This study aims to examine the relationship between demographic, and behavioral variables that we have considered as risk factors and obesity in American youth in 2015 and 2019.

Methods: Data pertaining to obesity risk factors and BMI measurements were obtained from the YRBSS. Cross Tables and linear regression models were constructed and subsequent analyses were used to examine the correlation between risk factors and BMI. Two-sample t-tests were used to explore the difference between the 2015 and 2019 datasets.

Results: Race and ethnicity were found to be significantly associated with a change in BMI from 2015 to 2019 alongside other behavioral risk factors such as fruit consumption, skipping breakfast, physical activity, involvement in sporting teams, sleeping hours, and academic performance.

Conclusions: BMI is significantly affected by various risk factors. Ensuing research should examine the association of more factors with BMI.

Keywords: Body Mass Index (BMI), Youth Risk Behavior Surveillance System (YRBSS), Obesity, Hispanic, Consumption

Background

The last three decades have seen alarming development in the obesity crisis [1], and recorded data has continuously shown that minority communities, predominantly the Hispanic and the Non-Hispanic African American communities, have been most severely affected by this crisis [2]. Upon closer inspection, we can observe behavioral patterns and conditional factors contributing to the significantly higher occurrence rate of obesity in the Hispanic and Non-Hispanic African American communities. These conditional factors include lower economic status [3], targeted advertisement of unhealthy beverages including alcohol and foods [4, 5], normification of higher BMI [6], reduced physical activity [7], low sports participation [8], psychological stress [9, 10]. Taken together, these conditional factors contribute to the alarmingly high concentrations of obesity observed in the Hispanic and Non-Hispanic African American communities.

Studies have shown that obesity observed in childhood often develops into severe obesity in adulthood [11]. Data sets such as the National Health and Nutrition Examination Survey (NHANES) have shown a steady increase in the rate of childhood obesity among all racial communities in the United States in the past three decades. Similar to adulthood obesity, childhood obesity rates in the Hispanic and Non-Hispanic African American communities have

been found to be significantly higher than in Asian American or Non-Hispanic White communities. Therefore, it is critical to examine in detail and attempt to combat the obesity crisis we observe today.

Frequent observational studies in high-obesity communities have shown the apparent lack of leisure, physical activity, and sport participation [8]. Resources such as playground equipment and other resources that promote physical activity have been observed to be positively associated with participation in physical activity [12]. Low-resourced communities have less availability of these resources. Accordingly, their members are less likely to participate in physical activity, increasing the risk for obesity.

Targeted advertising has a profound effect on the obesity crisis in low socioeconomic and minority communities. High-density and high-poverty areas see a heavy influx of advertisements for alcohol and tobacco when compared to affluent areas [4]. Similarly, high-poverty areas with a large Latino population have been observed to host advertisements for unhealthy foods and beverages in Spanish, specifically designed to target the Latino minority [5]. The effects of frequent advertisements appear to compound, making these communities highly vulnerable to poor dietary habits.

It is also of particular interest to note that studies have found that Latino adolescents and children slept less on average every night regardless of socioeconomic status [13]. This finding is notable as research has shown that lack of sleep can independently be a risk factor for obesity [14]. However, this finding remains to be confirmed, and further analysis is required.

Stress, particularly parental stress, has been observed to influence childhood obesity. Parental stressors regarding personal medical issues have been reported to correlate with childhood BMI [9] significantly. Parental stressors such as community safety have also been reported to be significant to childhood BMI, with families who relocated to low-poverty, low-crime communities from high-poverty, high-crime communities experiencing lower rates of obesity as compared to a control group after 4-7 years [15]. The parental-adolescent conflict has also been observed to promote obesity-inducing eating habits in adolescents [10].

However, while numerous studies have shown that obesity occurs on a larger scale in the African American and Hispanic/Latino communities in the United States [2, 9, 16], when the relationship between race, ethnicity, and obesity/overweight is examined independently from socioeconomic status, it was found that low income was more closely associated with obesity than race and ethnicity [17].

A study has reported that a decline in academic performance has been recorded in grade sheets between the 10th and the 12th grade among obese students when a multiple logistic model accounting for sociodemographic characteristics, study habits, self-esteem, and obesity was taken [18]. The same study also found that obesity independently had a negative impact on academic performance. However, studies with a larger sample size and review articles have shown that the relationship between obesity and academic performance becomes less concrete and uncertain when adjusted to account for covariates such as socioeconomic status, physical

activity, and parental education [19].

In an attempt to combat the obesity crisis among the youth in America, several field-based studies have been conducted, and numerous initiatives have been taken. In their paper, Trude et al. aimed a study based on the intervention of the consumption of unhealthy foods and beverages targeted at zones primarily populated by members from the Hispanic and Non-Hispanic African American communities [20]. Coleman et al. tested for the effects of increased exercise and physical activity during physical education classes in low-income zone public schools using control groups. These studies resulted in trends toward significant improvement in the prevention of the obesity crisis in their respective sample populations [21].

The purpose of this study is to examine the correlation between obesity and multiple risk factors that we believed to be of significant importance regarding overweight and obesity and compare results between the 2015 and 2019 YRBSS datasets.

Methods

Youth Risk Behaviour Surveillance System (YRBSS)

Data used in our analysis has been primarily taken from the Youth Risk Behavior Surveillance System (YRBSS), a survey that includes the national school-based survey conducted by the Centers for Disease Control and Prevention (CDC) and state and local surveys conducted by the state, territorial and local education and health agencies and tribal governments. The YRBSS survey is taken every two years, with a standardized minimum denominator sample size of 100. In cases where the primary population is significantly smaller, lower sample sizes have been taken to accommodate the purpose of the study. For the purpose of this research, YRBSS datasets from 2015 and 2019 have been used.

In the YRBSS dataset, categories for the “sex” variable include 1 = Female and 2 = Male. There are four categories for defining race and ethnicity, “race4” which includes 1 = White, 2 = Black or African American, 3 = Hispanic/Latino, and 4 = All Other Races.

The variables focused on in this study include questions q69-q77 from the YRBSS, which provide data for the dietary habits of the sample population, presenting us with an insight into the eating behavior of our high schoolers. Questions q69 and q70 focus on the quantitative data collection for healthy fruit consumption, while questions q71-q74 emphasize the quantitative data collection for healthy vegetable consumption. In contrast, question q75 relates to the consumption of unhealthy beverages. Question q76 asks the question to collect quantitative data on milk consumption. For these questions, there are seven categories; 1 = No consumption in the past 7 days, 2 = 1-3 times in the past 7 days, 3 = 4-6 times in the past 7 days, 4 = 1 time per day, 5 = 2 times per day, 6 = 3 times per day, 7 = 4 times or more per day.

As some articles have reported [22], a significant population skips breakfast. Question q77 focuses on breakfast consumption in the 7 days prior to the survey and is utilized to compare datasets for BMI and breakfast skipping. For question q77, the qualitative variables were

collected with 8-categories; 1 = 0 days, 2 = 1 day, 3 = 2 days, 4 = 3 days, 5 = 4 days, 6 = 5 days, 7 = 6 days, 8 = 7 days.

Questions q78 to q82 in the YRBSS collect quantitative variables that can serve as outcome variables, which provide us with information on the physical activity of our sample population. Question q78 collects quantitative data for how many days survey takers were physically active for 60 minutes or more in the week prior to the survey. For question q78, categorical variables were collected with 8-scales; 1 = 0 days, 2 = 1 day, 3 = 2 days, 4 = 3 days, 5 = 4 days, 6 = 5 days, 7 = 6 days, 8 = 7 days. Questions q79 and q80 collect information on how many hours did survey takers spend watching television and computers on school days, respectively, both collecting factors include seven categories; 1 = 0 hours, 2 = Less than 1 hour per day, 3 = 1 hour per day, 4 = 2 hours per day, 5 = 3 hours per day, 6 = 4 hours per day, 7 = 5 or more hours per day. Question q81 gathers data on how many days did survey takers participate in Physical Education (PE) classes with categories: 1 = 0 days, 2 = 1 day, 3 = 2 days, 4 = 3 days, 5 = 4 days, 6 = 5 days. Question q82 collects data on how many sports teams were survey takers involved in during the 12 months prior to the survey with 1 = 0 teams, 2 = 1 team, 3 = 2 teams, and 4 = 3 or more teams.

This data is used to help us develop a better understanding of how the lack of physical activity correlates to overweight or obesity among our sample population, also how significant the presence of lack of physical activity is to obesity among our high schoolers, and how physical activity correlates to dietary habits and sleeping habits when compared with our other questions.

As seen in previous studies [21], we know that sleeping habits are disproportionately disrupted for minority communities as they often live in overcrowded spaces. The quantitative data collected from question q88 provides an insight into the sleeping habits of our sample population as disrupted sleep can be significant to obesity [24]. Question q88 in the YRBSS collects categorical data in the form of 1 = 4 hours or less, 2 = 5 hours, 3 = 6 hours, 4 = 7 hours, 5 = 8 hours, 6 = 9 hours, 7 = 10 hours or more.

Another variable we explored was academic performance and its correlation to BMI. Question q89 in the YRBSS collects quantitative data on the academic performance of survey takers which is explored to examine the relationship between academic performance and BMI. Question 89 collects categorical data with variables 1 = Mostly A's, 2 = Mostly B's, 3 = Mostly C's, 4 = Mostly D's, 5 = Mostly F's, 6 = None of these grades, 7 = Not sure.

Statistical Analysis

Taking subsets of data from the years 2015 and 2019 from YRBSS datasets, we first conducted a cross-table analysis using R studio version 1.4.1717 to describe the relationship between variables, like, sex, race, fruit juice consumption, and fruit consumption. We also consider green salad, vegetables (potatoes, carrots, and others), soda/pop, and milk consumption, skipping breakfast, daily physical activity, daily television watching time, participation in physical education classes, involvement in sporting teams, hours of sleep and academic performance and the four BMI categories: obese, overweight, normal-weight and underweight. For visual

comparison, the Box and Whisker plots were examined. Descriptive statistics, like means and standard deviations were calculated. The density plots for the selected variables were examined for graphical comparison. Linear regression models were implemented to describe the relationship between our selected variables and BMI or race⁴. Welch's t-tests were also calculated for these variables between the 2015 and 2019 datasets to test for significance.

Results

The 2015 YRBSS survey had a total of 15624 participants, among which 6844 participants identified as White, 1665 participants identified as Black/African American, 5114 participants identified as Hispanic/Latino, and 1627 participants identified as being from other races. There were 7149 participants who identified as female, and 7221 participants who identified as male. In the 2019 YRBSS dataset, there were 13677 survey takers out of which 6667 identified as White and 2034 identified themselves as Black/African American. There were 3034 respondents who identified as Latino/Hispanic and 1493 survey takers defined themselves as “other races.” A total of 6179 participants identified as female, while 5971 participants identified as male.

The 2015 analysis shows that about 10.2% of females and 12.4% of male survey participants were obese with a BMI of more than or equal to 30, 17.9% of females and 20.1% of male respondents were categorized as overweight with a BMI between 25 and 30, approximately 62.6% of females and 58.0% of males in the study were normal weight with a BMI between 18.5 and 25 and 9.3% of females and 9.4% of males survey participants were underweight with a BMI of less than 18.5. Interestingly, in the 2019 YRBSS dataset, 10.2% of female survey participants were categorized as obese and 17.3% as overweight. 62.0% of female survey participants were in the normal weight range and 10.5% were underweight. On the other hand, about 11.8% of male survey participants were categorized as obese, which is 0.6% less than in 2015, 19.3% as overweight, 58.9% as normal weight, and 10.0% as underweight.

About 13.4% of Latino survey takers were categorized as being obese in comparison to 13.1% of Black/African American respondents, 9.8% of White high schoolers, and 9.8% from “other races” in the 2015 YRBSS dataset. Similarly, the high schoolers who were Latino and African American were reported to have much higher rates of overweight (21.7% and 20.9% respectively) when compared to their White (17.3%) counterparts and also from other races (16.6%). Similarly, data from the 2019 YRBSS shows that 8.9% of White survey takers were obese in comparison to 15.7% of Black/African American students, 13.5% of Latino/Hispanic survey respondents, and 9.4% of “other races.” Similarly, 16.4% of White survey takers were categorized as being overweight in comparison to 20.7% of Black/African American survey takers, 22.3% of Latino/Hispanic survey takers, and 15.3% of survey takers from other races.

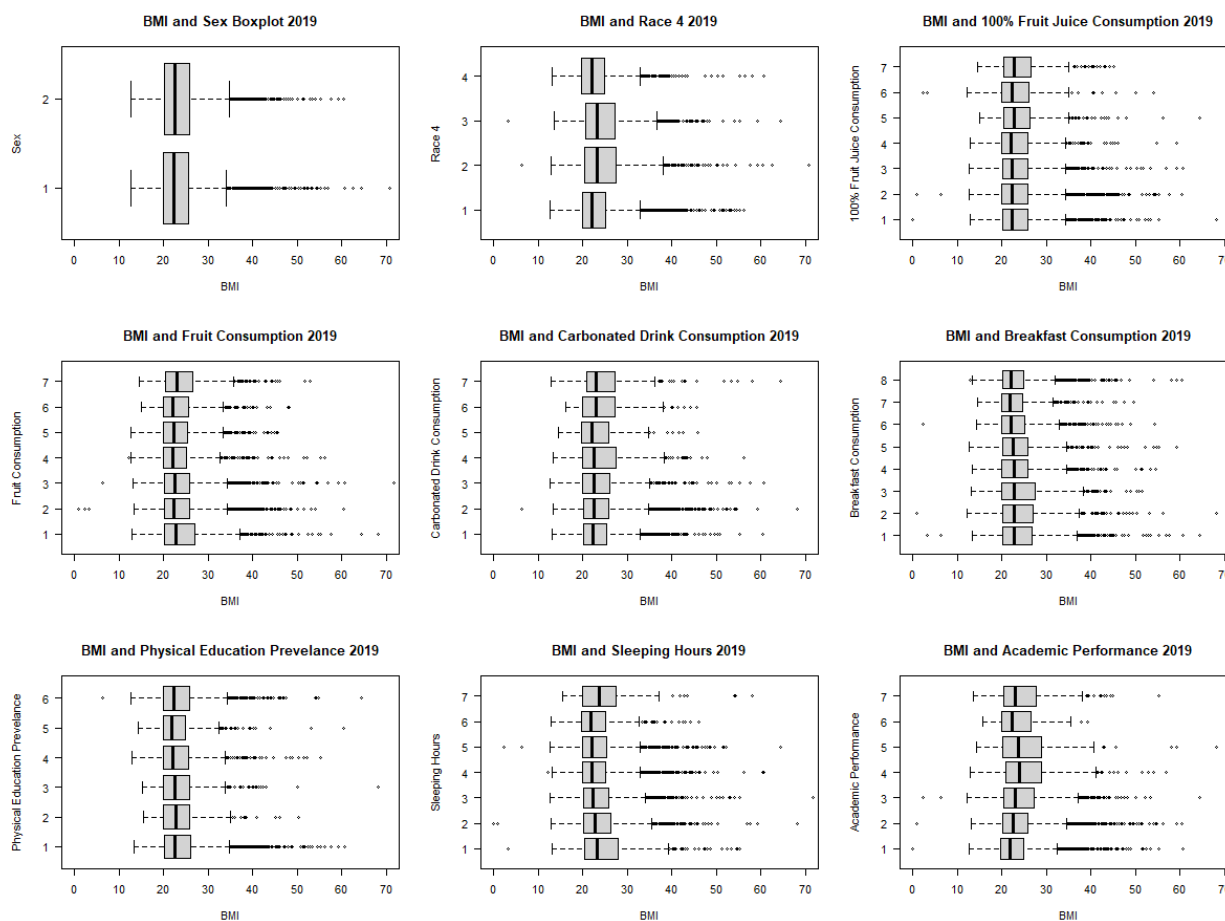


Fig. 1. Boxplot for BMI and Variables from the 2019 YRBSS dataset. Variables (Sex, Race 4, 100% Fruit Juice Consumption, Fruit Consumption, Carbonated Drink (Soda/Pop) Consumption, Breakfast Consumption, Physical Education Classes, Sleeping Hours, and Academic Performance) were categorical and numerical values 1-2, 1-4, 1-6, 1-7 and 1-8 represent different classifications.

In the 2015 YRBSS dataset, we observe that individuals from a higher BMI category consume similar amounts of 100% fruit juice as compared to individuals with a normal BMI category on a weekly basis with 24.5% of obese participating students having not consumed fruit juices once in the previous week, as compared to 21.6% of overweight and 23.3% of normal-weight survey takers. We also observe that participating students with a higher BMI consume fewer fruits on average when compared to students with a normal BMI. Our analysis revealed that 11.9% of students who were obese reported not have consumed fruits in the week before the survey was conducted as compared to 10.1% of overweight and 9.8% of students who were normal-weight. From the 2019 YRBSS survey, we observed that 32.8% of obese students had not consumed any 100% fruit juice in the week prior to the study while 30.5% of overweight participating students and 31.2% of normal-weight students reported the same. We observed that 15.3% of obese participating students reported having not consumed any fruits in the week prior to the survey compared to 13.3% of overweight students and 11.0% of normal-weight survey takers.

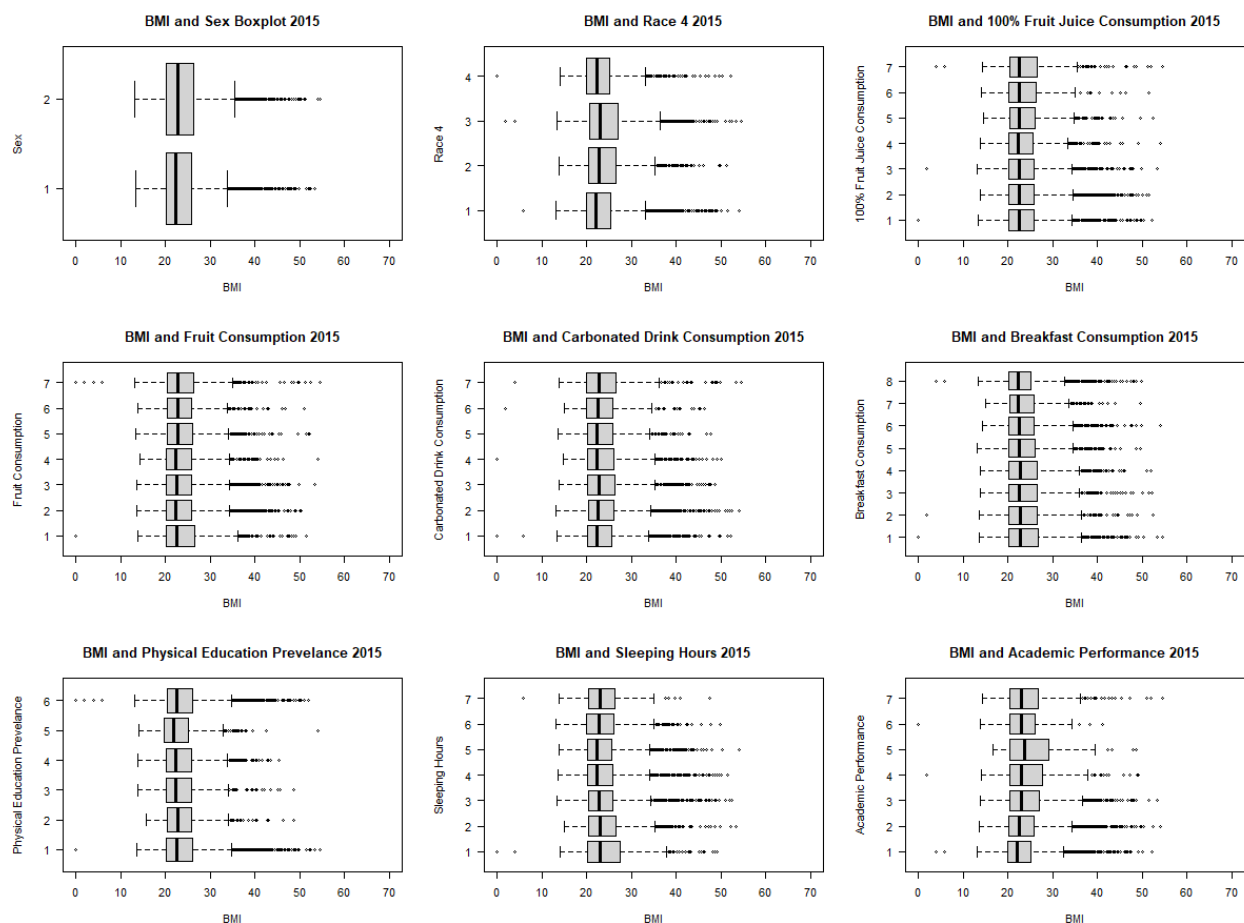


Fig. 2. Boxplot for BMI and Variables from the 2015 YRBSS dataset. Variables (Sex, Race 4, 100% Fruit Juice Consumption, Fruit Consumption, Carbonated Drink (Soda/Pop) Consumption, Breakfast Consumption, Physical Education Classes, Sleeping Hours, and Academic Performance) were categorical and numerical values 1-2, 1-4, 1-6, 1-7 and 1-8 represent different classifications.

In the 2015 YRBSS survey, high BMI individuals (Obese and Overweight) both reported skipping breakfast at a higher rate compared to normal-weight individuals with 15.7% of individuals who were obese reporting to have not consumed breakfast in the week prior to the survey and 14.5% of individuals who were overweight reporting to have done the same. In comparison, 13.2% of survey takers who were normal-weight reported to have not consumed breakfast in the week prior to the survey. Similarly, data from the 2019 YRBSS survey reported that 21.7% of obese survey takers had skipped breakfast entirely every day in the week prior to the survey in comparison to 19.7% of overweight survey takers and 14.8% of normal-weight survey takers.

We also observed that 50.6% of obese participating students reported had not participated in any PE classes in the week prior to the survey as compared to 47.7% of overweight students and 47.6% of normal-weight students in 2015 while in 2019, 55.8% of obese, 52.6% of overweight and 51.5% of normal-weight students reported the same.

We observed that 11.4% of obese survey takers reported having slept on average less than 4 hours per night as compared to 7.4% of overweight survey takers and 7.1% of normal-weight survey takers in 2015. In 2019, 15.3% of obese survey takers reported having slept less than 4 hours a night on average as compared to 11.9% of overweight survey takers and 8.3% of normal-weight survey takers. Our analysis revealed that 6.5% of White survey participants reported having slept less than 4 hours per night on average as compared to 11.9% of Black/African American survey takers, 7.9% of Hispanic/Latino participants, and 11.2% of participants from other races in 2015. 8.6% of White, 15.0% of Black/African American, 10.4% of Hispanic/Latino, and 11.9% of other race participants reported the same in 2019.

Data from the 2015 YRBSS dataset showed that academic performances declined with an increase in weight. While 23.6% of obese survey takers reported having mostly A grades in their academics, 28.4% of overweight survey takers and 34.2% of normal-weight survey takers reported the same. Similarly, the data reports that 38.3% of obese survey takers received most B grades in their academics as compared to 40.0% of overweight and 38.6% of normal-weight survey takers. We also observed that 2.7% of obese survey takers reported having mostly F grades as compared to 1.9% of overweight and 1.1% of normal-weight survey takers. Similarly, data from the 2019 YRBSS dataset showed that only 28.6% of obese survey takers reported having mostly A grades as compared to 34.8% of normal-weight survey takers and 43.1% of normal-weight survey takers. We observed that 36.7% of obese survey takers reported having mostly B grades as compared to 38.4% and 35.7% of overweight and normal-weight survey takers respectively. 2.0% of obese, 1.2% of overweight, and 0.9% of normal-weight survey takers reported having mostly F grades.

Cross Tables from the 2015 YRBSS dataset showed that 39.0% of White students reported having scored mostly A grades as compared to 24.6% of Black/African American students, 22.2% of Latino/Hispanic students, and 36.6% of students from other races. We observed that 37.3% of White students reported having scored mostly B grades as compared to 39.5% of Black/African American students, 40.6% of Latino/Hispanic students, and 35.1% of students from other races. We observed that 1.1% of White students reported having received mostly F grades as compared to 1.5% of Black/African American students, 2.5% of Latino/Hispanic participating students, and 1.6% of students from other races. From the 2019 YRBSS dataset, we observe that 46.4% of White students, 29.4% of Black or African American students, 28.3% of Hispanic/Latino students, and 46.9% of students from other races reported having mostly A grades. 33.8% of White, 39.2% of Black/African American, 39.1% of Hispanic/Latino and 33.6% of other race students reported having mostly B grades. Our analysis indicated that 1.0% of White, 1.1% of Black/African American, 2.2% of Hispanic/Latino and 0.8% of other race students reported having mostly F grades. Box plots showing the correlation between the various factors discussed and BMI have been shown in Figures 1 and 2.

To examine the impact of sex on BMI and to compare the differences between 2015 and 2019, we constructed regression models. The regression models revealed that for females the average BMI was 23.55 in 2015 and 23.50 in 2019. We performed a two-sample t-test which revealed that the difference between 2015 and 2019 was not significant ($t=0.65$, $p>0.05$). The regression

models revealed that for males, the average BMI was 23.86 in 2015 and 23.74 in 2019. The two-sample t-test showed that there was no significant increment ($t=1.33$, $p>0.05$).

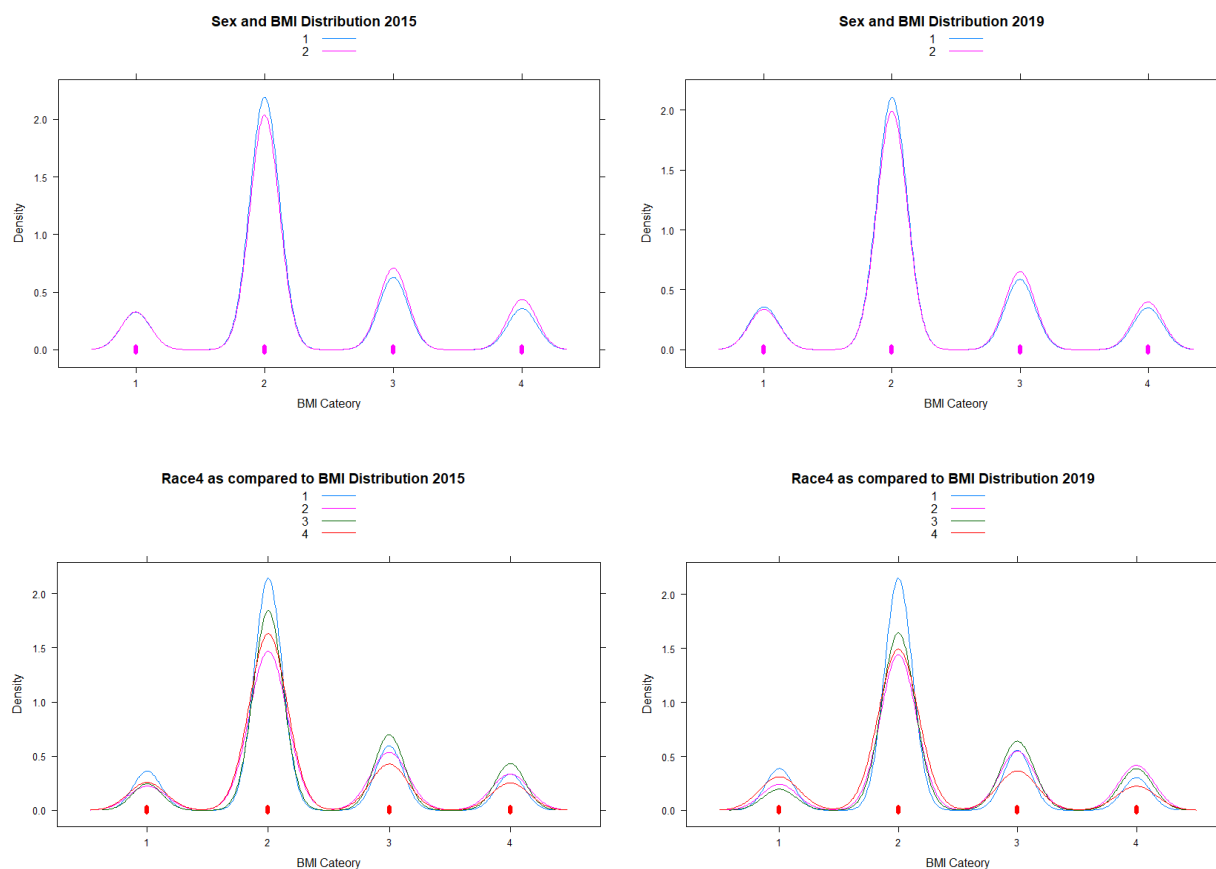


Fig. 3. Combined Probability Distribution Tables for BMI categories 1-4 and Variables Sex and Race 4 from the 2015 and 2019 YRBSS datasets.

We conducted a similar two-sample t-test to explore the impact of race and ethnicity (White, Black/African American, Hispanic/Latino, and Others) on BMI across 2015 and 2019. The regression models revealed that for White survey takers, the average BMI was 23.31 in 2015 and 23.10 in 2019 and the increment of the average BMI was significant ($t=2.50$, $p<0.05$). For Black/African American survey takers, our model revealed that BMI significantly increased ($t=-2.18$, $p<0.05$) from an average BMI of 23.21 in 2015 to 24.73 in 2019. We observed that Hispanic/Latino survey takers did not have a significant increment ($t=-0.91$, $p>0.05$) in BMI with an average of 24.28 in 2015 and 24.39 in 2019. Survey takers who belonged to “Others” had a reduced average BMI from 23.34 in 2015 to 23.07 in 2019 but this decrease was not significant ($t=1.29$, $p>0.05$). These results are highlighted in Figure 3.

Two-sample t-tests for fruit consumption revealed that fruit consumption habits demonstrated significance in regards to BMI with the average BMI of survey takers who reported they had not consumed any fruit in the week prior to the survey being 23.89 in 2015 and 24.30 in 2019 ($t=-1.70$, $p<0.05$). Survey takers who reported having consumed fruits 2 times per day in the week prior to the survey experienced a significant ($t=1.91$, $p<0.001$) decrease in average BMI

from 23.79 in 2015 to 23.26 in 2019. Similarly, survey takers who reported having consumed green salads 1-3 times in the week prior to the survey had a significant reduction ($t=2.36$, $p<0.05$) in average BMI from 23.73 in 2019 to 23.48 in 2015. Our regression models and two-sample t-tests revealed that for all other consumption habits of fruit and green salad, BMI was not significantly affected across 2015 and 2019 ($p>0.05$). We also observed that the average BMI remained relatively unchanged for survey takers with different soda/pop consumption habits between 2015 and 2019 ($p>0.05$).

Breakfast consumption was found to be significantly ($t=-2.21$, $p<0.05$) associated with BMI increment across 2015 (24.16) and 2019 (24.57) for survey takers who reported that they did not consume breakfast in the week prior to the survey. Survey takers who reported having consumed breakfast 6 times in the week prior to the survey were found to have a significant decrease ($t=2.64$, $p<0.01$) in average BMI from 2015 to 2019 with the average BMI dropping from 23.62 in 2015 to 22.91 in 2019. Similarly, consuming breakfast 7 times in the week prior to the survey was found to be significantly ($t=2.62$, $p<0.01$) associated with BMI with the average BMI dropping from 23.38 in 2015 to 23.06 in 2019.

Our regression models and two-sample t-tests revealed that sleeping for 7 hours on average during a school night had a significant ($t=3.36$, $p<0.0001$) effect on decreasing the average BMI from 2015 (23.61) to 2019 (23.21). These tests also revealed that sleeping for 9 hours on average also had a significant ($t=2.65$, $p<0.01$) decremental effect on BMI with the average BMI decreasing from 23.72 in 2015 to 24.68 in 2019.

Acquiring mostly A grades was significantly ($t=2.43$, $p<0.05$) linked to declining average BMI with participating students acquiring mostly A grades having an average BMI of 23.10 in 2015 and 22.85 in 2019. In contrast, acquiring mostly D grades was significantly ($t=-2.55$, $p<0.05$) linked with an increment in BMI with participating students acquiring mostly D grades having an average BMI of 24.49 in 2015 and an average BMI of 25.62 in 2019. These results have been highlighted in Figure 4.

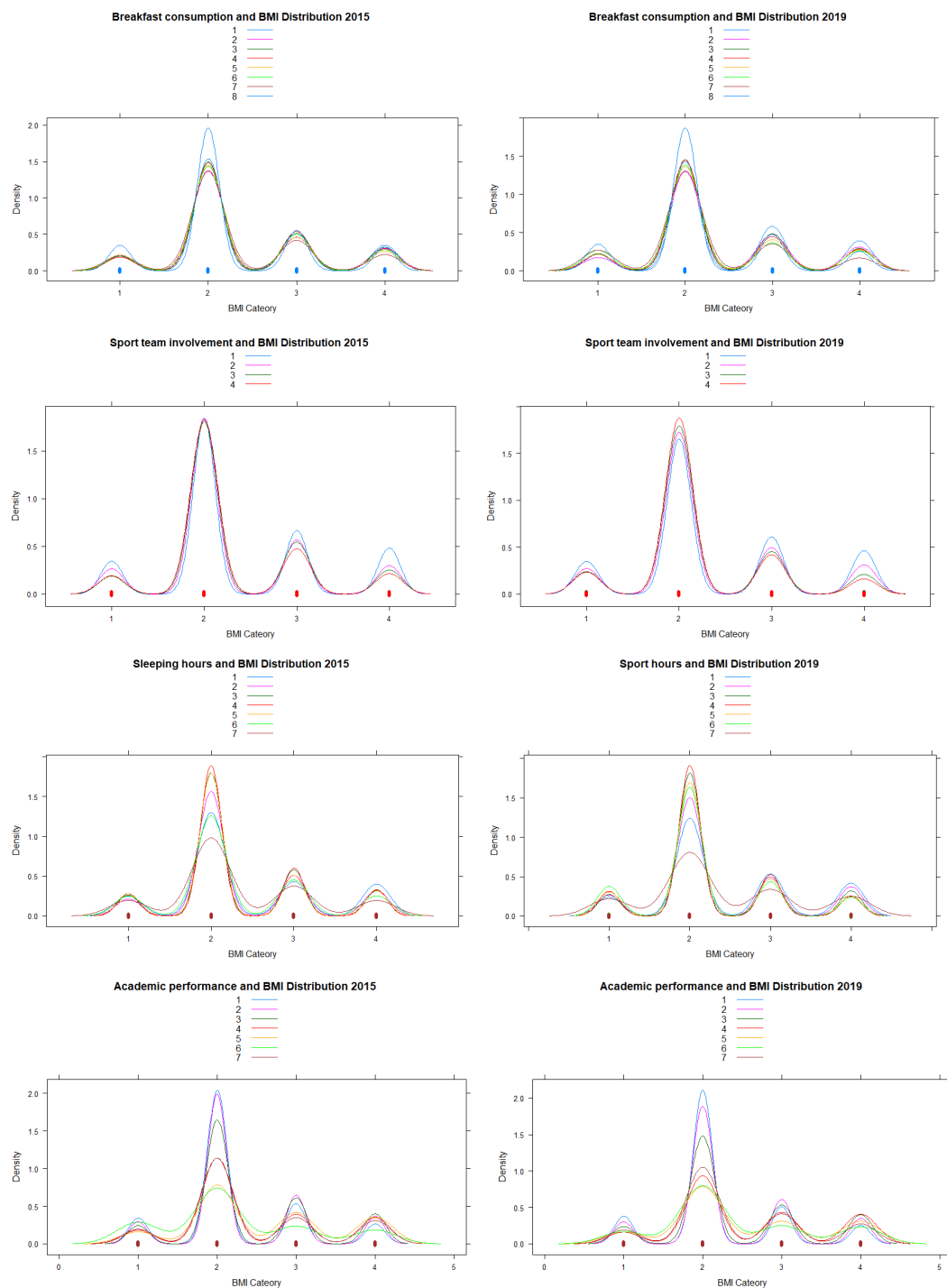


Fig. 4. Combined Probability Distribution Tables for BMI categories 1-4 and Variables Breakfast Consumption, Sporting Involvement, Sleeping Hours, and Academic Performance from the 2015 and 2019 YRBSS dataset.

Discussion

This study explores how different variables, particularly gender, race, food consumption habits, physical activity, sleeping hours and academic performance correlates to BMI and/or the 4 categories of BMI.

Our analysis indicates that more male survey takers were obese in both 2015 and 2019. While the percentage of obese female survey takers remained stagnant in 2015 and 2019, the percentage of male survey takers decreased slightly from 12.4% in 2015 to 11.8% in 2019.

As seen in previous studies [9, 25] and review articles [26], obesity rates among both adults and adolescents in African American and Latino communities are higher than in white communities. From our analysis, we observed 13.4% of Latino/Hispanic and 13.1% of Black/African American high school students being categorized as obese in 2015 as compared to only 9.8% of White high school students in 2015 and 13.5% of Latino/Hispanic and 15.7% of Black/African American students being obese as compared to only 8.9% of White students in 2019. We observed similarly higher rates of overweight in Latino/Hispanic and Black/African American students as well. Studies have previously shown that factors such as lower socioeconomic status [3, 27, 28], social behavior patterns [6], poor living conditions, and poor school districts [27, 29] all compound to greatly increase the risk of obesity among these communities. Calculated intervention in the form of the introduction of affordable healthy food choices [20] alongside responsible advertising and encouragement of healthier lifestyles [21] has been shown to significantly improve consumption habits and lifestyle choices in affected communities. As the obesity crisis escalates, further large-scale studies regarding these areas of study should be considered.

Our analysis of fruit and 100% fruit juice consumption showed that obese survey participants consumed slightly less fruit and 100% fruit juices as compared to their overweight and normal-weight peers. However, it was interesting to note that we observed a decrease in consumption of fruit and 100% fruit juices across obese, overweight, and normal-weight survey takers. Survey participants with obesity and overweight also seemed to not consume green salads with a slightly higher frequency than normal-weight survey takers.

Another interesting variable we observed included breakfast skipping. Previous studies [22] show that breakfast skipping rates are significant in the US. We observed that obese survey takers reported having skipped breakfast more than overweight and normal-weight survey takers in both 2015 and 2019. Individuals who skip breakfast tend to have improper nourishment and breakfast eaters were found to be less overweight. While our analysis has shown that breakfast skipping can contribute to an increment in BMI, a further examination into breakfast skipping and nutrition/ the obesity crisis is recommended.

Lack of physical activity and obesity/overweight was concurrent through our analysis in both 2015 and 2019. Obese survey participants reported having participated in fewer Physical Education (PE) classes, engaged with fewer sporting teams in the 12 months prior to the survey, and partook in fewer activities that resulted in increased heart rates for more than 60 minutes a day when compared to overweight and normal-weight survey takers. As studies have shown

[27] introduction of wellness policies and actively encouraging physical activity can have a positive impact on adolescents and children and more efforts for such campaigns are required.

Sleeping habits seem to be closely related to obesity and being overweight. Obese survey takers slept significantly less on average than overweight and normal-weight survey takers in both 2015 and 2019. Alarmingly, sleeping for less than 4 hours a day on average increased from 2015 to 2019 for obese, overweight, and normal-weight survey takers. While cross-analyzing, we also found that more Black/African American and Other race survey takers sleep less than 4 hours on average when compared to White survey takers. Latino/Hispanic survey participants were also found to have slept less than 4 hours on average more than White survey participants, however, this number was not as large as compared to Black and Other races. Sleeping habits for minority survey participants could have been disproportionately affected due to their living conditions as they are generally living in highly cramped and overpopulated communities with poor social environments that affect sleeping habits.

The decrease in academic performance with an increase in BMI was consistent in both 2015 and 2019. Normal-weight students had significantly higher academic grades achieving significantly more A and B grades than obese survey takers. Obese students on the other hand reported to have more C, D, and F grades when compared to normal weight survey takers. It must be noted however, academic performance increased for normal-weight, overweight, and obese students on average from 2015 to 2019. Concurrently, White students reported having performed better academically with higher A and B grades as compared to Black/African American and Latino/Hispanic students while Black/African American and Latino/Hispanic students reported to have scored more C, D, and F grades. Academic performance can be affected by various reasons including stress due to poverty [28], parental stressors [27], and poor social environments that affect academic performance.

Conclusion

In conclusion, our results show slight correlations between BMI/BMI categories and gender, race, food and beverage consumption habits, physical activity, sleeping hours, and academic performance. In both 2015 and 2019, we found male high school students to have slightly more rates of overweight and obesity. White and Other race students were less prone to be obese while Hispanic/Latino and Black/African American students were more prone to be overweight and obese. Breakfast skipping was reported to have been a more common occurrence among obese students in comparison to normal-weight students in both 2015 and 2019 by a significant margin. Survey takers who were overweight and obese reported being engaged in less physical activity when compared to normal-weight survey takers. More obese survey takers were reported to have slept less than 4 hours every day on average when compared to overweight and normal-weight survey takers. Black/African American and Other race survey participants reported having slept less than 4 hours on average more than White survey participants. Academic performance for Normal-weight students was significantly higher than for obese survey takers. White and Other race students were reported to have performed better than Black/African American and Latino/Hispanic students.

As the study primarily pulls data from the YRBSS dataset, a limitation we have to address in our paper is the lack of uniformly collected data in older YRBSS datasets. Variables such as Questions 88 and 89 were not collected in older iterations of the YRBSS. Because of this, we were not able to conduct our analysis for a large data set consisting of multiple years to develop a better understanding of the BMI and BMI factor trends in minority youth populations. Furthermore, as the YRBSS collects data that is self-reported, the collected data may be grossly over or underestimated.

Despite the limitations, our analysis presented significant associations between changes in BMI with factors of race and ethnicity, fruit consumption, breakfast consumption, physical activity, involvement in sports teams, sleep, and academic performance between 2015 and 2019. Ensuing research should examine the associations between high BMI/obesity with other risk factors. The YRBSS dataset will expand in upcoming years providing a larger sample size with uniform data which can contribute to upcoming analysis and evaluation.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the Center for Disease Control and Prevention (CDC), <https://www.cdc.gov/healthyyouth/data/yrbs/data.htm>.

Abbreviations

BMI: Body Mass Index; SES: Socio-Economic Status; NHANES: US National Health and Nutrition Examination Surveys; YRBSS: Youth Risk Behavior Surveillance System

Competing Interests:

The authors declare that they have no competing interests.

Authors' Contributions:

AD assisted in all statistical analysis, drafted and reviewed the manuscript, and approved the final manuscript as submitted. NS assisted in all statistical design and analysis, critically reviewed the manuscript, and approved the final manuscript as submitted. All authors read and approved the final manuscript.

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