Sedentary Status Among California Adolescents and Its Impact on BMI

by

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Abstract

Adolescent obesity is a serious health problem in the United States that occurs when teens weigh more than a healthy weight for their height. Adolescent obesity may be caused by prolonged sedentary time. There may also be racial/ethnic differences in sedentary time among adolescents. School environment and community demographics based on school type may also be triggers for obesity in adolescents. The purpose of this study was to determine the relationship between sedentary time and body mass index (BMI) in adolescents and describe adolescent sedentary time by race/ethnicity and school type. The data used in this study were extracted from the California Health Interview Survey (CHIS)-Adolescent 2020, which was conducted between September 2019 and November 2020 by randomly selected households in California. A simple linear regression, a one-way ANOVA, and independent *t*-test were used to analyze the data. The findings showed that sedentary time during weekend among California adolescents has a limited impact on obesity. However, racial/ethnic differences were in sedentary time among adolescents, but school type was not a significant predictor of obesity.

Keywords: adolescent obesity, sedentary time, community environment, race/ethnicity, school types

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Introduction

Review of Literature

Adolescent obesity is a severe health problem in the United States. Obesity occurs when a person weighs more than a healthy weight for their height and is measured by calculating an individual's body mass index (BMI) (Center for Disease Control [CDC], 2022). BMI is calculated as weight (kg) divided by height (m^2) (CDC, 2022). An adolescent whose weight and height ratio is between 85% and 95% for their age range is considered overweight, and a BMI ratio greater than 95% is considered obese (Barlow, 2007). According to the 2017-2018 National Health and Nutrition Examination Survey (NHANES), 19.3% of children and adolescents aged 2 to 19 in the U.S. are obese. The obesity trend among 12- to 19-year-olds has risen steadily since 1971 (CDC, 2021). Based on statewide data from California, racial/ethnic disparities in the prevalence of high BMI have widened (Falbe et al., 2016). There has been a marked increase in obesity rates over USA among Hispanic (25.6%) and non-Hispanic black (24.2%) children and adolescents (CDC, 2022).

Current Situation of Adolescent Obesity

There is substantial evidence suggesting that household income is associated with obesity prevalence in adolescents (Goodman et al., 2003; Singh et al., 2008; Ogden et al., 2018). Differences in obesity rates are significantly higher for adolescents from lower income families compared with those from higher income families. The obesity prevalence in the lowest income group was 18.9% compared to only 10.9% of the highest income group in the U.S. during 2011-2014 (Ogden et al., 2018). Low-income adolescents have less access to public health resources, such as obesity prevention campaigns or community activities, than adolescents from higher income households (Babey et al., 2010).

Between 2001 and 2007 in California, the prevalence of obesity among low-income adolescents is rising while the obesity rate among high-income adolescents has not significantly differed (Babey et al., 2010). While obesity rates increased across all racial/ethnic groups over 2003-2006, there was a marked increase in obesity rates among African Americans and Latinos, including adolescents (Ogden et al., 2008). Both African Americans and Latinos are more likely to live in poverty (Freedman et al., 2006).

California is the most populous state in the United States, with more than 39.5 million residents, and its population distribution is highly diverse. California shares a border with Mexico, which has the highest prevalence of overweight adults and one of the highest rates of overweight and obese children and adolescents worldwide (DiBonaventura et al., 2018). The migration dynamics and obesity environment created by the large immigrant population of Mexican Americans is particularly evident in California (Buttenheim et al., 2013). The 2019 Youth Risk Behavior Surveillance System (YRBSS) system report showed the obesity rate of adolescents aged 10 to 17 in California was 15.2% (CDC, 2019). The state had the fifth highest obesity rate among high school students according to the same report (CDC, 2021).

The Impact of Obesity on Adolescents

Adolescents who are overweight or obese face serious health problems as they transition into adulthood, such as having a lower household income (Black et al., 2018). Severely obese children have a higher prevalence of cardiovascular disease (Skelton et al., 2009). Obesity also increases the risk of type 2 diabetes, respiratory disease, and gallbladder disease (CDC, 2022).

Adolescent and childhood obesity can lead to psychological and social problems. According to Morrison et al. (2015), depression and anxiety are common among adolescents participating in weight management programs. Being overweight is often associated with lower

quality of life and lower self-esteem and may also be related to poor school performance (Garmy et al., 2014). School bullying and discriminatory experiences are widespread among obese adolescents (Beck, 2016).

Obesity may affect adolescents' developmental trajectory. First, obesity may hinder the human capital acquisition, such as an individual's cognitive skills (Averett & Stifel, 2010) and socio-emotional skills (Sabia & Rees, 2015). Another possible scenario is the fatigue and stress obese adolescent face due to bullying. This fatigue and anxiety affect learning attention and teachers' assessment of students' abilities (Puhl & Latner, 2007). Obese adolescents may also experience reduced employment opportunities due to lower personal self-esteem and physical conditions in adulthood (Mocan & Tekin, 2011). Adolescents' personalities and local culture may also influence these problems.

Obesity in adults and adolescents results in substantial additional medical expenses and economic losses. Obesity-related medical costs in the United States are estimated at $147 billion annually (Finkelstein et al., 2009). Obesity-related indirect costs between $3.38 billion and $6.38 billion (Trogdon et al., 2008) include employee absenteeism for health reasons due to obesity and lost productivity from reduced performance at work (Hammond & Levine, 2010).

At the onset of the COVID-19 pandemic, the BMIs of children aged 2 to 19 nearly doubled when compared to pre-pandemic levels (Lange et al., 2021). In a study of COVID-19 cases, obese patients 18 years of age and younger had a higher risk of hospitalization and severe illness than non-obese patients (Kompaniyets et al., 2021). With the remnants of the pandemic still lingering, interventions targeting the physical condition of adolescents are urgent.

Relationship Between Sedentary Time and Adolescent BMI

Sedentary time usually refers to an individual watching T.V., playing computer games, talking with friends, or engaging in other sedentary activities (Bejarano et al., 2021). Numerous studies have shown links between sedentary lifestyle behaviors, such as sitting in front of a computer, and being overweight (Jelastopulu et al., 2012). In addition, the use of cellphones and the convenience of modern transportation have further increased the likelihood of adolescents developing sedentary behaviors (Rosenberg et al., 2010). Excessive sedentary behavior may expose children to metabolic disorders and risk factors for weight gain (Zhu & Owen, 2016).

Being sedentary for more than two hours per day has been associated with adverse body composition, decreased health status, and decreased academic performance among school-age children (Tremblay et al., 2011). In California, 54.3% of high school students have high computer usage, 18.5% watch T.V. frequently, and only 20.5% get at least 60 minutes of physical activity every day (CDC, 2020). One study showed a higher proportion of Latino and Asian adolescents participated in more excessive sedentary activities and limited physical activity (Wilkosz et al., 2010). According to the American Academy of Pediatrics (AAOP, 1995), adolescents should limit their television and other screens to no more than two hours per day. Increased screen time leads to a corresponding increase in time spent in sedentary activities and a lack of physical activity in adolescents (Rideout et al., 2010). Marshall et al. (2004), however, asserted that, since the associations between age, gender, and health outcomes are inconsistent, there is also evidence that adolescent television viewing is minimally associated with becoming overweight and obese.

Increased sedentary time has been correlated to differences in eating behavior, one of the critical risk factors for obesity in adolescents (Barlow, 2007). The experiment of Pearson and

Natalie (2011) proposed that adolescents' sedentary behavior was significantly related to unhealthy life factors. When adolescents sit in front of screens, their energy expenditure decreases and they may consume extra calories (Epstein et al., 2002). Many adolescents consume high-energy drinks and snacks during prolonged screen activities (Pearson & Biddle, 2011). One study showed high-calorie, low-nutrient dense foods frequently promoted on television and computer advertisements can have detrimental effects on adolescents' dietary habits (Wiecha et al., 2006).

Sedentary behaviors are also associated with lower levels of community walkability. According to Sallis et al. (2018), Adolescents who live in walkable neighborhoods report less time watching T.V. and traveling in vehicles. While walking ability was not directly related to weight status in their study, adolescents living in areas with poor walking ability were most likely to be obese Neighborhoods that lack opportunities for physical activity may lead residents to engage in more sedentary recreational activities (Van Dyck et al., 2012). Research by Brown et al. (2018) proposes to improve the built environment to increase participation in physical activity to reduce obesity risk. They found walkable community designs encourage walking and cycling to significant destinations and contribute to overall physical activity among community residents. Interestingly, Liu et al. (2007) showed that greater distance from home to supermarkets was associated with higher rates of child overweight. Further, another study showed that young girls who live less than 0.25 miles from a convenience store are at higher risk of being overweight and obese (Leung et al., 2010).

Obesity in adolescents is likely influenced by the community environment. Datar et al. (2020) studied environment, exercise, and nutrition data from adolescents whose families were part of the U.S. Army. The participants were exposed to communities with varying obesity rates

because of their families' assignment to specific facilities (Datar et al., 2020). Adolescents whose families were assigned to neighborhoods with higher obesity rates were more likely to be overweight or obese (Datar et al., 2020). Community settings with high obesity rates may normalize unhealthy weight and make obesity prevention more difficult (Burke & Heiland, 2018).

Targeted Obesity Interventions

Health promotion helps people strengthen, gain control over, and improve their health (World Health Organization, 2017). Therefore, in addition to the current public health interventions that mainly focus on adolescent physical activity, implementing targeted adolescent obesity health promotion through school health services can maximize adolescent health benefits (Tremblay et al., 2011). Appropriate and efficient interventions for adolescent obesity prevention may be the key to promoting the improvement of health status among this population.

There is no single or simple solution to obesity prevention, and it is a complex problem that requires a multi-faceted collaborative effort. On one hand, to reduce the current prevalence of obesity among adolescents, developing culturally sensitive and gender-specific interventions catered to different ethnic groups and unique needs of adolescents is necessary (Wilkosz et al., 2010). Understanding community demographics, such as population distribution, geographic location, etc., allows researchers to better understand adolescents with obesity, thus allowing them to produce targeted interventions that are more effective in reducing the prevalence of obesity in adolescents (Babey et al., 2010). This should include low-income neighborhoods with low walkability. However, according to Babey et al.'s (2010) analysis of data on the prevalence of obesity among adolescents in California, preventing childhood obesity may not help adolescents from low-income families. This difference is mainly reflected the low-income parents

of relatively young adolescents who are generally less educated and less confident in community safety (Babey et al., 2010).

For adolescents, the school day includes prolonged periods of sitting, but teachers can be key agents in providing health interventions to reduce adolescent sedentary behavior (Laine et al., 2017). For example, vocational schools are more promising settings for health-promoting interventions because a more significant proportion of adolescents from lower socioeconomic backgrounds attend these schools. These settings have a higher risk of maladaptive health behaviors (Elgar et al., 2015).

The most direct classification of schools in the U.S. is public and private schools. Community schools in public schools usually serve students who live in the community near the school (National Education Association, 2022). Students who attend private schools come from a broader range of households, so some students may be further away from school and may spend more time in motor vehicles than students who attend public schools (Simons et al., 2013). According to data from the U.S. Department of Education's National Center for Education Statistics (NCES, 2019), the percentage of Hispanic students in public elementary and secondary schools was 27% compared with 15% of black students. In private schools, the figures were 11% and 9%, respectively (NCES, 2019). Also, the proportion of students living in low income households is highest among selected public-school students (26%) and lowest among private school students (13%). Higher income families are also more likely to choose private schools. The proportion of students from higher income families who chose public school was 56%, compared to students from low income families who chose to attend private school, which was 79% (NCES, 2019).

Many students in public schools are obese and have low levels of physical activity, low daily intake of fruits and vegetables, and low daily intakes of water, fiber, vitamins, and minerals (Li & Hooker, 2010). Cities with large immigrant communities, such as Los Angeles, however have seen higher rates of obesity among students in private schools than in public schools (Shi et al., 2017). School type may be a good indicator of teen obesity and sedentary risk (Baniissa et al., 2020).

Although the obesity rate of adolescents from low-income families is higher than that of high-income families, this does not mean that these adolescents do not face risks for developing obesity. Risk factors for students who attend private schools include longer sedentary time due to longer commutes to and from school and possible lack of parental companionship. Designing different targeted obesity interventions for students in public schools and private schools may be more effective for reducing obesity prevalence among adolescents.

Conclusion

The obesity epidemic is a serious, ongoing health problem that affects children and adolescents in the United States and California. Numerous studies have shown that being overweight or obese may have many adverse effects on adolescents in the future (Black et al., 2018). Sedentary behaviors, one of the greatest risk factors for obesity, is essential issue that public health professionals should address. The association between sedentary behavior and obesity cannot be ignored. Therefore, the purpose of the current study was to examine the relationship between sedentary behavior and BMI in California adolescents. The relationship was examined by evaluating the correlation between obesity and race/ethnic group and obesity and public versus private school attendance. Understanding the differences in health behaviors and health status among different groups of adolescents may help formulate targeted obesity health

intervention programs to reduce sedentary behaviors, such as screen time, and reduce the prevalence of obesity in adolescents (Wilkosz et al., 2010).

Purpose of the Study

The purpose of this study was to determine the relationship between sedentary time and BMI in adolescents and describe adolescent sedentary time by race/ethnicity and school type. Additionally, this study examined the effects of race/ethnicity and school type on sedentary time. Results from this study can be used to develop a California specific, targeted adolescent obesity health intervention program focused on decreasing sedentary time in adolescents.

Research Questions

This study aimed to answer the following questions:

1. Is there a relationship between sedentary time and BMI among adolescents living in California?
2. Is race/ethnicity associated with sedentary time among adolescents living in California?
3. Is school type (public vs. private) associated with sedentary time among adolescents living in California?

Hypotheses

It was hypothesized that there would be a relationship between adolescents' sedentary time and BMI for the first question, and null hypothesis was there would be no relationship between adolescents' sedentary time and BMI. The hypothesis for the second research question was that race/ethnicity are associated with sedentary time among adolescents living in California. The null hypotheses was race/ethnicity are not associated with sedentary time among adolescents living in California. The hypothesis for the third research question was that school type (public

vs. private) is associated with sedentary time among adolescents living in California. The null hypotheses was school type (public vs. private) is not associated with sedentary time among adolescents living in California.

Method

Design

This study employed a cross-sectional design to examine the relationship between sedentary time and obesity among California adolescents and to investigate sedentary time among adolescents by race/ethnic group and school type. Research data came from the 2019-2020 California Health Interview Survey (CHIS). The CHIS is the largest state health survey in the United States and an important source of data on Californians, including the state's racial and ethnic groups (UCLA Center for Health Policy Research [CHPR], 2021). The 2019-2020 CHIS dataset was the most recent publicly available data, which was collected between September 2019 and November 2020 (UCLA CHPR, 2021). The data used in this study are from the CHIS-Adolescent 2020.

Procedures

The UCLA CHPR (2021) utilized computer technology to randomly sample addresses in each of the 44 geographic areas represented by 41 individual counties in California, and the last three areas were split among the remaining 17 counties that were less populated. These 44 geographic areas represented the entire state. The address-based sample improved coverage of California households and allowed for more ways to contact and collect data. The CHIS can be completed on the web or by telephone by randomly selected households. Each family randomly selects an adult, teen, and child to participate in the data collection.

This study utilized the adolescent dataset. All data were collected through computer-assisted web or telephone interviews. The average time spent by adolescents in the online and telephone interviews was 26 minutes and 13 minutes. The CHIS questionnaire for adolescents includes the following health topics: health status, health conditions, mental health, health

behaviors, dental health, neighborhood and housing, access to and use of health care, health insurance, public program eligibility, childcare and school, and respondent characteristics. The overall unconditional household response rate was 12.2%. After all follow-up attempts to complete the full questionnaire were exhausted, adults who completed at least approximately 80% of the questionnaire were counted as "complete" (UCLA CHPR, 2021).

Participants

The CHIS is known for its hard-to-find data on specific subgroups and provides relatively reliable samples of major racial/ethnic groups, sexual minorities, and other populations living in California (UCLA CHPR, 2021). The CHIS includes data from families in all 58 counties of California; 22,661 households were surveyed in 2020, including 1,365 adolescents (UCLA CHPR, 2021). The participants for the current study were adolescents who completed the CHIS survey.

Independent Variables

The independent variables for the first research question was sedentary time (TV, comp games, talk w/friends). Sedentary time is a continuous variable in minutes, which was primarily recorded as the amount of time adolescents spent watching TV, playing computer games, talking with friends, or engaging in other sitting activities during a typical or usual weekend day. The CHIS phone interview and web questions asked the participants, "During the weekends, about how much time do you spend on a typical or usual weekend day sitting and watching TV, playing computer games, talking with friends or doing other sitting activities?" The variable code was TD39.

The independent variables for the second and third question were race/ethnicity and type of school. Both race/ethnicity and school type were well-defined categorical variables. The CHIS

phone interview and web questions used a segmented question-and-answer method to cover as many types of racial/ethnic groups in California as possible. Questions about racial in CHIS begins with a direct question of "Are you Latino or Hispanic?" If the answer is no, it skips to "Please tell me which one or more of the following you would use to describe yourself: Would you describe yourself as Native Hawaiian, Other Pacific Islander, American Indian, Alaska Native, Asian, Black, African American, or White?" and then determine each person's racial branch based on the responses. As summary data, race/ethnicity was formulated using the department of finance race variable for general comparisons. The variable code was OMBSRTN_P1. The questions were assessed using options of "Latino = 1," "White, Non-Latino = 2," "Other Race = 3," "Asian Only, NH = 5," and "Two or More Races, NH = 7." School type is a categorical variable determined based on the telephone survey and the web question, "What is the name of the school you go to or last attended?" with "Private School = 2," "Public School = 1," and "Inapplicable = -1." The variable code was SCH_TYP.

Dependent Variables

The dependent variable in first question was adolescent BMI, which was calculated as weight (kg) divided by height (m^2). The data collection questions for height and weight were. "About how tall are you without shoes?" and "About how much do you weigh without shoes?" At the same time, BMI also has a classification property, that is, it is classified according to the corresponding percentile of BMI and recoded into four groups: "Underweight (Less than the 5th percentile) = 1," "Healthy Weight (5th percentile to less than the 85th percentile) = 2," "Overweight (85th to less than the 95th percentile) = 3," and "Obesity (Equal to or greater than the 95th percentile) = 4" (Kuczmarski et al., 2002). This study used BMI data with specific values as continuous variables. Continuous variables are more advantageous for ANOVA and

independent sample *t*-tests. It is more concise to evaluate to categorical variables and use fewer parameters (Lazic, 2008). Continuous variable data provided insight into the different sources of sedentary time changes in adolescents, increasing the flexibility and sensitivity of the study. Sedentary time (TV, comp games, talk w/friends) was the dependent variable in the second and third research question.

Data Analysis

A simple linear regression was used to analyze research question one, while a one-way ANOVA and independent sample *t*-test was used to analyze questions two and three, respectively. Descriptive statistics were also performed on various variables (age, gender, race/ethnicity, household income, and youth work status) to verify that all statistical assumptions were met before statistical analysis was performed.

The sample size was estimated using G*Power software version 3.1.9.6. For the first question, a medium effect size of 0.15, alpha of 0.05, and power of .80 was used to estimate a minimum sample size of 55 for simple linear regression. A medium effect size of 0.5, an alpha level of .05, and a power of 80% was used to estimate the minimum sample size needed for the second and third questions. The minimum sample size for a one-way ANOVA was 68, and for third question, the minimum sample size required for an independent *t*-test was 55.

Results

Major Findings

There was a total of 1,365 participants in this study. The demographic characteristics of the participants are shown in Table 1 (see Appendix). The average age for participants was 15.06 with a range of 12 to 17 years. Among all the participants, according to the gender specified on the original birth certificate, the proportions of males (47.55%) and females (52.55%) were similar, with a higher number of females. In term of race/ethnicity, White, Non-Hispanic (NH) had the highest proportion (45.42%) followed by Hispanic (32.67%). In addition, Asian Only, NH accounted for 10.55% of the sample, and the remaining 8.13% and 3.22% were Two or More Races, NH, and Other Race, respectively. Nearly 68% of the adolescent participants reported never walking home during the week, and 84.40% of teenagers reporting neither riding a bicycle nor skateboarding as their method of commuting to school.

The Effect of Sedentary Time on Adolescent BMI

A simple linear regression model was utilized to determine if there was a relationship between sedentary time and BMI among adolescents living in California. The mean reported sedentary time data was 406.90 minutes in weekend. The maximum value of sedentary time reported was 1,440 minutes, and the minimum was 24 minutes. The mean BMI was 21.88, with the highest BMI being 43 and the lowest was 9. Single linear regression conforms to linearity and normality assumptions. The results of the regression indicated that the model explained only 0.4% of the variance, and sedentary behavior among adolescents in California is a scant significant predictor of BMI (R^2= .004, F (1, 1363) = 6.950, p = .008). The coefficient table is shown in Table 2 (see Appendix).

Factors that Affect Sedentary Time

To determine if the hypothesized race/ethnicity or school type (public vs. private) was associated with sedentary time among adolescents living in California, a one-way ANOVA and independent sample *t*-test were performed. In the test for homogeneity of variances, the variances of the five groups are not equal ($p < .05$); therefore, a Welch's ANOVA was used. A statistically significant effect was found (F (4, 1364) = 17.779, $p < .05$) between race/ethnicity and sedentary time (see table 3 in Appendix). According to the average comparison, the average sedentary time of other races, which included Black or African American, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, was the longest (M = 510.86, sd = 317.62, n = 44), followed by NH Asian (M = 439.38, sd = 268.29, n = 144). The lowest reported sedentary time was among Hispanic participants (M = 391.88, sd = 268.29, n = 144). A post-hoc test showed that the sedentary time of Hispanic adolescents was significantly different from that of other groups of adolescents.

An independent *t*-test was performed to evaluate the difference between sedentary time and those who attended a public versus private school. There was no statistically significant difference (t (1146) = -1.51, p = .13) between school type and minutes spent sedentary (see Table 4 in Appendix).

Discussion

Summary of Major Findings

The purpose of this study was to examine the relationship between sedentary time and BMI in adolescents and to describe adolescent sedentary time by race/ethnicity and school type. The results of this study suggest that sedentary time among California adolescents on the weekend accounted for only a small fraction of the effect on BMI. The effect of sedentary time on BMI was only 0.4% (R^2= .004, F (1, 1363) = 6.950, p = .008). This finding is in close agreement with the study by Marshall et al. (2004) that showed adolescent television viewing was associated with minimal associations with overweight and obesity. Other possible factors such as physical activity time, eating habits play a more influential role in adolescents' BMI. The adolescents in the sample spent an average of 6 hours and 47 minutes a day sedentary, on the weekends, which is more than three times as much as the American Academy of Pediatrics and other experts recommend (Barlow, 2007).

Studies examining sedentary time often correlate it with exercise time (Larouche et al., 2018) (Podnar et al., 2021). In the case of increased sedentary time, corresponding exercise time decreases. Therefore, an increase in sedentary time alone may have a limited impact on BMI status, that is, the factor affecting BMI is more due to a decrease in exercise time (Larouche et al., 2018). The data collected in the CHIS regarding sedentary behavior in youths included sitting watching TV, playing computer games, talking with friends, or engaging in other sedentary activities, but these factors only accounted for how sedentary participants were on weekends and does not mention how much adolescents spend sedentary or active in school during weekdays. Also, the survey did not specifically mention youth cell phone use. Cell phone use is not necessarily a sedentary behavior. Due to its inherent portability, various phone functions can be

used during inactivity (standing), low-intensity physical activity (such as slow walking), and moderate-intensity exercise. A study by Lepp et al. (2013) found that high-frequency mobile phone users were more likely than low-frequency users to report relinquishing physical activity opportunities to use their mobile phones instead. This finding indicates that cell phone use has a large impact on sedentary time (Lepp et al., 2013).

This study also found that sedentary time varied by race/ethnic group but not by school type. The other races, which included those who identified as African Americans, Native Hawaiian, and Other Pacific Islander, were the most sedentary on average over weekends, but they had the smallest sample size (M = 510.86, sd = 317.62, n = 44). The racial/ethnic group with the second longest reported sedentary time was NH Asian participants (M = 439.38, sd = 268.29, n = 144); these groups had relatively high average sedentary times, compared to Hispanic participants, who reported the lowest sedentary time of 391 minutes. In a study by Babey et al. (2013), African American adolescents watched about six hours more TV per week compared to whites; Asian adolescents, by contrast, were estimated to spend five more hours on computer entertainment than whites. This study's findings are consistent with the findings from Babey and colleagues (2013) study. This provides a reference for possible future sedentary time health interventions tailored to ethnicity.

There was no significant difference in sedentary time between the two school types, which is inconsistent with the findings of Shi et al (2017). This may be the result of different geographic environments and insufficient and uneven sample sizes. However, the racial distribution of sedentary time contrasted with the higher proportion of ethnically specific students in public schools compared with private schools. Compared to private schools, public schools have more students from racial/ethnic groups who are likely to have longer sedentary

times. Possibilities for further exploration by school type lie in the school environment and food availability. Dighe et al. (2020) suggested that physical activity (PA) and the food environment play an essential and unique role in improving childhood weight outcomes. For example, the consumption of fruits and vegetables (F/V) in public and private schools may not be consistent (Baniissa et al., 2020). Public health efforts targeting school-type differences in PA and healthy food consumption may help address the burden of obesity.

Study Limitations

This study has several limitations. First, the two main ways CHIS collects data are telephone interviews and Internet surveys. Self-reported data are less credible because the researchers are not present when the survey is conducted (UCLA, 2021); therefore, sedentary time might have been underestimated in the first question. Under the premise of subjective reporting, people tend to prefer to report more positive information. Self-reports are mostly subjective data rather than objective measurements, which was another limitation; although, literature also points to slight differences between self-reporting and objective measurements (Schmitz et al., 2004).

Second, the uneven sample size distribution to answer the second question resulted in an insufficient analysis. Regarding race/ethnicity, 32.7% of respondents were Hispanic, and 45.4% of teens were white. The two groups accounted for 88.1% of all respondents. In terms of school type, the number of respondents in private schools was nearly one-tenth that of public schools. The uneven distribution of samples results in the lack of balance between groups and the lack of generality of the samples. Although both research questions met the effect size requirement in terms of sample size, the limited participation from other groups might have negatively affected the results of this study.

In addition, there may be seasonal differences in BMI data. BMI obtained from a single interview survey alone cannot provide an accurate and comprehensive picture of adolescent obesity. Adolescent growth and body composition are also seasonal. In terms of height, school-aged children in the northern hemisphere experience the fastest growth in height in spring or summer (Dalskov et al., 2016). In terms of weight, overweight children gain peak weight during the summer, whereas normal-weight children do not (Rodriguez et al., 2014). Also, people with more muscle mass and less body fat may have a higher weight and a higher BMI despite being low in fat (Abramowitz et al., 2018). BMI does not necessarily determine obesity, it only assesses height and weight, not actual body fat percentage.

In most instances, adolescents leave school during the summer, and school type can no longer be an intervening factor for their BMI profile. The more significant summer weight gain observed in children may reflect an undisciplined lifestyle and lack of school-related physical activity (Rodriguez et al., 2014). To investigate the third question, further research needs to collect obesity data according to different time periods and life situations of adolescents. The data should be aggregated by collecting and synthesizing different body indices of adolescents, such as body fat percentage and central obesity. Designing a program for different school types to continuously track students during school hours would be a more rational and comprehensive assessment of adolescents' lifestyle and health condition.

Implications for Public Health Practice

This study examined the relationship between sedentary time and BMI among California youth and racial/ethnic and school type distinctions for sedentary time. Weekend sedentary behaviors among adolescents were shown to have little effect on BMI. In the process of public health practice, it is necessary to focus on co-interventions against other possible causes of

obesity, such as reducing sedentary activities by calling for increased physical activity time during school hours or supporting healthier food consumption. In a study by Podnar et al. (2021) on the effectiveness of childhood obesity interventions, the inclusion of sedentary behaviors in physical activity- or fitness-oriented interventions was not associated with improved intervention effects.

The study found potential racial/ethnic differences in weekend sedentary time among adolescents. At the same time, there is evidence that racial/ethnic disparities in the prevalence of high BMI have widened over time (Falbe et al., 2016). Therefore, public health personnel should gain better understanding of adolescent obesity in specific populations by actively investigating community demographics, such as racial/ethnic distribution, geographic location, etc.

There remains an urgent need for public health practitioners to develop policies and interventions that effectively reduce racial/ethnic disparities in obesity prevalence. The CDC (2021) sponsored the San Diego County Department of Health and Human Services in Racial and Ethnic Approaches to Community Health (REACH) 2018 to conduct tailored nutrition, physical activity, and clinical community connection interventions for African Americans and Hispanics. These tailored interventions included improving nutritional standards in YMCA after-school programs and physical activity strategies to improve active transportation and safety (CDC, 2021).

Students in public and private schools did not differ significantly on sedentary time. Further research on individual, family, and school environmental factors should be conducted to determine their impact on adolescent health, thereby reducing the inequalities between students in public and private schools. More contextually targeted obesity interventions will reduce disparities by identifying differences in racial distribution, community demographics, and

educational resource allocation across communities and schools. For the school environment, research focused on in-school food consumption guidelines, cafeteria food menus, and dietary and exercise self-efficacy is equally important (Baniissa et al., 2020). It is necessary to implement school policies to incentivize adolescents to consume the recommended F/V intake daily and participate in physical activity for better health outcomes. The WHO (201) recommends at least 60 minutes of moderate to vigorous physical activity per day, and a dietary intake of at least 400 grams F/V per day. Healthier selections for school meals have been associated with healthier meal choices made by students (Fox et al., 2009).

Promoting healthy lifestyles among adolescents is a public health priority. The Alliance for Healthy Kids of Northern Virginia launched a campaign in 2012 called 9-5-2-1-0 to promote healthy lifestyles among adolescents that can be adapted to school settings. In this initiative, obesity prevention messages are simplified by promoting 9 hours of sleep per day, 5 servings of fruits and vegetables, 2 hours or less of out-of-school screen time, 1 hour of PA, and 0 sugar-sweetened beverages per day (Northern Virginia Healthy Kids Coalition, 2015). School cafeterias can promote the use of salad bars and offer fresh vegetables and fruit slices to enhance the nutritional value of school lunches (Goh et al., 2009). Adolescents experience significant reductions in caloric expenditure while attempting to improve their academic success (Benden et al., 2011). Promoting stand-up teaching in classrooms or standing desks can also reduce students' sedentary behavior.

For families and communities outside of school, there is an even greater need to develop a unified and collaborative model of health promotion that can involve government health officials, teachers, parents, adolescents, and social media (WHO, 2003). Health educators and policy makers need to raise social awareness about the negative impact of obesity, including

sedentary behavior and unhealthy eating habits on adolescent health outcomes. Also, before developing a public health intervention program, actively investigating community population distribution and school community environment conditions, and promoting comprehensive intervention of individuals, families and schools on adolescent obesity will be the main development direction.

Conclusion

Weekend sedentary time may affect California adolescents' BMIs and health outcomes. This study found there are still racial/ethnic differences in sedentary time in weekend among adolescents, but school type was not a significant predictor for sedentary time. The school environment and dietary status of adolescents of different school types during school hours should be further examined. Moreover, there needs to be an increase in targeted health interventions to reduce possible racial/ethnic disparities in living conditions. This study is an important step in this direction and identifies potential avenues for future research and health intervention programs.

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Appendix

Table 1

Demographic Details of Adolescent Participants (n = 1,365)

	n	%
Gender		
Male	694	47.55
Female	716	52.45
Ethnicity		
Latino	446	32.67
White, Non-Latino (NH)	620	45.42
Other Race	44	3.22
Asian Only, NH	144	10.55
Two or More Races, NH	111	8.13
School Type		
Public School	1047	76.70
Private School	101	7.40
Inapplicable	217	15.90
Days Walk Home from School Past Wk		
0 Days	923	67.62
1-2 Days	105	7.69
3-4 Days	79	5.79
5 or More Days	165	12.09
Inapplicable	93	6.81
Days Bike/Skate Home from School Past Wk		
0 Days	1152	84.40
1-2 Days	55	4.03
3-5 Days	65	4.76
Inapplicable	93	6.81
Age	15.06/1.59	

Note. n = sample size; % = percentage; Wk = Week; Age (mean/ standard deviation). Source:

California Health Interview Survey, CHIS. (2019-2020)

Table 2

Results from Simple Linear Regression Analyses Evaluating the Sedentary Time and BMI among Adolescents Living in California

Predictor	B	β	t	CI
Constant	21.359		92.325	(21.203, 21.515)
Sedentary Time	0.001	.071	2.636	(0.001, 0.002)

Note. R2 =.004, P =.008. Source: California Health Interview Survey, CHIS. (2019-2010)

Table 3

One-Way Analysis of Sedentary Time by Race/Ethnic Group

	N	Mean	SD	F	P
OMB/CURRENT DOF RACE				17.779	<.001
Hispanic	446	391.88	241.658		
White, Non-Latino (NH)	620	399.33	242.028		
Other Race	44	510.86	317.622		
Asian Only, NH	144	439.28	268.289		
Two or More Races, NH	111	426.33	230.171		
Total	1365	406.90	247.435		
					*p <.05

Note. The ANOVA reveals a significant difference between race/ethnicity and sedentary time among adolescents within California. Source: California Health Interview Survey, CHIS. (2019-2010)

Table 4

Independent Samples T-Test of sedentary time by school type

	N	Mean	SD	T	P
School Type				-1.51	0.13
Public School	1047	401.80	238.048		
Private School	101	440.01	295.376		
					*p >.05

Note. The Independent Samples T-Test did not show a statistically significant difference in the means of sedentary time for public and private school among adolescent within California.

Source: California Health Interview Survey, CHIS. (2019-2010)