Adolescent obesity is a public health problem across the United States [1]. According to the National Health and Nutrition Examination Survey (NHANES), 16.9% of children and adolescents aged 2 through 19 are obese [2]. Specific to North Carolina, data from the 2015 Youth Risk Behavior Survey (YRBS) show that 15.9% of North Carolina students (9th through 12th grade) are overweight and 16.4% are obese [3]. Middle schools are pivotal settings in which to implement adolescent obesity prevention interventions [4]. Previous studies regarding long-term results of obesity interventions in middle school settings are lacking [5-7]. Reasons for elevated obesity rates may include increased sedentary activities (including screen time) and unhealthy food and beverage consumption [8-10]. Prior studies of the associations between sedentary activities (technology use or screen time), snack consumption, soft drink consumption, and risk of obesity among adolescents in school-based settings suggest that these unhealthy behaviors are associated with greater obesity risk among adolescents [8-10].

Since screen time is a risk factor for adolescent obesity, more research is needed to investigate why screen time might contribute to weight gain among adolescents. One possible association is that screen time leads to increased exposure to unhealthy food and/or beverage marketing, contributing to unhealthy snacking [11]. Screen time, specifically television time, is associated with adolescents’ snacking while engaging in screen-related activities [12]. Adolescents’ screen-based sedentary behaviors, primarily video game and computer use, tend to increase with age, possibly contributing to increased weight status [13]. To our knowledge, there have been no studies conducted in middle schools that specifically examined associations between total screen time, as opposed to television time, and unhealthy beverage and snack consumption in adolescents.

Motivating Adolescents with Technology to Choose

Examining the Association Between Screen Time, Beverage and Snack Consumption, and Weight Status Among Eastern North Carolina Youth

Kristie Hicks, Stephanie Jilcott Pitts, Suzanne Lazorick, Xiangming Fang, Ann Rafferty

BACKGROUND With the rise in technology use for the adolescent population, screen time may be related to unhealthy eating habits and contribute to adolescent obesity. Since 2007, an adolescent wellness program, Motivating Adolescents to Choose Health (MATCH), has been implemented in select North Carolina middle schools.

METHODS Using MATCH study data from fall 2015 in 26 North Carolina middle schools, we examined the cross-sectional associations between screen time, unhealthy beverage and snack consumption, and BMI z-score with linear regression models controlling for physical activity, school, sex, weight category, and race.

RESULTS Of the 2,763 youth surveyed, half were female, 48% were white, 33% were black, and 19% were other racial groups; 2% were underweight, 51% were healthy weight, 21% were overweight, and 26% were obese. Mean BMI percentile was the 72nd percentile and mean BMI z-score was 0.81. The average of self-reported behaviors included: 1,312 hours of screen time per year, sugary beverages consumed 2,073 times per year, and unhealthy snacks consumed 3,485 times per year. There were positive associations between screen time per year and both sugary beverage (B = 0.4699; 95% Confidence Interval [CI], 0.3689–0.5709; \( P < .001 \)), and unhealthy snack consumption per year (B = 1.0085; 95% CI, 0.8413–1.1757; \( P < .001 \)), after controlling for significant covariates. This suggests that an extra hour of screen time a day is associated with approximately 172 extra servings of sugary beverages per year (3.3 extra servings per week, or 0.5 extra servings per day) and 368 extra servings of unhealthy snacks per year (7.1 extra servings per week, or 1 extra per day). No association was found with BMI z-score (B = –0.00001; 95% CI, –0.00007–0.00005; \( P = .697 \)).

LIMITATIONS The baseline survey questions did not differentiate between types of screen time, and self-reported data may have impacted results.

CONCLUSION In North Carolina adolescents, increased screen time is associated with increases in both unhealthy beverage and snack consumption. Future research is needed to further elucidate how these factors and others impact BMI. MATCH may increase effectiveness by including program components that address the relationship between screen time and unhealthy dietary consumption.

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Address correspondence to Suzanne Lazorick, East Carolina University Brody School of Medicine, 600 Moye Blvd, 174 Life Sciences Building, Greenville, NC 27834 (lazoricks@ecu.edu).

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Health (MATCH) is a middle school-based intervention to prevent adolescent obesity [5]. MATCH was designed for rural, socioeconomically disadvantaged adolescents in North Carolina [6, 14]. MATCH has grown over the past 10 years and in 2015 was implemented in 29 North Carolina schools [5], and was planned for 49 schools in the fall of 2017. The intervention is aligned with both the North Carolina public schools’ and the Common Core curricula and operates under 4 core phases [12]. These phases are: 1) Evaluate: collecting anthropometric measurements, conducting fitness testing, and administering a lifestyle questionnaire; 2) Educate: providing interdisciplinary wellness lessons; 3) Motivate: promoting action plans and providing rewards; and 4) Activate: encouraging daily physical activity [14]. The educational components of MATCH are shown in Table 1.

The purpose of this cross-sectional analysis was to examine the association of total screen time with unhealthy beverage consumption, unhealthy snack consumption, and Body Mass Index (BMI) z-score among MATCH participants (N = 2763) in the 2015 fall semester. We hypothesized that total screen time (defined as hours spent using television, computers, tablets, video games, and smart phones) would be positively associated with increased frequency of unhealthy beverage and snack consumption and BMI z-score among MATCH participants.

Methods

Schools with predominately low socioeconomic status (> 50% of students eligible for free or reduced priced lunch) across North Carolina were recruited to participate in MATCH through school district superintendent offices. Initial funding targeted Eastern counties, but in recent years expansion has occurred to other regions. Generally, the offer to participate was extended to all middle schools in a given county or Local Education Agency (LEA). Once a school agreed to implement MATCH, all 7th-grade students served in regular classes in the school received the MATCH curriculum and were eligible to participate in the study. Study participants were 7th-grade students from 26 middle schools in 12 North Carolina school districts (Burke, Clinton City, Edenton-Chowan, Edgecombe, Hyde, Johnston, Martin, Pamlico, Pitt, Sampson, Washington, and Weldon City). All districts, with the exception of Burke, are located in Eastern North Carolina. MATCH researchers utilized an “opt-out” assent and consent system to determine students’ participation in the research study [6]. Students were included in the formal evaluation if they did not return either a signed student or parent “opt-out” form [6]. Although 29 middle schools participated in MATCH during the 2015–2016 school year, only students from 26 schools completed all baseline measures. This study was approved by the East Carolina University Institutional Review Board at the Brody School of Medicine (#07-0741).

Measure Overview

For MATCH evaluation at baseline and post-intervention, participants’ anthropometric measures and lifestyle habits were assessed [5]. The data for the current study came from the self-administered Sleep, Eating, Activity and Technology (SEAT) questionnaire. The SEAT questionnaire was developed to include specific questions about participants’ sleep, eating, activity, and technology use behaviors [5]. Questions used for the nutrition section of the SEAT questionnaire were from the validated Beverage and Snack Questionnaire (BSQ) developed specifically for use in middle school students [15]. The SEAT questionnaire data, anthropometric measures, and demographic characteristics for this study were collected at the beginning of the 2015 fall semester, before the MATCH intervention was delivered to the participants.

Total Screen Time

One item was used to assess participants’ total screen time (independent variable). The screen time question was designed just for MATCH and asks, “About how many hours each day are usually spent using some form of technology with a screen (eg, television, computer, tablet, video games, cell phone)2?”. The response options for this question were: less than 2 hours, 2 or 3 hours per day, 4 or 5

| TABLE 1. MATCH Educational Components by School Subject |
|--------------------------------------------------------|
| Sample components of MATCH                             |
| Health or Science                                      |
| • Energy balance                                       |
| • Weight categories                                    |
| • Health effects of overweight/obesity                 |
| • Cardiovascular system, risk factors/warning signs of cardiovascular disease |
| • Pulmonary system/effects of smoking                  |
| • Gastrointestinal/nutrition, nutrients, nutrient analysis, energy needs, label reading, meal planning |
| • Endocrine system, diabetes                           |
| Math                                                    |
| • Ratios and proportions                               |
| • Percent increase/decrease                            |
| • Calculating target heart rate for exercise           |
| • BMI calculation                                      |
| • Analyzing graphs                                     |
| Language Arts                                          |
| • Reading comprehension (wellness topics)              |
| • Persuasive writing (wellness topics)                 |
| • Peer accountability contracts                        |
| • Self-evaluation of behaviors and journaling          |
| • Final reflective essay                               |
| Social Studies                                         |
| • Demographic trends and environmental conditions’ impact on society |
| • Drawing conclusions and interpreting information     |
| Technology                                              |
| • Spreadsheets: exercise log, time usage, caloric expenditure, target heart rates |
| • Pedometer counts                                     |
| • Database skills: sorting and querying                |
| • Creating multimedia projects                         |

Note. MATCH, Motivating Adolescents to Choose Health; BMI, body mass index.
hours per day, and 6 or more hours per day. The responses were used to calculate the number of total screen time hours per year by multiplying the average for each response category by 365 days per year. For example, for a participant who selected “4 to 5 hours per day” for use of any form of screen technology, the response was converted to 4.5 hours (the value 1 was used for the “< 2” response and 7 was used for “> 6”) and multiplied by 365 days for an annual amount of screen use in hours per year.

**Sugary Beverage Consumption**

Eight questions were used to assess sugary beverage consumption. The general question, “How often did you drink these beverages in the past week?” was asked for all the beverage-related questions [15]. The following 4 beverage types, which were chosen because of their high sugar content, were listed as individual questions: 1) Fruit drinks such as Snapple, flavored teas, Capri Sun, and Kool-Aid; 2) Sports drinks such as Gatorade or Powerade; 3) Regular soda or pop such as Coke, Pepsi, 7-Up, Sprite, or root beer; and 4) Energy drinks such as Rockstar, Red Bull, Monster, or Full Throttle [15]. For each beverage type, a question was asked about consumption both at school and away from school [15]. Participants had the following weekly and daily response choices for each of the beverage questions and were instructed to select only one: never or less than 1 per week, 1 per week, 2 to 4 per week, 5 to 6 per week, 1 per day, 2 to 3 per day, or 4 or more per day [15].

**Snack Consumption**

Twelve questions were used to examine unhealthy snack consumption. The same general question, “How often did you eat these foods in the past week?” was asked for each type of food. For our study, the snack types were initially categorized as salty snacks and sugary snacks. The following salty snacks from the questionnaire were included in data analysis because these snack options contained the highest caloric value: 1) regular potato chips, tortilla chips, corn chips, and puffs such as Ruffles, Lay’s, Pringles, Doritos, Fritos, and Cheetos; and 2) other salty snacks like Cheese Nips, Chex Mix, Goldfish, crackers, and Ritz Bitz. The sugary snacks (ie, desserts) from the questionnaire were included because these snack choices had the highest sugar content: 1) candy such as chocolate, candy bars, Jelly Bellies, gummies, and Life Savers; 2) doughnuts, Pop Tarts, or breakfast pastries; 3) cookies, brownies, pies, and cakes; and 4) regular ice cream and milkshakes (include all flavors) [15]. Participants had the following weekly and daily response choices for each of the snack questions and were instructed to select only one: never or less than 1 per week, 1 per week, 2 to 4 per week, 5 to 6 per week, 1 per day, 2 to 3 per day, or 4 or more per day [15]. Similar to the beverage section, each snack question asked about consumption both at school and away from school [15].

For analysis, responses to “away from school” and “at school” consumption of beverages and snacks were combined to create a total sugary beverage variable, as well as total salty and total sugary snack variables. Total salty snacks and total sugary snacks were combined to create a total unhealthy snack variable. The beverage and snack categories were considered separate dependent variables for data analysis. For illustrative and analysis purposes, we calculated the estimated average beverage and snack intake for a 1-year period (total frequency of intake per year), using the process recommended by the authors of the instrument [15]. It should be noted that this use of a cross-sectional survey measure to illustrate annual intake allows comparisons and analyses but is not meant to represent actual, quantified annual beverage intake.

**Body Mass Index z-score**

The anthropometric measures used for this study included height and weight, measured following a standard protocol [5]. School personnel received standardized training and were responsible for privately collecting each student’s height and weight using calibrated scales and stadiometers via routine procedures [5, 14]. BMI was determined using measured heights and weights, which were transformed into relative sex- and age-specific BMI percentiles and z-scores, according to standardized Centers for Disease Control and Prevention (CDC) parameters [14, 16]. Weight category was assigned according to CDC definitions: underweight (< 5th percentile), healthy weight (5th – < 85th percentile), overweight (85th – < 95th percentile), or obese (≥ 95th percentile) [16].

**Demographics**

Baseline demographic characteristics were collected using students’ school files [5]. The following variables were examined as covariates in data analysis: sex (male or female), race (black, white, and other), weight category (underweight, healthy weight, overweight, and obese), and school.

**Physical Activity**

Physical activity, included in analyses as a covariate, was assessed using one question from the SEAT questionnaire. The question asked, “How many days each week are you physically active for at least 60 minutes each day? Add up all the time you spend doing any kind of physical activity that increases your heart rate and makes you breathe harder.” Participants were instructed to select one response, 0–7, in days per week.

**Data Analysis**

Descriptive statistics were used for each of the study variables, including medians, means, and standard deviations (SDs) for quantitative variables and frequencies and percentages for categorical variables. Spearman’s correlation analyses were conducted to determine the strength.
and direction of the relationships between the independent variable, screen time, and each of the dependent variables (unhealthy beverage and snack consumption and BMI z-score). We also examined the association with BMI z-score, stratified by weight category. Three separate linear regression analyses were used to examine the association between screen time with 1) sugary beverage consumption, 2) unhealthy snack consumption, and 3) BMI z-score, adjusting for 3 relevant covariates: physical activity, sex, and school.

Sex and racial differences in screen time, unhealthy beverage and snack consumption, and BMI z-score were examined using 2-sample t-test and one-way ANOVA. Due to the ordinal nature of the self-reported variables, we also conducted non-parametric analyses for sex and racial differences using the Wilcoxon and Kruskal-Wallis tests. Since the P values from non-parametric tests were very similar to those from parametric tests, only results from the t-test and ANOVA were reported. A significance level of .05 was adopted for all statistical tests. All data analyses for this study were conducted using SAS 9.4 (SAS Institute, Cary, North Carolina).

Results

A total of 2,763 participants from 26 middle schools completed all measures and did not opt out of the evaluation. This represented 76% of all participants (2,763/3,630 total). Descriptive statistics are shown in Table 2. Across the 26 schools, 24–201 (mean = 106) students participated from each school. The distribution of males (50.1%) and females (49.9%) in the sample was relatively evenly split. Nearly half (48%) of the participants were white and 33% were black. Overall, half of the participants were at a healthy weight (51%), the mean BMI percentile was the 72nd percentile and the mean BMI z-score was 0.81. The mean hours of reported total screen time was converted into hours per year (1,312) and hours per week (25) (see Table 3). Total sugary beverage consumption was calculated as times consumed per year (mean = 2,073) and times consumed per week (mean = 40); total mean unhealthy snack consumption was 3,485 per year and 67 times per week. Although all analyses were conducted using the per year values, results in Table 3 are also shown per week to aid in interpretation.

Spearman’s coefficient (r = 0.168) for the association between total screen time and total sugary beverages indicated a weak positive relationship that was statistically significant (P < .001). The Spearman’s coefficient (r = 0.237) indicated a slightly stronger positive association between total screen time and total unhealthy snacks, which was also significant (P < .001). However, there was no significant association between total screen time and BMI z-score (r = 0.024; P = .21). The association between total screen time and BMI z-score was statistically significant in the obese group (P = .02), but the strength of association was negligible (r = 0.0872).

On average, boys reported consuming more sugary beverages per year (mean = 2,181; (SD) = 2,208) than girls (mean = 1,965; SD = 2,003), P = .008. However, there was no difference by sex for reported consumption of unhealthy snacks per year: girls (mean = 3,684; SD = 4,847) versus boys (mean = 3,287; SD = 4,703). Analyses did reveal differences in reported consumption based on race. Black participants reported a significantly higher average of total sugary beverage consumption per year (mean = 2,573; SD = 2,254) than either white (mean = 1,877; SD = 2,015) or other (mean = 1,708; SD = 1,932), P < .001, and also a higher average of total unhealthy snack consumption per year (mean = 5,109; SD = 5,693) than either white (mean = 2,691; SD = 3,886) or other (mean = 2,711; SD = 3,973), P < .001.

Table 4 shows the regression coefficients between total screen time and each of the dependent variables, with the covariates, sex, school (to adjust for any school effect), and physical activity. We found a statistically significant positive association between total screen time per year and both total sugary beverage consumption per year (B = 0.4699; 95% CI, 0.3689–0.5709); P < .001) and total snack consumption per year (B = 1.0085; 95% CI, 0.8413–1.1757; P < .001), which suggests that an extra hour of screen time a day is associated with approximately 172 extra servings of sugary beverages per year (3.3 extra servings per week, or 0.5 extra servings per day) and 368 extra servings of unhealthy snacks per year (71 extra servings per week, or 1 extra per day). The relationship between screen time and BMI z-score was not significant (B = -0.00001; 95% CI, -0.00007–0.00005; P = .697).

Discussion

We hypothesized that higher screen time would be associated with increased frequency of total sugary beverage and snack consumption, ultimately contributing to a higher

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**TABLE 2. Baseline Demographic Characteristics of MATCH Participants (N = 2763)**

| Characteristic       | Frequency | Percent (%) |
|----------------------|-----------|-------------|
| **Sex**              |           |             |
| Female               | 1378      | 49.9        |
| Male                 | 1385      | 50.1        |
| **Race**             |           |             |
| White                | 1327      | 48.0        |
| Black                | 913       | 33.0        |
| Other                | 523       | 18.9        |
| **Weight category**  |           |             |
| Underweight          | 66        | 2.40        |
| Healthy weight       | 1410      | 51.0        |
| Overweight           | 566       | 20.5        |
| Obese                | 721       | 26.1        |

| Median (IQR) | Mean (SD) |
|--------------|-----------|
| BMI z-score  | 0.9 (0.09, 1.7) | 0.81 (1.2) |
| BMI percentile | 82.7 (53.5, 95.4) | 71.7 (28.01) |

Note. BMI, body mass index; IQR, interquartile range; SD, standard deviation.
BMI z-score. The relationships between screen time and both beverage and snack consumption were statistically significant. However, there was not a significant association between screen time and BMI z-score.

It should be noted that the measured data from this study indicate a higher prevalence of overweight and obese adolescents compared to the prevalence reported on national measured (NHANES) and state self-reported (YRBS) levels. This finding underscores the importance of our examination of adolescent obesity as a substantial public health problem in North Carolina worthy of more in-depth examination to understand related underlying behaviors. Moreover, although we did not find that screen time was associated with BMI z-score in this sample, the main study findings are 2-fold: 1) reported frequency of consumption of beverages and snacks in North Carolina youth is high, with youth on average consuming drinks 40 times per week and snacks 67 times per week; and 2) total screen time was positively associated with greater beverage and snack consumption. Consumption of unhealthy snacks with increased screen time is important because decreasing one behavior may influence decrease of the other.

Given the high reported intake frequency (40 and 67 times per week respectively for drinks and snacks), it is important to note that the BSQ survey queries intake frequency and not serving frequency. We compared our unhealthy snack and beverage consumption results to other studies with similar samples that used the BSQ. Prior published studies using the BSQ in similar aged students have compared intake at school to intake not at school [17, 18], and have not reported specific or calculated total intake frequency. Thus, we cannot assess if participants responded similarly to other groups in which this tool has been used, and the interpretation of the associations should be emphasized when making conclusions rather than taking the value as representing quantifiable, actual intake.

A recent study examined the frequencies of snacking behaviors and the association with dietary intake and weight status using a food frequency questionnaire administered to middle and high school students [19]. The researchers found significant associations between: 1) higher frequencies of snacking while watching television and 2) daily servings of energy dense/nutrient-poor snacks and BMI z-scores [19]. More research is needed to understand the pathways linking screen time with unhealthy snacking behavior in adolescents to inform future interventions.

Since our results indicated that total screen time was not associated with BMI z-score in this sample, there may be other behavioral, environmental, and/or emotional factors that should be considered when examining this relationship. Deeper investigation into the relationship between screen time and BMI, as well as the intermediate association with unhealthy dietary practices, is needed. Since the MATCH program’s measurement tool did not include an item to evaluate each form of screen use individually (ie, television, computer, tablet, video games, cell phone), we were unable to draw conclusions about whether a form of screen use less conducive to concurrent snacking, like video game use that engages the hands, was the highest contributor to higher screen time. Also, since the screen time item used in the SEAT questionnaire does not ask students to identify whether reported screen time was for academic or recreational purposes, or on weekdays versus weekend days, we were unable to draw conclusions about the likely...
hood of some types or timing of screen use activities being associated with unhealthy dietary consumption as opposed to other screen use activities.

Inclusion of physical activity as a covariate did not provide any further insight about why we found a relationship between screen time and unhealthy dietary consumption but not with BMI z-score. A previous study by Lowry and colleagues found a positive association between adolescent daily physical activity and sugary beverage consumption, as well as an association between TV/computer/video game use and increased consumption of unhealthy foods and beverages [20]. An examination of this prior study’s results suggests that dietary behaviors are related to physical activity and sedentary behaviors (ie, screen use) [20]. Another prior study suggests that high screen time may be a strong indicator of inadequate physical activity [8].

Limitations

This study has several limitations. With the MATCH data collected in all southern, rural settings, and data from only select North Carolina public middle schools, and not private or home schools, the results may not be generalizable. The survey questions used also present limitations. As mentioned above, the BSQ questions assess intake frequency and not actual servings, so results cannot be used to estimate quantity of intake. The SEAT questionnaire is limited because the screen time question does not differentiate between types or timing, of screen time and it relies on self-reported data from 7th-grade students. Examining screen time with separate questions for method and timing of use (eg, television, computer, tablet, video games, cell phone; weekday versus weekend) as opposed to using the total screen time question may have provided a richer explanation of which types of screen time may influence dietary consumption. Results were calculated on an annual basis for analytic and comparison purposes, but the measures were cross-sectional, so results should not be used to draw conclusions about behaviors on an ongoing basis. Strengths of the study include the relatively large number of schools that can provide a good representation of the state’s 7th-grade students and their health behaviors, use of validated nutrition questions, and the focus on a specific adolescent population. Also, the sample focused on some of the highest risk groups (rural and black) for obesity.

Conclusion

Public health efforts to implement adolescent obesity prevention interventions may be improved with an understanding of how dietary behaviors and screen time are related and contribute to the risk of adolescent obesity. The current study’s results can inform the MATCH team as they consider additional program components related to screen time and unhealthy dietary behaviors. MATCH may benefit from changing current lessons and adding emphasis about the potential effects of screen time on unhealthy dietary behaviors and the importance of limiting discretionary and non-educational forms of screen time for a healthier lifestyle. Increasing the number of lessons about screen time may influence students’ beverage and snack consumption. Further research is necessary to examine the influences that physical activity, demographic characteristics, environmental factors, and behaviors have on dietary consumption and BMI outcomes.

Kristie Hicks, MPH, CHES lifestyle coach, Minority Diabetes Prevention Program; nutrition graduate assistant, Brody School of Medicine, East Carolina University, Greenville, North Carolina.

Stephanie Jilcott Pitts, PhD associate professor, Department of Public Health, Brody School of Medicine, East Carolina University, Greenville, North Carolina.

Suzanne Lazorick, MD, MPH, FAAP associate professor of pediatrics and public health, ECU Pediatric Healthy Weight Research and Treatment Center, Brody School of Medicine, East Carolina University, Greenville, North Carolina.

Xiangming Fang, PhD associate professor, Department of Biostatics, College of Allied Health Sciences, East Carolina University, Greenville, North Carolina.

Ann Rafferty, PhD teaching associate professor, Department of Public Health, Brody School of Medicine, East Carolina University, Greenville, North Carolina.

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